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Abstract

This paper studies the optimal income redistribution and optimal monitoring when disability benefits are intended for disabled people but some of the disabled do not claim disability benefits and enter the labor force. Classification errors also occur. Some able applicants with high distaste for work are falsely granted disability benefits (type II errors) and some disabled applicants are denied disability benefits (type I errors). The accuracy of monitoring depends on the resources devoted to it. Labor supply responses are at the extensive margin. The paper derives the optimal income tax-transfer schedule that incorporates welfare and disability benefits and takes into account monitoring costs. The cost of monitoring and the co-existence of welfare and disability benefits play in favor of Earned Income Tax Credits for disabled workers who forgo disability benefits as well as for disabled workers who forgo welfare assistance.

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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.[1] This paper integrates classification errors of type II (i.e. able people who falsely claim to be disabled and receive disability benefits) with classification errors of type I (i.e. applicants who are truly disabled but fail to qualify hence are rejected from disability assistance). According to empirical evidence, both type I and type II error rates in the U.S. disability programs are substantial. While there is some disagreement in the literature regarding the magnitude of the type I error rate (with estimates ranging from about 20% to almost 60%), most studies tend to consider that the type II error rate is about 20% (see, e.g., Nagi, 1969; Smith and Lilienfeld, 1971; Benitez-Silva *et al.*, 2011).

A large empirical literature has analyzed incomplete take-up among intended recipients in various programs and has emphasized a huge variation in participation across different programs (see, e.g., Moffitt, 2003, Currie, 2006). In EU countries, about 30% of people who report severe disability do not get disability benefits and work (Eurostat, 2001). Some disability benefits programs contain perverse incentives that exclude disabled persons with partial work capacity from the labor market, as carefully detailled in OECD (2009). To be consistent with these pieces of evidence, we endogenize take-up[2] so that people with relatively low degrees of disability are deterred from disability assistance and enter the labor force while those with relatively higher degrees of disability claim disability benefits. Here non-take-up is defined as disabled people who do not apply for disability benefits and enter the labor force which contrasts with more standard models of take-up. In the latter, their labor supply decision is identical whether they claim or not benefits (see e.g., Moffitt, 1983).[3]

In our model, disability benefits co-exist with welfare benefits, the former are targeted benefits (Akerlof, 1978) conditional on disability status while the latter are solely dependent on reported income and delivered through the income tax schedule, as standard in the tax literature (see e.g., Mirrlees 1971, Stiglitz 1987, Boadway, Marceau and Sato 1999). People who do not work and who do not receive disability benefits receive welfare benefits.[4]

The model assumes that individuals are distributed over two private characteristics: their individual productivity on the one hand, and their disutility when working on the other hand. The distributions of both characteristics are common knowledge. Individual productivity is distributed over two values (high and low), whereas the disutility when working is continuous. Moreover, individuals are either disabled or able, and their disability status is perfectly correlated with their productivity. Thus, a disabled (able) individual will always have a low (high) productivity.

[1] 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.

[2] Jacquet and Van der Linden (2006) already introduce endogenous and imperfect take-up into the tagging model of Akerlof (1978). Some eligible are deterred from applying by the losses involved in feeling and being stigmatized (stigma being heterogeneous among claimants). Kleven and Kopczuk (2011) also endogenize take-up and model that complexity deters some of the eligible.

[3] In the tagging literature, take-up is usually exogenous but this literature also relies on the assumption that all eligible people, whether they are tagged or untagged, do work (as in Akerlof, 1978), or that all eligible do not work (see, e.g., Parsons, 1996 and Salanié, 2002).

[4] The welfare benefit is also called demogrant in the tax literature (e.g., Salanié 2002).

Following, e.g., Cuff (2000), the disutility when working of the disabled is due to their physical or mental pain associated with work. The disutility when working of the able is caused by distaste for work. People are held responsible for their taste for work but not for their pain when working due to disability (see, e.g., Arneson (1990), Roemer (1998)). This distinction allows for a clear boundary between people who are eligible for disability benefits (that is, the disabled) and those who are not (that is, the able).

The analysis is realized under a normative criterion corrected for features that individuals are responsible for (e.g., Schokkaert *et al.*, 2004 and Cremer *et al.,* 2007). 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.

The government observes neither the individual disability status nor the disutility parameters. It only observes the income levels. Redistribution policy is then limited by incentive constraints that must be satisfied if individuals are to reveal their true types (Mirrlees, 1971). We build on Akerlof (1978) who shows that incentive compatibility constraints can be relaxed by relying on the observation of disability status (or other characteristics, the so-called 'tags', correlated with agents' productivity) for a subset of the disabled population.[5] In our model, individuals who choose to apply for disability assistance are monitored and their disability status is imperfectly observed.[6] Even if monitoring (tagging) is not perfect, redistribution can be enhanced by giving more to the non-employed who are tagged as disabled than to the non-employed who, rejected from disability assistance, end up on welfare assistance. This has been shown in e.g., Diamond and Sheshinski (1995), Parsons (1996) and Salanié (2002). This literature assumes fixed type I and II error rates, i.e. an exogenous monitoring technology. This paper differs from the existing literature by endogenizing the monitoring technology.[7]

Our model allows to cast light on three important redistributive issues.

First, endogenizing take-up, monitoring and other behavioral responses provides a clear understanding of the key economic effects underlying the optimal tax formulae. Compared to a world with full take-up of disability benefits, it becomes optimal to provide incentives to work for some disabled individuals (whose degree of disability does not prevent them to work in a low-paid job). Since monitoring costs make inactivity more expensive, financial incentives are needed to reduce

[5] Diamond and Sheshinski (1995), Parsons (1996) and Salanié (2002) show that redistribution can be enhanced by giving more to those who are monitored as disabled, even if the screening is imperfect.

[6] 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 (monitoring) 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.

[7] 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. A recent paper by Kleven and Kopczuk (2011) also endogenizes monitoring. The authors study the optimal complexity of transfer program when type I and type II errors co-exist with non-take-up which is induced by the complexity of the transfer program. However, their model does not allow to provide any insight regarding the optimal tax and transfer schedule and the induced distortions simply because no tax revenue is modeled, benefits are exogenously financed and because monitoring is assumed costless.

inactivity. Therefore, introducing endogenous monitoring into the tax model reduces the participation tax (defined as the tax the worker pays plus the welfare benefit) on disabled and able workers. It also reduces the sum of the tax in low-skilled jobs with the disability benefit.

Second, it highlights when it becomes optimal to provide these disabled with substantial financial incentives to work. 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 non-employed 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 and disability benefits, the literature has well established that when labor supply responses are modeled along the extensive margin, a marginal social welfare weight lower (larger) than one on disabled workers who forgo welfare assistance implies an 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 (who forgo welfare assistance) does not preclude an EITC. An EITC provides work incentives that, by reducing the number of applicants for benefits, reduce monitoring costs. Consequently, an EITC is optimal for a greater array of model parameters than in a pure tax-transfer model. This paper also shows that a marginal social welfare weight on recipients of disability benefits lower than one implies an EITC for disabled workers who forgo welfare assistance but also for disabled workers who forgo disability assistance.

Third, relaxing the standard assumption that monitoring, and therefore the probability of errors, is taken as given, this paper highlights that the optimal level of type II errors trades off more tax revenue by reducing the number of cheaters and the cost of monitoring. Moreover, the optimal level of type I errors trades off more tax revenue by increasing the number of type I errors (because monitoring cost is reduced and because some disabled people enter the labor force) and the welfare loss from disabled people who are falsely rejected from disability assistance. As one would expect, when the marginal cost of monitoring is very high, no monitoring is optimal.

These three results are valid under paternalistic preferences and also under a utilitarian criterion, as confirmed in Appendix G.

In the full information economy, under paternalistic utilitarian preferences, there are no type I and type II errors and all able people work whatever their disutility of work, in the full information economy. In asymmetric information, the paper highlights that a costless monitoring technology that would perfectly screen between disabled and able applicants and would enforce all able to work is not optimal. 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.

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. The appendix provides the optimal tax schedules under utilitarian preferences.

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).[8] 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. It is assumed that w_H-workers may work in either low skilled or high skilled jobs, but w_L-workers may work only in low skilled jobs.

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, 2011) while most estimates of hours of work elasticities conditional on working are small (Blundell and MaCurdy, 1999). Utility is quasilinear and represented by:

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

where x is consumption, $v(x) : \mathbb{R}^+ \to \mathbb{R} : x \to v(x)$ with $v' > 0 \geq v''$ and $\lim_{x\to\infty} v'(x) = 0$ and δ is a parameter measuring disutility when working. 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 $F(\delta_d) : \mathbb{R}^+ \to [0,1] : \delta_d \to F(\delta_d)$ 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 $G(\delta_a) : \mathbb{R}^+ \to [0,1] : \delta_a \to G(\delta_a)$ and the corresponding (continuous and positive) density function $g(\delta_a)$. Individual characteristics are private information to each person while the distribution thereof is assumed to be public information.

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. Following Harkness (1993), Cuff (2000) and Marchand *et al.* (2003), we assume that δ_d measures disutility when working as a result of the degree of disability, i.e., the intensity of the physical or mental pain associated with work when disabled. By contrast, 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 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.[9] This creates a

[8] We want to see whether an EITC or an 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.

[9] It is possible to follow the suggestion by Pestieau and Racionero (2009) to disentangle the disabled's parameter

clear boundary between eligible (disabled) and noneligible (able) applicants for disability benefits. This boundary is helpful to clearly highlight the effects of errors in distributing disability benefits.

Disability benefits are aimed at disabled people who do not work. By contrast, the non-employed who do not receive disability benefits receive welfare benefits that are provided without any condition on their disability status (hence, without monitoring). Welfare benefits are the usual transfers for people at the bottom of the earnings distribution in the tax model without tagging.

The model allows that some individuals do not apply for benefits they are eligible for (and enter the labor force). Stigma is a possible explanation for incomplete take-up. Incorporating take-up costs does not modify our main qualitative results and simply adds a new term in some of the optimal tax formulae.[10] Here, we neglect take-up costs to avoid additional complexity in our already quite general model that does not substantially modify the analytical results.

2.2 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). When an individual applies for disability benefits, she is monitored by the disability agency. The monitoring technology is only informative about the disability classification (neither about precise health status δ_d, nor about attitudes to work δ_a).

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 classification errors of type I (rejection errors) and by classification errors of type II (award errors).

Differing from the existing literature (Stern, 1982; Diamond and Sheshinski, 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 q ("false positive"), i.e., the higher the precision with which an able agent claiming disability benefits is detected. Similarly, the higher is M, the lower is the probability of type I error p ("false negative"), i.e., the higher the precision with which a disabled agent claiming disability benefits is rejected. Formally, the per capita cost of monitoring, $M(p, q)$, depends on the precision of the monitoring technology with $\partial M/\partial p < 0$, $\partial M/\partial q < 0$, $\partial^2 M/\partial p^2 \geqslant 0$, $\partial^2 M/\partial q^2 \geqslant 0$ and a definite negative Hessian matrix of $M(p, q)$ with $M(p, q) : [0, 1) \times [0, 1) \mapsto \mathbb{R}^+ \times \mathbb{R}^+$.[11] As emphasized in the introduction, estimations of the levels of type I and type II error rates in the U.S. disability programs differ. For example, Smith and Lilienfeld (1971) sent back for review by the U.S. Social Security Administration (SSA)'s own Bureau of Disability Insurance a sample of 250 cases initially allowed the preceding year and of 248 cases initially denied. The redeterminations

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.

[10] This is shown in the working paper Jacquet (2010). In the latter paper, the utility when not working is $v(x) - \sigma$ where σ denotes the (endogenous) reputational stigma à la Besley and Coate (1992) or the take-up cost of snowball (i.e., the take-up by undeserving implies a snowball effect on the take-up by the deserving).

[11] We also assume that $\lim_{(p,q)\to(1,0)} M(p, q) = 0$. Having $p = 1$ and $q = 0$ corresponds to the situation where none of the applicants receive disability benefits. Therefore, nobody will actually claim disability benefits and the disability benefit will not be observed. Monitoring is then assumed costless. The model boils down to a standard nonlinear income tax system (without tagging) so that welfare benefits are provided to all non-employed people. Similarly, we also assume that $\lim_{(p,q)\to(0,1)} M(p, q) = 0$. Intuitively, providing benefits to all applicants implies that the level of type II error is maximal ($q = 1$) but there is no type I error ($p = 0$). Since this does not require any screening, the cost per applicant can be assumed to be nil, i.e. $M(0, 1) = 0$. Finally, $\lim_{(p,q)\to(0,0)} M(p, q) = +\infty$.

indicate a type I error rate of 22.5% and a type II error rate, quite close, of 21.2%. Nagi (1969) submitted a sample of 2454 disability insurance cases (1434 of which had been initially allowed and 1020 initially denied by the SSA) to a group of independent clinical experts. The latter found a type I error rate of 48% and a (much lower) type II error rate of 19%. A reexamination of the cases by the SSA in the light of the additional information provided by the external audit led to 20.8% of the denials being changed to allowances (type I errors) and 8.2% of the initial allowances being changed to denials (type II errors). A more recent study by Benitez-Silva *et al.* (2011) estimate the type I error rate in the US Social Security disability award processes to be about 60% and the type II error rate to about 20%.

This model analyzes the choice of monitoring expenditures (M), that is equivalent to choosing the levels of type I and type II errors (p and q respectively). If monitoring were perfect, the disability agency would perfectly observe the disability (ability) status of $w_L(w_H)$-claimants and hence their lower (higher) productivity but not the individual δ_d or δ_a.

3 Full information

Under full information (so-called first-best), the disability agencies have no role to play, there is no monitoring, no type I and type II errors. 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 $\ell_H(\delta_a) : \mathbb{R}^+ \to \{0,1\} : \ell_H(\delta_a) = 1$ ($\ell_H(\delta_a) = 0$) 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 raise 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

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

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

Appendix G presents results under utilitarian preferences. In the core of this paper, however, our 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

$$\begin{aligned} P \equiv &N_d \left[\int_0^\infty \left[\ell_L(\delta_d)(v(x_L^w(\delta_d)) - \delta_d) + (1 - \ell_L(\delta_d)) v(x_L^u(\delta_d)) \right] dF(\delta_d) \right] \\ &+ N_a \left[\int_0^\infty \left[\ell_H(\delta_a) v(x_H^w(\delta_a)) + (1 - \ell_H(\delta_a)) v(x_H^u(\delta_a)) \right] dG(\delta_\alpha) \right] \end{aligned} \quad (1)$$

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 do not use, in their objective functions, 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.

For comparison, Appendix G shows that our main analytical results are still valid under utilitarian preferences.

Under the paternalistic utilitarian objective function (1), all that matters is the sum of utilities except that the levels of disutility of work δ_a are not taken into account. This section presents the optimum when full information prevails. The optimum is characterized as follows.

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.*

A proof is given in Appendix A and the intuition is as follows. In full information, 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. The tax system then redistributes from able individuals toward disabled ones because the former have a larger productivity. 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. All able individuals are then treated the same by the tax system, whatever their individual level of δ_a. Compared to the outcome we would get under utilitarian preferences, the level of redistribution from the able group towards the disabled group is reinforced due to the non-inclusion of δ_a in the paternalistic objective function. Under utilitarianism, not all able people work (see Appendix G) while, under the paternalistic criterion, all able people do 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 $\overline{\delta}_d$ such that those with $\delta_d > \overline{\delta}_d$ do not work and those with $\delta_d \leq \overline{\delta}_d$ do work. $\overline{\delta}_d$ 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., $\overline{\delta}_d = v'(\overline{x})w_L$ with $\overline{x}$ denoting the consumption level. There is then also some redistribution going on within the group of disabled people. Since the levels of disutility due to disability δ_d are included into the objective function, all disabled people are not treated the same by the tax system. Redistribution takes place from the disabled workers toward the disabled inactive.

Finally, since the consumption level is the same for everyone, 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.

The full information optimum may assist in grasping the redistributive motives of our model. First, redistribution takes place from the able people toward the disabled because of the skill heterogeneity. Second, because δ_a is not encapsulated in the paternalistic utilitarian preferences, all able agents (whatever their level of δ_a) do work, under full information. Third, redistribution takes place within the disabled because of the heterogeneity in their δ_d levels.

4 Asymmetric Information

Under asymmetric information, the tax authority is only able to observe income levels and thus can condition taxation only on income. In this context, the government provides a welfare benefit to individuals who do not work.

When monitoring is introduced, disability agencies have access to more information than the tax authority. When an individual applies for disability benefits, the disability agency can test the claimant and obtains more information on her ability versus disability status. However, disability agencies do not observe either δ_d or δ_a. A non-employed applicant who is screened by the disability agency as disabled receives a disability benefit x_D. The other non-employed receive welfare benefits x_W.

The government decides over four consumption bundles: x_D for beneficiaries of disability benefits, x_W for welfare beneficiaries, x_L for workers in low-skilled jobs, x_H for workers in high-skilled jobs and the optimal levels of type I errors (p) and of type II errors (q).

Able workers can work either in a low or high-skilled job depending on $\max\{v(x_L) - \delta_a, v(x_H) - \delta_a\}$. However, since our objective functions are increasing in individuals' consumption, it will never be optimal that able people work in low-skilled jobs. A formal proof is given in Appendix B. By putting able workers in high-skilled jobs instead, they produce more that can be used to increase everyone's consumption in a way that respects the set of incentive compatibility constraints and hence increases social objective value. Consequently, to induce high-skilled people to work in high-skilled jobs,

$$x_H \geq x_L, \tag{2}$$

since the individual aversion to work δ_a is the same in both jobs. Equation (2) implies that only disabled people work in low-skilled jobs at the optimum. Therefore, these workers are perfectly tagged as disabled.

4.1 Individual decisions and threshold values

An individual decides to apply or not for disability benefits. If they apply, there is some probability they get a disability benefit (they are deemed ineligible for the disability benefit), this probability is q $(1-q)$ for able individuals and $1-p$ (p) for disabled applicants. When the applicant is rejected, she faces two choices, go to work and get $v(x_X) - \delta_y$ (with $(X, y) = (L, d)$ for disabled agents or $(X, y) = (H, a)$ for able agents) or go on welfare (and do not work) and get the welfare benefit x_W.[12]

[12] The model does not allow for fines of getting caught because there is no fine in practice.

We now analyze the decisions of disabled agents formally and graphically. Each disabled individual chooses, depending on her level of δ_d, according to

$$\max\left\{v\left(x_L\right)-\delta_d, v\left(x_W\right), \left(1-p\right)v\left(x_D\right)+p\max\left(v\left(x_L\right)-\delta_d, v\left(x_W\right)\right)\right\}.$$

For each value of δ_d, the utility of the disabled individual when she chooses to work, $v\left(x_L\right)-\delta_d$, is indicated by the plain line on Figure 1 and is decreasing with δ_d. The utility on welfare, $v\left(x_W\right)$ is represented by the (horizontal) dotted line on Figure 1. Therefore, the dotted line intersects the plain line and we denote by $\widehat{\delta}_d$ the level of δ_d where this intersection occurs, i.e. where

$$\widehat{\delta}_d = v(x_L) - v(x_W). \tag{3}$$

The hyphenated curve represents the utility of applicants. It is decreasing when $\delta_d \leq \widehat{\delta}_d$ with a lower slope that the plain line $\left(v\left(x_L\right)-\delta_d\right)$ because its expression is $\left(1-p\right)v\left(x_D\right)+p\left(v\left(x_L\right)-\delta_d\right)$. The hyphenated curve is horizontal when $\delta_d > \widehat{\delta}_d$ because its expression then becomes $\left(1-p\right)v\left(x_D\right)+pv\left(x_W\right)$. Disability benefits are then at least as large as welfare benefits,

$$x_D \geq x_W, \tag{4}$$

otherwise, the hyphenated curve in Figure 1 would always be below the plane curve $v(x_L)-\delta_d$ or the dotted curve $v(x_W)$ so that no agent would ever apply for disability benefits.

Moreover, we easily see from Figure 1 that the threshold value $\widehat{\delta}_d$ characterizes disabled agents who, when rejected from disability assistance (with a probability p), are indifferent between working in low-skilled jobs and being on welfare assistance, i.e.

$$\left(1-p\right)v(x_D)+p\left[v(x_L)-\widehat{\delta}_d\right] = \left(1-p\right)v(x_D)+pv(x_W)$$

which can be rewritten as equation (3). Disabled agents with disutilities of labor above this threshold value will go on welfare when rejected from disability assistance since $v\left(x_L\right)-\delta_d < v\left(x_W\right)$ when $\delta_d > \widehat{\delta}_d$.

Similarly, we can define the threshold value $\widetilde{\delta}_d$ characterizing disabled agents who are indifferent between $v(x_L)-\delta_d$ in a low-skilled job on the one hand, and $v(x_D)$ on disability assistance or $v(x_L)-\delta_\delta$ (with probabilities $1-p$ and p, respectively) on the other hand, i.e.[13]

$$\begin{aligned} & v(x_L)-\widetilde{\delta}_d = p\left[v(x_L)-\widetilde{\delta}_d\right]+\left(1-p\right)v\left(x_D\right) \\ & \Leftrightarrow \widetilde{\delta}_d = v(x_L)-v(x_D) \end{aligned} \tag{5}$$

The choice of disabled agents to claim or not disability benefits does not depend on the probability p. For agents whose $\delta_d \in \left(\widetilde{\delta}_d, \infty\right)$, 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, $v\left(x_L\right)-\delta_d$. Therefore, p does not drive the decision to apply or not for benefits.[14]

TO INSERT FIGURE 1 ABOUT HERE

[13] Recall that we assume $\delta_d \in [0, +\infty)$, however, more generally, this intersection could take place for a negative value of δ_d. In this case, we would have a corner solution where all disabled people apply for disability benefits.

[14] In this model, the decision to work or to apply for disability is independent of p and tagging forces disabled with $\delta_d > \widetilde{\delta}_d$ to work with probability p. We might alternatively think that disabled people are more likely to apply for disability benefits the greater the chance of getting them, i.e. p being lower. One way to model this could be to

A figure very similar to Figure 1 and a similar analysis to the one above could be drawn to highlight the choices of the able people. It would consist in substituting p, x_L, $\widetilde{\delta}_d$, $\widehat{\delta}_d$ with $1-q$, x_H, $\widetilde{\delta}_a$, $\widehat{\delta}_a$, respectively. It is skipped here and we directly provide the threshold values.

The threshold $\widetilde{\delta}_a$ characterizes able individuals indifferent between working in high-skilled job on the one hand, and $v(x_D)$ on disability assistance or $v(x_H)-\delta_a$ (with probabilities q and $1-q$, respectively) on the other hand:

$$v(x_H)-\widetilde{\delta}_a=(1-q)\left[v(x_H)-\widetilde{\delta}_a\right]+qv(x_D)$$
$$\Leftrightarrow \widetilde{\delta}_a=v(x_H)-v(x_D) \tag{6}$$

Similarly, another threshold value $\widehat{\delta}_a$ characterizes able agents who apply for disability benefits and are indifferent between going back to work and being on welfare, i.e.:

$$qv(x_D)+(1-q)\left[v(x_H)-\widehat{\delta}_a\right]=qv(x_D)+(1-q)\,v(x_W)$$
$$\Leftrightarrow \widehat{\delta}_a=v(x_H)-v(x_W). \tag{7}$$

Since disability benefits are greater than welfare benefits (4), we have $\widetilde{\delta}_a\leq\widehat{\delta}_a$ from (6) and (7) and $\widetilde{\delta}_d\leq\widehat{\delta}_d$ from (3) and (5). Since consumption in high-skilled jobs is larger than in low-skilled jobs (see (2)), we also obtain $\widetilde{\delta}_a\geq\widetilde{\delta}_d$ and $\widehat{\delta}_a\geq\widehat{\delta}_d$. Moreover, from (5)-(7), we obtain $\widehat{\delta}_a-\widetilde{\delta}_a=\widehat{\delta}_d-\widetilde{\delta}_d$. Figure 2 summarizes choices of individuals, densities and threshold levels.

TO INSERT FIGURE 2 ABOUT HERE

Lemma 1 points out that in both ability groups, there are people who work and people who do not work.

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

Appendix C provides the proof.

4.2 Ranking of consumption levels and distribution of individuals in the population

From (5) and $\widetilde{\delta}_d>0$, we have

$$x_L>x_D.$$

Combined with (2) and (4), the ranking of consumption levels can be summarized as

$$x_H\geq x_L>x_D\geq x_W \tag{8}$$

introduce a cost of applying for disability benefits, $k<1$ as follows:

$$v(x_L)-\widetilde{\delta}_d=pk\left[v(x_L)-\widetilde{\delta}_d\right]+(1-p)\,v\left(x_D\right)$$
$$\widetilde{\delta}_d=v(x_L)-\frac{(1-p)}{1-pk}v\left(x_D\right)$$

so that a higher p increases the number of disabled choosing to work. This would add behavioral responses to the necessary condition (33) that we neglect here.

The government budget constraint can be written as

$$\pi_L^d (w_L - x_L) - (\pi_D^d + \pi_D^a) x_D - (\pi_W^d + \pi_W^a) x_W + \pi_H^a (w_H - x_H) \\ - \left(\frac{\pi_D^d}{1-p} + \frac{\pi_D^a}{q} \right) M(p,q) = -R, \tag{9}$$

where π_W^d is the share of the population that is disabled and being (falsely) rejected from disability assistance end up on welfare, π_W^a is the share of the population that is able and being (correctly) rejected from disability assistance go on welfare, π_L^d is the share of population that is disabled and works, π_D^d is the share of population that is disabled and receives disability benefits, π_D^a is the share of population that is able but unjustifiably collects disability benefits, π_H^a is the proportion of the population that is able and works (it includes the refused undeserving claimants who work). Table 1 displays the proportion of individuals in each position. The per capita cost of monitoring $M(p,q)$ appears ex ante and for any individual who has applied for disability assistance, i.e., for the proportion $N_d \left(1 - F\left(\widetilde{\delta}_d\right)\right) + N_a \left(1 - G\left(\widetilde{\delta}_a\right)\right) = \pi_D^d / (1-p) + \pi_D^a / q$.

	disabled (w_L, δ_d)	able (w_H, δ_a)
recipients of disability benefits	$\pi_D^d \equiv N_d (1-p) \left(1 - F\left(\widetilde{\delta}_d\right)\right)$	$\pi_D^a \equiv N_a q \left(1 - G\left(\widetilde{\delta}_a\right)\right)$
recipients of welfare benefits	$\pi_W^d \equiv N_d p \left(1 - F\left(\widehat{\delta}_d\right)\right)$	$\pi_W^a \equiv N_a (1-q) \left(1 - G\left(\widehat{\delta}_a\right)\right)$
workers	$\pi_L^d \equiv N_d \left[F\left(\widetilde{\delta}_d\right) + p\left(F\left(\widehat{\delta}_d\right) - F\left(\widetilde{\delta}_d\right)\right)\right]$	$\pi_H^a \equiv N_a \left[G\left(\widetilde{\delta}_a\right) + (1-q)\left(G\left(\widehat{\delta}_a\right) - G\left(\widetilde{\delta}_a\right)\right)\right]$

Table 1: Distribution of individuals in the population.

4.3 Elasticity concepts and social marginal welfare weights

To simplify the optimal tax formulae, we can introduce more definitions. Let $T_L \equiv w_L - x_L$, $T_H \equiv w_H - x_H$, $T_W \equiv -x_W$, be the tax paid by people on welfare assistance and $T_D \equiv -x_D$ 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

$$\eta_L \left(x_L, \widetilde{\delta}_d, \widehat{\delta}_d\right) \equiv \frac{x_L}{\pi_L^d} \frac{\partial \pi_L^d}{\partial x_L}, \tag{10}$$

$$\eta_H \left(x_H, \widetilde{\delta}_a, \widehat{\delta}_a\right) \equiv \frac{x_H}{\pi_H^a} \frac{\partial \pi_H^a}{\partial x_H} \tag{11}$$

where $\partial \pi_L^d / \partial x_L = N_d \left[(1-p) f\left(\widetilde{\delta}_d\right) \partial \widetilde{\delta}_d / \partial x_L + p f\left(\widehat{\delta}_d\right) \partial \widehat{\delta}_d / \partial x_L\right]$ with $\partial \widetilde{\delta}_d / \partial x_L = \partial \widehat{\delta}_d / \partial x_L = v'(x_L)$ from (5) and (3) and where $\partial \pi_H^a / \partial x_H = N_a \left[q g\left(\widetilde{\delta}_a\right) \partial \widetilde{\delta}_a / \partial x_H + (1-q) g\left(\widehat{\delta}_a\right) \partial \widehat{\delta}_a / \partial x_H\right]$ with $\partial \widetilde{\delta}_a / \partial x_H = \partial \widehat{\delta}_a / \partial x_H = v'(x_H)$ from (6) and (7). 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. The empirical literature on the participation decisions (e.g., Immervoll et alii (2007) and Meghir and Phillips (2011)) typically estimates the elasticities of participation with respect to the difference between income in employment and in unemployment. For given welfare and disability benefits, η_L and η_H equal these estimated elasticities.

We define the elasticity of the recipients of disability benefits with respect to the benefit x_D as

$$\eta_D\left(x_D,\widetilde{\delta}_d,\widetilde{\delta}_a\right)\equiv\frac{x_D}{\pi_D^d+\pi_D^a}\frac{\partial\left(\pi_D^d+\pi_D^a\right)}{\partial x_D} \tag{12}$$

where $\partial\pi_D^d/\partial x_D = N_d(1-p)f\left(\widetilde{\delta}_d\right)v'(x_D)$ from (5) and $\partial\pi_D^a/\partial x_D = N_a qg\left(\widetilde{\delta}_a\right)v'(x_D)$ from (6). This elasticity measures the percentage of disabled and able people on disability assistance who leave disability assistance when x_D is reduced by 1 percent. Empirical studies such as Parsons (1980), Bound and Waidmann (1992) and Gruber (2000) provide elasticities of labor force nonparticipation with respect to disability benefits. The latter elasticity is however slightly distinct from η_D since it is defined using the percentage of *recipients of disability benefits* entering the labor force instead of the percentage of *workers* entering disability assistance.

We also define three quasi-elasticities. First, the quasi-elasticity of participation without prior application of the disabled workers as

$$\nu_L\left(x_L,\widetilde{\delta}_d,\widehat{\delta}_d\right)\equiv\frac{-x_L}{\pi_L^d}\frac{\partial\pi_D^d}{\partial x_L} \tag{13}$$

where $-\partial\pi_D^d/\partial x_L = N_d(1-p)f\left(\widetilde{\delta}_d\right)v'(x_L)$ which is also equal to $\left(\partial\pi_L^d/\partial\widetilde{\delta}_d\right)\left(\partial\widetilde{\delta}_d/\partial x_L\right)$. This quasi-elasticity measures the percentage of disabled people who directly take low-skilled jobs without applying for disability benefits when x_L increases by 1 percent. Similarly, the quasi-elasticity of participation without prior application of the able workers is defined as

$$\nu_H\left(x_H,\widetilde{\delta}_a,\widehat{\delta}_a\right)\equiv\frac{-x_H}{\pi_H^a}\frac{\partial\pi_D^a}{\partial x_H} \tag{14}$$

where $-\partial\pi_D^a/\partial x_H = N_a qg\left(\widetilde{\delta}_a\right)v'(x_H)$ which is also equal to $\left(\partial\pi_H^a/\partial\widetilde{\delta}_a\right)\left(\partial\widetilde{\delta}_a/\partial x_H\right)$. This quasi-elasticity measures the percentage of able workers who directly take high-skilled jobs without applying for disability benefits when x_H increases by 1 percent. Third, the quasi-elasticity of being on disability assistance of the able people with respect to x_D is defined as

$$\nu_D\left(x_D,\widetilde{\delta}_d,\widetilde{\delta}_a,\widehat{\delta}_a\right)\equiv\frac{x_D}{\pi_D^a+\pi_D^d}\frac{\partial\pi_D^a}{\partial x_D} \tag{15}$$

where $\partial\pi_D^a/\partial x_D = N_a qg\left(\widetilde{\delta}_a\right)v'(x_D)$. This quasi-elasticity measures the percentage of recipients of disability benefits who leave disability assistance for high-skilled jobs when x_D decreases by 1 percent.

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

$$g_L\equiv\frac{v'(x_L)}{\lambda} \tag{16}$$

$$g_H\equiv\frac{v'(x_H)}{\lambda} \tag{17}$$

$$g_D\equiv\frac{v'(x_D)}{\lambda} \tag{18}$$

4.4 The optimal tax schedule

The paternalistic utilitarian preferences $\widetilde{P}$ can be written as

$$\widetilde{P} \equiv N_d \left[\int_0^{\widetilde{\delta}_d} \left(v\left(x_L\right) - \delta_d\right) dF\left(\delta_d\right) + p \int_{\widetilde{\delta}_d}^{\widehat{\delta}_d} \left(v\left(x_L\right) - \delta_d\right) dF\left(\delta_d\right) \right]$$
$$+\pi_H^a v(x_H) + \left(\pi_D^d + \pi_D^a\right) v(x_D) + \left(\pi_W^d + \pi_W^a\right) v(x_W)$$

The Lagrangian states as

$$\widetilde{\mathcal{L}} \equiv \widetilde{P} + \lambda \Big[\pi_L^d \left(w_L - x_L\right) - \left(\pi_D^d + \pi_D^a\right) x_D - \left(\pi_W^d + \pi_W^a\right) x_W + \pi_H^a \left(w_H - x_H\right) - \left(\frac{\pi_D^d}{1-p} + \frac{\pi_D^a}{q} \right) M(p,q) + R \Big], \tag{19}$$

where $\widetilde{\delta}_a$, $\widehat{\delta}_a$, $\widetilde{\delta}_d$, $\widehat{\delta}_d$ are given by (6)-(3).

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

$$g_A \equiv \frac{\pi_L^d}{v'(x_L)} + \frac{\pi_H^a}{v'(x_H)} + \frac{\pi_D^d + \pi_D^a}{v'(x_D)} + \frac{\pi_W^d + \pi_W^a}{v'(x_W)}. \tag{20}$$

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

$$D \equiv \frac{\widetilde{P}_{x_L}}{v'(x_L)} + \frac{\widetilde{P}_{x_H}}{v'(x_H)} + \frac{\widetilde{P}_{x_D}}{v'\left(x_D\right)} + \frac{\widetilde{P}_{x_W}}{v'\left(x_W\right)}. \tag{21}$$

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

Proposition 2 *Under asymmetric information, the optimal levels of consumption, type I and type II errors satisfy the budget constraint (9) and the following six equations:*

$$\frac{T_L - T_W}{x_L} = \frac{1}{\eta_L} \left[1 - g_L - \frac{\nu_L}{x_L} \left(\frac{M(p,q)}{1-p} + T_W - T_D \right) \right] \tag{22}$$

$$\frac{T_H - T_W}{x_H} = \frac{1}{\eta_H} \left[1 - g_H - \frac{\nu_H}{x_H} \left(\frac{M(p,q)}{q} + T_W - T_D + \frac{qg\left(\widetilde{\delta}_a\right)\widetilde{\delta}_a + (1-q)\, g\left(\widehat{\delta}_a\right)\widehat{\delta}_a}{\lambda q g\left(\widetilde{\delta}_a\right)} \right) \right] \tag{23}$$

$$\frac{T_L - T_D}{x_D} = \frac{1}{\eta_D} \left[g_D - 1 - \left[\frac{M(p,q)\left[N_d f\left(\widetilde{\delta}_d\right) + N_a g\left(\widetilde{\delta}_a\right)\right] v'\left(x_D\right)}{N_d\left(1-p\right)\left(1 - F\left(\widetilde{\delta}_d\right)\right) + N_a q \left(1 - G\left(\widetilde{\delta}_a\right)\right)} + \frac{\nu_D}{x_D}\left(T_H - T_L\right) + \frac{N_a q g\left(\widetilde{\delta}_a\right)\widetilde{\delta}_a v'\left(x_D\right)}{\lambda\left[N_d\left(1-p\right)\left(1 - F\left(\widetilde{\delta}_d\right)\right) + N_a q \left(1 - G\left(\widetilde{\delta}_a\right)\right)\right]} \right] \right] \tag{24}$$

$$\lambda^{-1} = g_A / D \tag{25}$$

and

$$(1-p)\frac{\partial \widetilde{\mathcal{L}}}{\partial p} = 0 \text{ and } \frac{\partial \widetilde{\mathcal{L}}}{\partial p} \geq 0 \tag{26}$$

$$(1-q)\frac{\partial \widetilde{\mathcal{L}}}{\partial q} = 0 \text{ and } \frac{\partial \widetilde{\mathcal{L}}}{\partial q} \geq 0 \tag{27}$$

We interpret each equation in turn. This allows us to highlight the key economic effects underlying the optimal tax profile. In particular, it emphasizes the new effects that appear in comparison with the standard tax model without disability assistance and monitoring.

First-order condition with respect to x_L, (22)

To interpret Equation (22), consider a small increase in consumption x_L (i.e., a small reduction of the income tax in low-skilled jobs), around the optimal tax schedule. This creates a mechanical effect and behavioral (labor supply response) effects. The mechanical effect is $\pi_L^d (g_L - 1)\, dx_L$ that is, a mechanical decrease in tax revenue equal to $-\pi_L^d dx_L$ and a mechanical welfare gain (expressed in terms of the value of public funds), $g_L \pi_L^d dx_L$, since the social welfare of disabled workers increases by their marginal social welfare weight g_L. Three behavioral responses also take place. The change $dx_L > 0$ induces $N_d (1-p) f\left(\widetilde{\delta}_d\right)\left(\partial \widetilde{\delta}_d / \partial x_L\right)$ (pivotal) disability benefits' recipients to directly enter the labor force (without even applying for disability assistance) and $N_d p f\left(\widetilde{\delta}_d\right)\left(\partial \widetilde{\delta}_d / \partial x_L\right)$ disabled workers, who previously chose to work when rejected from disability assistance, to work directly (without even applying for disability benefits). Each of the latter induces a gain of $M(p,q)$ in government revenue. Each of the former induces a gain in government revenue equal to $w_L - x_L + x_D + M(p,q) \equiv T_L - T_D + M(p,q)$. That is the tax paid by each disabled worker (T_L) and the savings from the benefits no longer paid to her as disabled recipient ($-T_D$), as well as the associated cost of monitoring ($M(p,q)$). The third behavioral response comes from $N_d p f\left(\widehat{\delta}_d\right)\left(\partial \widehat{\delta}_d / \partial x_L\right)$ (pivotal) welfare recipients rejected from disability assistance who now work rather than going on welfare. The gain in tax revenue for each of them is equal to $w_L - x_L + x_W \equiv T_L - T_W$. That is the tax paid by each disabled worker (T_L) and the saving from the welfare benefit no longer paid to her ($-T_W$). At the optimum, the sum of all these mechanical and behavioral effects equals zero and gives

$$\pi_L^d (g_L - 1) + N_d (1-p) f\left(\widetilde{\delta}_d\right)\left(\partial \widetilde{\delta}_d / \partial x_L\right)\left(T_L - T_D + \frac{M(p,q)}{1-p}\right)$$
$$+ N_d p f\left(\widehat{\delta}_d\right)\left(\partial \widehat{\delta}_d / \partial x_L\right)(T_L - T_W) = 0 \tag{28}$$

From the Lagrangian (19), it is straightforward to check that this expression is the first-order condition with respect to x_L. Adding (subtracting) $N_d (1-p) f\left(\widetilde{\delta}_d\right)\left(\partial \widetilde{\delta}_d / \partial x_L\right)(T_L - T_W)$ to the last (second) term of the L.H.S. of (28) and using the elasticity (10) as well as (13) allows to rewrite the previous equation as (22).

The term $(1 - g_L)/\eta_L$ in (22) is the *classic equity-efficiency tradeoff* in the model without neither monitoring nor disability assistance. Assuming there is no disability assistance, no monitoring hence substituting $M(p,q) = 0$, $p = 0$ and $T_W = T_D$ in (22) yields the standard optimal tax schedule with extensive responses (Diamond, 1980; Saez, 2002), i.e.

$$\frac{T_L - T_W}{x_L} = \frac{1 - g_L}{\eta_L} \tag{29}$$

The participation tax on disabled workers, $T_L - T_W$, is inversely related to the participation elasticity η_L in the vein of the inverse elasticity rule of Ramsey. Similarly, the financial incentive to enter the labor force increases (hence the participation tax, $T_L - T_W$, decreases) with the marginal social welfare weight of (disabled) workers (g_L).

The other terms, $-(\nu_L/x_L)(M(p,q)/(1-p) + T_W - T_D)$, in (22) represent the *screening (or tagging) role*. Comparing Equations (29) and (22), we see that the model with tagging is identical to the simple tax model with weight g_L replaced by $\widehat{g}_L = g_L + \frac{\nu_L}{x_L}\left(\frac{M(p,q)}{1-p} + T_W - T_D\right)$. Therefore, adding disability assistance and costly monitoring amounts to attributing a higher welfare weight to workers in low-skilled jobs when there are more disabled people prone to work without applying for disability benefits, when monitoring is more costly or when the difference between disability benefit and welfare benefit is higher. Let us have a deeper look at each term.

A larger quasi-elasticity of participation without prior application of the disabled workers, ν_L, reduces the participation tax $T_L - T_W$. Intuitively, a larger percentage of disabled people who directly take low-skilled jobs without applying for disability benefits reduces the monitoring expenditures. Therefore, less tax revenue is needed which reduces the participation tax $T_L - T_W$. Conversely, a similar reasoning applies to explain why a lower quasi-elasticity of participation ν_L raises the participation tax $T_L - T_W$.

With costly monitoring ($M(p,q) > 0$), the term $-(\nu_L/x_L)\, M(p,q)/(1-p)$ in the R.H.S. of formula (22) emphasizes that the participation tax $T_L - T_W$ decreases with the per capita cost of monitoring $M(p,q)$. In other words, the financial incentive to enter the labor force increases with the per capita cost of monitoring. Intuitively, monitoring costs make inactivity more expensive, hence financial incentives are needed to reduce inactivity.

From the term $-(\nu_L/x_L)(T_W - T_D)$, we also see that improving the redistribution toward a subset of the disabled, i.e. increasing the differential between disability and welfare benefits $T_W - T_D = x_D - x_W$ (which is non-negative from (8)), reduces the participation tax $(T_L - T_W)$ to keep stable the number of workers. In particular, a larger disability benefit $-T_D = x_D$ reduces the tax in low-skilled job T_L in order to keep stable the threshold value that characterizes disabled workers indifferent between a low-skilled job and applying for disability assistance, i.e. $\widetilde{\delta}_d$ in (5).

First-order condition with respect to x_H, (23)

Considering a small change $dx_H > 0$, adding the induced mechanical and behavioral effects and putting this sum equal to zero would easily give:

$$\begin{aligned}
&\pi_H^a (g_H - 1) + N_a q g\left(\widetilde{\delta}_a\right)\left(\partial\widetilde{\delta}_a/\partial x_H\right)\left(T_H - T_D + \frac{M(p,q)}{q}\right) \\
&+N_a (1-q)\, g\left(\widehat{\delta}_a\right)\left(\partial\widehat{\delta}_a/\partial x_H\right)(T_H - T_W) \\
&+N_a \frac{\widetilde{\delta}_a q g\left(\widetilde{\delta}_a\right)\left(\partial\widetilde{\delta}_a/\partial x_H\right) + \widehat{\delta}_a (1-q)\, g\left(\widehat{\delta}_a\right)\left(\partial\widehat{\delta}_a/\partial x_H\right)}{\lambda} = 0. \qquad (30)
\end{aligned}$$

From the Lagrangian (19), it is straightforward to check that this expression is the first-order condition with respect to x_H. The interpretation of Equation (23) is similar to the above interpretation of (22) where p and subscript L are substituted by $1-q$ and H, respectively. The other difference between both equations is a first best motive for taxation captured by the last term of the R.H.S. of (23), which can be rewritten as $\nu_H N_a \left[qg\left(\widetilde{\delta}_a\right)\widetilde{\delta}_a + (1-q)\, g\left(\widehat{\delta}_a\right)\widehat{\delta}_a\right] / \left[\eta_H x_H N_a \lambda q g\left(\widetilde{\delta}_a\right)\right]$, that we now explain. This expression is the result of the fact that the marginal disutilities $\widetilde{\delta}_a$ and $\widehat{\delta}_a$ are not included in the paternalistic criterion. This term appears since an infinitesimal change in the consumption bundle of able workers ($dx_H > 0$) induces the $N_a q g\left(\widetilde{\delta}_a\right)\widetilde{\delta}_a$ pivotal able agents who are on disability assistance and the $N_a (1-q)\, g\left(\widehat{\delta}_a\right)\widehat{\delta}_a$ pivotal able agents who are on welfare to start working. This has a first-order effect on paternalistic evaluation of their well-being equal to

$v(x_H) - v(x_D)$ and $v(x_H) - v(x_W)$ which, by virtue of (6) and (7), reduces to $\widetilde{\delta}_a$ and $\widehat{\delta}_a$ respectively so that we get the numerator of the above expression. The Lagrangian multiplier λ in the denominator converts this first-order effect in terms of public funds. 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. From (23), the larger this term, the lower the participation tax $T_H - T_W$ since it reinforces the labor supply of the able individuals which better complies with the paternalistic preferences.

Under utilitarian preferences, this first-best motive for taxation vanishes since there is no divergence between private and social preferences. Under utilitarian preferences, the participation tax on the able people is then very similar to the one on the disabled in Equation (22), see Appendix G.

First-order condition with respect to x_D, (24)

It is easy to check that Equation (24) is the first-order condition with respect to x_D. Considering a small increase in consumption x_D allows to heuristically derive the following expression

$$\begin{aligned}&\left(\pi_D^a + \pi_D^d\right)(g_D - 1) + N_a q g\left(\widetilde{\delta}_a\right)\left(\partial\widetilde{\delta}_a/\partial x_D\right)\left(T_H - T_D + \frac{M(p,q)}{q}\right)\\&+N_d(1-p) f\left(\widetilde{\delta}_d\right)\left(\partial\widetilde{\delta}_d/\partial x_D\right)\left(T_L - T_D + \frac{M(p,q)}{1-p}\right)\\&+\frac{\widetilde{\delta}_a N_a q g\left(\widetilde{\delta}_a\right)\left(\partial\widetilde{\delta}_a/\partial x_D\right)}{\lambda} = 0.\end{aligned} \tag{31}$$

which is equivalent to (24). Since this exercise is basically similar to the one we made for (22), it is skipped here.

The first term in the R.H.S. of (24), $(g_D - 1)/\eta_D$, is the *classic equity-efficiency tradeoff*. It emphasizes that the participation tax $T_L - T_D$ is inversely related to η_D, the participation elasticity of the recipients of disability benefits with respect to the benefit x_D.

The participation tax, $T_L - T_D$, increases with the marginal social welfare weight of disability benefits' recipients g_D. Intuitively, the larger this marginal social welfare weight, the more people on disability assistance are subsidized compared to disabled workers.

In the R.H.S. of Equation (24), the term which includes monitoring $M(p,q)$ emphasizes that a larger cost of monitoring reduces the participation tax $T_L - T_D$. Introducing endogenous monitoring amounts to reducing the welfare weight of recipients of disability benefits so that the tax in low-skilled jobs plus the disability benefit shrinks. Intuitively, investing more public funds in monitoring expenditure (in order to reduce the tagging errors) reduces the amounts that can be redistributed toward people on disability assistance. Moreover, $N_d(1-p)\left(1 - F\left(\widetilde{\delta}_d\right)\right) + N_a q\left(1 - G\left(\widetilde{\delta}_a\right)\right)$ at the denominator stands for all (able and disabled) recipients of disability benefits. Ceteris paribus, the monitoring term becomes less negative when this proportion of population gets larger. Therefore, the participation tax increases. Intuitively, this is because more disabled recipients reduces the number of taxpayers and increases the total cost of monitoring. Therefore, more tax revenue is needed which increases the participation tax $T_L - T_D$. In contrast, the participation tax decreases with the expression $N_d f\left(\widetilde{\delta}_d\right) + N_a g\left(\widetilde{\delta}_a\right)$ at the numerator, ceteris paribus. The latter stands for all pivotal (able and disabled) recipients of disability benefits who apply for disability benefits while they would not apply and would work if x_D were reduced by a small amount. The participation tax decreases with $N_d f\left(\widetilde{\delta}_d\right)+N_a g\left(\widetilde{\delta}_a\right)$ to provide financial incentives to enter the labor force to those pivotal agents.

We skip the interpretations of the last two terms in the R.H.S. of Equation (24) since they are similar to the interpretations we have for the last term of (22) and the penultimate term of (23) and to the first-best motive for taxation term in (23).

A necessary condition on the marginal cost of public funds λ, (25)

The necessary condition (25) comes from equations (22), (23), (24) and the necessary condition with respect to x_W that can be stated as

$$\begin{aligned}&\left(\pi_W^a+\pi_W^d\right)\left(v'\left(x_W\right)/\lambda-1\right)+\frac{\widehat{\delta}_a N_a\left(1-q\right)g\left(\widehat{\delta}_a\right)\left(\partial\widehat{\delta}_a/\partial x_W\right)}{\lambda}\\&+N_a\left(1-q\right)g\left(\widehat{\delta}_a\right)\left(\partial\widehat{\delta}_a/\partial x_W\right)\left(T_H-T_W\right)+N_d p f\left(\widehat{\delta}_d\right)\left(\partial\widehat{\delta}_d/\partial x_W\right)\left(T_L-T_W\right)=0\end{aligned} \tag{32}$$

Dividing (28), (30), (31) and (32) by $v'(x_L)$, $v'(x_H)$, $v'(x_D)$ and $v'(x_W)$, respectively, and adding these equations gives (25).

Equation (25) is similar to Diamond and Sheshinski (1995)'s equation (6), p.6 (see also Viard 2001). It yields an important redistributive principle of the optimal redistributive programs. 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 $1/v'\left(x_Y\right)$ extra units of consumption ($Y=L,H$), and per inactive person we need $1/v'\left(x_X\right)$ extra units of consumption ($X=W,D$). Weighting this by the frequencies of these groups in the population, we find that we need an additional g_A units of public revenue to finance this operation (see (20)). In terms of social welfare, this is worth λg_A. 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 (21). Equation (25) 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 (25) by λ, this principle can be rephrased as: the average (using population proportions) value of the inverses of the marginal welfare weights is one.

First-order conditions with respect to p and q, (26) and (27)

Equations (26) and (27) are the first-order conditions with respect to the levels of type I and type II errors, p and q, respectively.

The optimal level of type I errors (p) trades off a reduction in monitoring costs and the extra tax revenue from disabled people who enter the labor force against the costs in terms of welfare (in particular, from disabled applicants who, falsely rejected from disability assistance, end up on welfare assistance). The inequality in (26) can be written as:

$$\begin{aligned}&\frac{N_d}{\lambda}\left[\left(1-F\left(\widehat{\delta}_d\right)\right)\widehat{\delta}_d-\left(1-F\left(\widetilde{\delta}_d\right)\right)\widetilde{\delta}_d+\int_{\widetilde{\delta}_d}^{\widehat{\delta}_d}\delta_d dF\left(\delta_d\right)\right]\leq\\&\left[\frac{\partial\pi_L^d}{\partial p}\left(w_L-x_L\right)-\frac{\partial\pi_D^d}{\partial p}x_D-\frac{\partial\pi_W^d}{\partial p}x_W\right]-\left(\frac{\pi_D^d}{1-p}+\frac{\pi_D^a}{q}\right)\frac{\partial M(p,q)}{\partial p}.\end{aligned} \tag{33}$$

We interpret this equation heuristically as follows. Consider $dp > 0$, it implies the following mechanical and monitoring effects on government revenue and welfare. There is a mechanical gain in monitoring expenditures equal to

$$-\left(\pi_D^d/\left(1-p\right)+\pi_D^a/q\right)\left(\partial M(p,q)/\partial p\right)dp$$

because the per capita cost on the $\left(\pi_D^d/\left(1-p\right)+\pi_D^a/q\right)$ people who are monitored is reduced $(\partial M(p,q)/\partial p < 0)$. There is an effect on government revenue and welfare due to the change in the accuracy of monitoring. There is a gain in tax revenue equal to

$$\begin{aligned}&(w_L-x_L)N_d\left(F\left(\widehat{\delta}_d\right)-F\left(\widetilde{\delta}_d\right)\right)dp-x_W N_d\left(1-F\left(\widehat{\delta}_d\right)\right)dp\\&+x_D N_d\left(1-F\left(\widetilde{\delta}_d\right)\right)dp,\end{aligned}$$

as a result of extra disabled recipients who work or receive welfare benefits x_W rather than being on disability assistance. Moreover, $dp > 0$ also affects the welfare due to the change of occupation of these disabled people. This gain in welfare can be written as

$$\frac{\int_{\widetilde{\delta}_d}^{\widehat{\delta}_d}\left(v\left(x_L\right)-\delta_d\right)dF\left(\delta_d\right)+\left(1-F\left(\widehat{\delta}_d\right)\right)v\left(x_W\right)-\left(1-F\left(\widetilde{\delta}_d\right)\right)v\left(x_D\right)}{\lambda}N_d dp$$

which can be rewritten as

$$\frac{-\left(1-F\left(\widehat{\delta}_d\right)\right)\widehat{\delta}_d+\left(1-F\left(\widetilde{\delta}_d\right)\right)\widetilde{\delta}_d-\int_{\widetilde{\delta}_d}^{\widehat{\delta}_d}\delta_d dF\left(\delta_d\right)}{\lambda}N_d dp$$

from (5) and (3). In case of an interior solution for p, all of these effects sum to zero. The inequality (33) is then binding.

The optimal level of type II errors (q) results from the optimal trade-off between improving the accuracy of monitoring which brings more tax revenue from the new workers but which, at the same time, is costly. The inequality in (27) can be rewritten as:

$$\begin{aligned}&\frac{N_a}{\lambda}\left[\left(1-G\left(\widehat{\delta}_a\right)\right)\widehat{\delta}_a-\left(1-G\left(\widetilde{\delta}_a\right)\right)\widetilde{\delta}_a\right]\leq\\&\left[\frac{\partial\pi_H^a}{\partial q}\left(w_H-x_H\right)-\frac{\partial\pi_D^a}{\partial q}x_D-\frac{\partial\pi_W^a}{\partial q}x_W\right]-\left(\frac{\pi_D^d}{1-p}+\frac{\pi_D^a}{q}\right)\frac{\partial M(p,q)}{\partial p}.\end{aligned}\tag{34}$$

In case of an interior solution for q, all of these effects sum to zero. The inequality (34) is then binding.

A heuristic interpretation very similar to the one we just made for (26) is easy to make hence it is skipped here. The main difference between (33) and (34) is the integral term $\int_{\widetilde{\delta}_d}^{\widehat{\delta}_d}\delta_d dF\left(\delta_d\right)$ in the former inequality which has no equivalent term in the latter inequality. This is due to the δ_d disutility terms of disabled workers which are valued by the Paternalistic objective function while the δ_a disutility terms of able workers are not taken into account by the objective function.

In case of an interior solution for the probability of type I errors $p < 1$ (type II errors $q < 1$), the optimal amount of monitoring is such that the impact of a small increase in the probability of type I errors $dp > 0$ (type II errors $dq > 0$) cancels out the mechanical and behavioral effects such that $\partial\pounds/\partial p = 0$ ($\partial\pounds/\partial q = 0$). When the marginal costs of monitoring $|\partial M/\partial p|$ ($|\partial M/\partial q|$) is not huge, some positive cost of monitoring is always optimal because it reduces the number of type I and type II errors, thereby improving efficiency. However, when $|\partial M/\partial p|$ ($|\partial M/\partial q|$) is very high, $p = 1$ ($q = 1$) prevails at the optimum. No monitoring is optimal (i.e. $M\left(p,q\right) = 0$), as whoever applies for disability benefits is rejected (obtains them).

4.5 Optimality of an EITC among the disabled

From Proposition 2, we can now study whether an EITC-style work incentive scheme among the disabled can be optimal.

In the extensive margin model of Diamond (1980) and Saez (2002) where all inactive receive welfare benefits, Equation (29) points out that a negative (positive) participation tax $T_L - T_W$, i.e. an EITC (an NIT) for workers who forgo welfare assistance, is optimal depending on $g_L \geq 1$ ($g_L < 1$) (Saez, 2002). Intuitively, when the social marginal welfare weight g_L is relatively large on low-paid workers, they receive a work subsidy ($-T_L > 0$) which is larger than the welfare benefit ($-T_W$).

In our model with both welfare and disability benefits and monitoring costs, the following corollary emphasizes that $g_L \geq 1$ is a sufficient condition for an EITC for disabled workers who forgo welfare assistance, i.e. a negative participation tax $T_L - T_W < 0$. Contrastingly, $g_L < 1$ does not guarantee an NIT, i.e. a positive participation tax $T_L - T_W > 0$, for these workers.

Corollary 1 *An EITC (i.e. a negative participation tax) for disabled workers who forgo welfare assistance is optimal when $g_L \geq 1$. This EITC result can also carry through with $g_L < 1$.*

The proof is provided in Appendix D. Corollary 1 gives a sufficient condition for an EITC for disabled workers who forgo welfare assistance, i.e. $T_L - T_W < 0$. Moreover, an EITC provides work incentives that, by reducing the number of applicants for disability benefits, reduce monitoring costs. Consequently, an EITC is optimal for a greater array of marginal social welfare weights g_L than in the pure extensive margin model: An EITC can be optimal when $g_L < 1$ when monitoring is introduced in the extensive margin model.

The next corollary shows that it can also be optimal to have an EITC for disabled workers who forgo disability assistance, i.e. $T_L - T_D < 0$.

Corollary 2 *An EITC for disabled workers who forgo disability assistance is optimal when $g_D < 1$. An EITC for disabled workers who forgo welfare assistance is also optimal when $g_D < 1$.*

Appendix E gives the proof. Assuming $g_D < 1$ implies an EITC for disabled workers who forgo disability benefits, i.e. $T_L - T_D < 0$ as well as an EITC for disabled workers who forgo welfare assistance, i.e. $T_L - T_W < 0$. Let us note that $g_D < 1$ yields $g_L < 1$ because $g_L < g_D$ from (8), (16) and (18). We then have an example where an EITC for disabled workers who forgo welfare assistance coexists with $g_L < 1$, as highlighted by Corollary 1.

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

4.6 Results with costless monitoring

Under full information, Section 3 has shown that enforcing all able agents to work is optimal under paternalistic utilitarian preferences. This is feasible because individual characteristics are perfectly observed. It may be interesting to study whether enforcing all able people to work is still optimal under asymmetric information when the monitoring perfectly screens between able and disabled applicants and, is costless. A perfect screening between able and disabled people who apply for disability benefits means there are no type I and type II errors ($p = q = 0$). The disability agency perfectly observes the disability status of applicants but not the disability status of people who do not apply. We assume that monitoring is costless hence $M(p, q) = 0$ whatever the values of p and q. Under asymmetric information, the next proposition points out that enforcing all able people to work while using $p = q = 0$ and costless monitoring of applicants is not optimal.

Proposition 3 *With costless monitoring, no type I errors (i.e. $p = 0$), no type II errors (i.e. $q = 0$) and full employment of the able (i.e. $\widehat{\delta}_a \to \infty$) is not optimal under paternalistic utilitarian preferences.*

Appendix F gives the proof. This result relies on the fact that individual levels of disutility of work δ_d and δ_a are not observable under asymmetric information. Monitoring improves information on the applicants because their productivity w_Y ($Y = L, H$) is perfectly observed provided that $p = q = 0$. However, full revelation never occurs. To implement the first-best allocation, the tax authority would need to observe perfectly not only the health status of claimants but also the precise δ level. However, neither the tax authority nor the disability agencies observe the individual δ levels. Without this information, to have some disabled with δ_d below some threshold who work, like it is the case in the first-best economy, the government needs to rely on financial incentives. Hence, $x_L > x_D$ is the only way to guarantee that some disabled agents work in the second-best. 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 $x_H = x_L$. Therefore, we obtain $\lambda = v'(x_H) = v'(x_L) < v'(x_D)$ (as also emphasized in the proof in Appendix F). This has a too large welfare cost for the disabled recipients that makes this configuration not optimal.

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 3. 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, having no classification errors and all able people who work would be welfare-reducing.

5 Conclusion

This paper assumed an economy where individuals choose whether they participate to the labor market. If they do not participate, they receive welfare benefits or, after monitoring of their disability status, they may obtain disability benefits. Type I errors, type II errors and non take-up co-exist in disability assistance. An endogenous and costly monitoring allows restricting the number of type I and type II errors.

The optimal redistributive schedule that encapsulates nonlinear taxation, welfare benefits and disability benefits has been derived under paternalistic utilitarian and utilitarian preferences. Our main outcomes can be summarized as follows.

We have shown that the participation tax on workers who forgo welfare assistance is inversely related to the participation elasticity and decreases with the marginal social welfare weight of disabled workers, as in the model without disability benefits nor monitoring. We have also found that this participation tax decreases with the (per capita) monitoring cost. Intuitively, monitoring costs make inactivity more expensive, hence financial incentives are used to reduce inactivity. Moreover, this participation tax is decreasing with the percentage of disabled people who enter the labor force without having applied for disability assistance. Intuitively, the larger this percentage, the lower the monitoring expenditure hence less tax revenue is needed which reduces the participation tax.

We have shown that a social marginal welfare weight on disabled workers lower than one does not guarantee a Negative Income Tax as it would in a model without monitoring nor disability benefits (see Diamond (1980) and Saez (2002)). An Earned Income Tax Credit can then prevail. Intuitively, an Earned Income Tax Credit provides strong work incentives that, by reducing the number of applicants for disability benefits, reduce monitoring costs. Consequently, an Earned Income Tax Credit is optimal for a greater array of model parameters than in the model without neither monitoring nor disability assistance.

The model sheds light on the optimal levels of type I and type II errors. The optimal level of type I error is determined by the trade-off between a gain in tax revenue on the one hand and a loss in welfare on the other. The gain in tax revenue stems from an increase in the number of type I errors (because monitoring cost is reduced and because some disabled people enter the labor force). The welfare loss comes from disabled people who are wrongly rejected from disability assistance. The optimal level of type II errors is determined by the trade-off between a gain and a loss in tax revenue. Reducing the number of cheaters is costly in monitoring but avoids giving disability benefits to undeserving people.

Finally, we have shown that a costless monitoring technology that would perfectly screen between disabled and able applicants and would enforce all able to work is not optimal. Intuitively, the tax authority would observe the correct health status of claimants by its monitoring but not their precise disutility if they worked. Therefore, the ideal full information allocation could not be reached.

Appendices

A Proof of Proposition 1

The Lagrangian states as

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

where P is the paternalistic utilitarian criterion (provided in Equation (1)) and λ is the (nonnegative) Lagrangian multiplier associated with the budget constraint.

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

$$\begin{aligned}
&\ell_L(\delta_d)\left[v'(x_L^w(\delta_d)) - \lambda\right] = 0 \\
&(1 - \ell_L(\delta_d))\left[v'(x_L^u(\delta_d)) - \lambda\right] = 0 \\
&\ell_H(\delta_a)\left[v'(x_H^w(\delta_a)) - \lambda\right] = 0 \\
&(1 - \ell_H(\delta_a))\left[v'(x_H^u(\delta_a)) - \lambda\right] = 0
\end{aligned}$$

Since $\ell_X(\delta_y)$ $((X, y) = (L, d), (H, a))$ 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 $\forall (\delta_d, \delta_a)$:

$$\begin{aligned}
&v'(x_L^w(\delta_d)) = v'(x_L^u(\delta_d)) = v'(x_H^w(\delta_a)) = v'(x_H^u(\delta_a)) = \lambda \\
&\Longleftrightarrow \overline{x} = x_L^w(\delta_d) = x_L^u(\delta_d) = x_H^w(\delta_a) = x_L^u(\delta_a),
\end{aligned} \tag{35}$$

From (35), the tax/transfer toward the disabled workers, $\overline{x} - w_L$, is lower than the transfer to the inactive disabled, $\overline{x}$. An NIT is optimal. From the budget constraint, we have

$$\overline{x} = N_d w_L \int_0^\infty \ell_L(d_\delta)\, dF(d_\delta) + N_a w_H \int_0^\infty \ell_H(\delta_a)\, dG(\delta_a) + R \tag{36}$$

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

$$\begin{aligned}
&v\left(N_d w_L \int_0^\infty \ell_L(\delta_d)\, dF(\delta_d) + N_a w_H \int_0^\infty \ell_H(\delta_a)\, dG(\delta_\alpha) + R\right) \\
&- N_d \int_0^\infty \ell_L(\delta_d)\, \delta_d dF(\delta_d)
\end{aligned}$$

The value of our objective function is maximal when all able agents work: $\ell_H(\delta_a) = 1$ $\forall \delta_a$. Therefore, from the budget constraint, we have $\overline{x} = N_d w_L \int_0^\infty \ell_L(d_\delta)\, dF(d_\delta) + N_a w_H + R$. Further, as δ_d rises from 0 to ∞, the function $\ell_L(\delta_d)\, \delta_d$, where $\ell_L(\delta_d) = 1$ $\forall \delta_d$, 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 $\ell_L(\delta_d)$ will have the following shape: $\ell_L(\delta_d) = 1$ for all $\delta_d \leq \overline{\delta}_d$ and $\ell_L(\delta_d) = 0$ otherwise. The critical value is determined by

$$\begin{aligned}
&v'(\overline{x}) N_y w_Y f\left(\widehat{\delta}_y\right) - N_y \overline{\delta}_y f\left(\widehat{\delta}_y\right) = 0 \\
&\Leftrightarrow \overline{\delta}_y = v'(\overline{x}) w_Y > 0,
\end{aligned} \tag{37}$$

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

B Proof of Equation (2)

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 (6) and (7) where $\max\{x_L, x_H\}$ replaces x_H, 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 $\widetilde{\delta}_a$, $\widehat{\delta}_a$ and the number of able people who work is unchanged. The number of able people who are on disability assistance and on welfare assistance are then also unchanged. Hence, from (6) and (7), $\widetilde{\delta}_d$, $\widehat{\delta}_d$ and the number of disabled people on disability assistance and on welfare assistance do 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 Proof of Lemma 1

(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 are finite, from (6) and (5), $\widetilde{\delta}_a$ 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: $x_L = x_H = x_D = x_W = R'$ with $R' \equiv Max\{0, R\}$. 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 and able people work is optimal.

D Proof of Corollary 1

From (22), $g_L \geq 1 \Leftrightarrow T_L - T_W \leq 0$ since (i) the second term in the R.H.S of (22) is non-positive because $M(p, q) \geq 0$ and (ii) the third term in the R.H.S of (22) is non-positive because $T_W - T_D = -x_W + x_D \geq 0$ from (8). Therefore, an EITC for disabled workers who leave welfare is optimal. This result prevails with $M(p, q) \geq 0$. Moreover, $g_L < 1$ does not imply $T_L > T_W$ (i.e., an NIT for disabled workers who forgo welfare) as long as monitoring is costly (i.e. $M(p, q) > 0$) or a disability system prevails (i.e. $x_D > x_W$). This is because the first term in the R.H.S. of (22) is positive but the two other terms are negative. Both an NIT and an EITC may prevail when $g_L < 1$.

E Proof of Corollary 2

Assume $g_D < 1$, the first term of the L.H.S. of (31) is negative. The second and the fourth terms of the L.H.S. of (31) are non-positive since $\partial\widetilde{\delta}_a/\partial x_D = -v'(x_D) < 0$ from (6). The third term in the L.H.S. can be rewritten as

$$(T_L - T_D) N_d (1 - p) f\left(\widetilde{\delta}_d\right) \left(\partial\widetilde{\delta}_d/\partial x_D\right) + M(p, q) N_d f\left(\widetilde{\delta}_d\right) \left(\partial\widetilde{\delta}_d/\partial x_D\right),$$

where $M(p,q)N_d f\left(\widetilde{\delta}_d\right)\left(\partial\widetilde{\delta}_d/\partial x_D\right) \leq 0$ because $\partial\widetilde{\delta}_d/\partial x_D = -v'(x_D) < 0$ from (5). Therefore, $(T_L - T_D) N_d (1-p) f\left(\widetilde{\delta}_d\right)\left(\partial\widetilde{\delta}_d/\partial x_D\right)$ is positive in order to satisfy (31). Since $N_d(1-p) f\left(\widetilde{\delta}_d\right)$ $\left(\partial\widetilde{\delta}_d/\partial x_D\right) < 0$ (because $\partial\widetilde{\delta}_d/\partial x_D < 0$), we have $T_L - T_D < 0$.

Moreover, we know that $-T_D \geq -T_W (> 0)$ from (8). Therefore, $T_L - T_D < 0$ implies $T_L - T_W < 0$. That is, disabled workers who forgo welfare assistance also face an EITC.

F Proof of Proposition 3

For contrast, we assume $p = 0$, $q = 0$ and $\widehat{\delta}_a \mapsto \infty$. All disabled who apply for disability benefits get them, i.e. $p = 0$. None of them receive the welfare benefit x_W. All able people are rejected from disability assistance, i.e. $q = 0$. From (7), $\widehat{\delta}_a \mapsto \infty$ means that $v(x_W) \mapsto -\infty$ i.e. $x_W = 0$ with $\lim_{x\mapsto 0} v(x) \mapsto -\infty$. We then have $\pi_H^a = N_a$ (and the ICC on the able agents (6) and (7) are neglected). The first-order condition with respect to x_H (30) becomes:

$$N_a(g_H - 1) = 0$$

Therefore, $v'(x_H) = \lambda$. This implies that (25) (which is still valid with costless monitoring) becomes:[15]

$$\frac{1-N_a}{v'(x_H)} = \frac{N_d F\left(\widetilde{\delta}_d\right)}{v'(x_L)} + \frac{N_d(1-p)\left(1 - F\left(\widetilde{\delta}_d\right)\right)}{v'(x_D)} \tag{38}$$

Since a weighted average with positive weights is bounded by its least and greatest elements, and since $x_L > x_D$ (from (8)): $\frac{1}{v'(x_L)} \geq \frac{1}{v'(x_H)} \geq \frac{1}{v'(x_D)}$ 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 (38) gives $v'(x_L) = v'(x_D)$ (since $1 - N_a = \pi_L^d + \pi_D^d$). This contradicts $x_L > x_D$. Therefore $p = q = 0$ and $\widehat{\delta}_a \mapsto \infty$ is not optimal.

G Results under utilitarian preferences

This appendix emphasizes that most of the results we have derived under paternalistic utilitarian preferences are still valid under utilitarianism. Utilitarian preferences consist in replacing the first term of the second line, $\ell_H(\delta_a) v(x_H^w(\delta_a))$, of the paternalistic utilitarian preferences (1) by $\ell_H(\delta_a)(v(x_H^w(\delta_a)) - \delta_a)$.

Under utilitarian preference, in full information, it is easy to see that the same first-order conditions as under paternalistic utilitarianism P are obtained, and so the solution is given by (35).

[15] When $p = q = 0$ and $\widehat{\delta}_a \to \infty$, (28) becomes

$$\pi_L^d(g_L - 1) = N_d f\left(\widetilde{\delta}_d\right) v'(x_L)(T_L - T_D)$$

and (31) becomes

$$\pi_D^d(g_D - 1) = N_d f\left(\widetilde{\delta}_d\right) v'(x_L)(T_L - T_D).$$

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

$$\frac{\pi_L^d + \pi_D^d}{\lambda} = \frac{\pi_L^d}{v'(x_L)} + \frac{\pi_D^d}{v'(x_D)}.$$

Substituting $\lambda = v'(x_H)$ into the latter gives (38).

From the budget constraint, we then have (36). Substituting (36) in the utilitarian preferences gives the value of utilitarian welfare as a function of the $\ell_L(\delta_d)$ and $\ell_H(\delta_a)$ functions:

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

Keeping the number of employed of both types fixed, it is only through the terms on the last line that the shape of the $\ell_L(\delta_d)$ and $\ell_H(\delta_a)$ functions matter under utilitarianism. Hence, as δ_k $(k = d, a)$ rises from 0 to ∞, the function $\ell_K(\delta_k)\,\delta_k$ $((K,k) = (L,d), (H,a))$, where $\ell_K(\delta_k) = 1$ $\forall \delta_k$, goes from 0 to ∞. Then it is always optimal to have those in work with the lowest δ_k $(k = d, a)$. Therefore, the functions $\ell_L(\delta_d)$ and $\ell_H(\delta_a)$ have the following shape: $\ell_L(\delta_d) = 1$ for all $\delta_d \leq \overline{\delta}_d$, otherwise zero and $\ell_H(\delta_a) = 1$ for all $\delta_a \leq \overline{\delta}_a$, otherwise zero. Both critical values satisfy (37) with $(y, Y) = (d, L)$ and (a, H), respectively. Differing from the optimum under the paternalistic criterion, since w_H and $v'(\overline{x})$ are finite, we now have $\overline{\delta}_a < \infty$, i.e., there are able agents who do not work and receive benefits. From $w_H > w_L$ and (37), $\overline{\delta}_a > \overline{\delta}_d$ as under paternalism.

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

$$\widetilde{S}^U \equiv N_d \left[\int_0^{\widetilde{\delta}_d} (v(x_L) - \delta_d)\, dF(\delta_d) + \left(1 - F\left(\widetilde{\delta}_d\right)\right)(v(x^u) - \sigma(\pi_a^u))\right]$$
$$+N_a \left[\left(G\left(\widetilde{\delta}_a\right) + (1-\mu)\left(1 - G\left(\widetilde{\delta}_a\right)\right)\right) v(x_H) - \int_0^{\widetilde{\delta}_a} \delta_a dG(\delta_a)\right.$$
$$\left. - (1-\mu) \int_{\widetilde{\delta}_a}^{\infty} \delta_a dG(\delta_a) + \mu\left(1 - G\left(\widetilde{\delta}_a\right)\right) v(x^u)\right]$$

Under utilitarian preferences, Proposition 2 is valid except that the first-best motives for taxation are equal to zero. Since the proof is identical to the ones 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 $\delta_a = \widetilde{\delta}_a$ and $\delta_a = \widehat{\delta}_a$. Their well-being weight is now the same, in the social preferences, whether they are recipients or workers. Therefore, the paternalistic terms $\left[qg\left(\widetilde{\delta}_a\right)\widetilde{\delta}_a + (1-q)\, g\left(\widehat{\delta}_a\right)\widehat{\delta}_a\right] / \left[\lambda qg\left(\widetilde{\delta}_a\right)\right]$ in Equation (23) and $\left[N_a qg\left(\widetilde{\delta}_a\right)\widetilde{\delta}_a v'(x_D)\right] / \left[\lambda\left(N_d(1-p)\left(1 - F\left(\widetilde{\delta}_d\right)\right) + N_a q\left(1 - G\left(\widetilde{\delta}_a\right)\right)\right)\right]$ in (24) do not appear under utilitarianism. It is straightforward to see that Corollaries 1 and 2 are still valid under utilitarianism.

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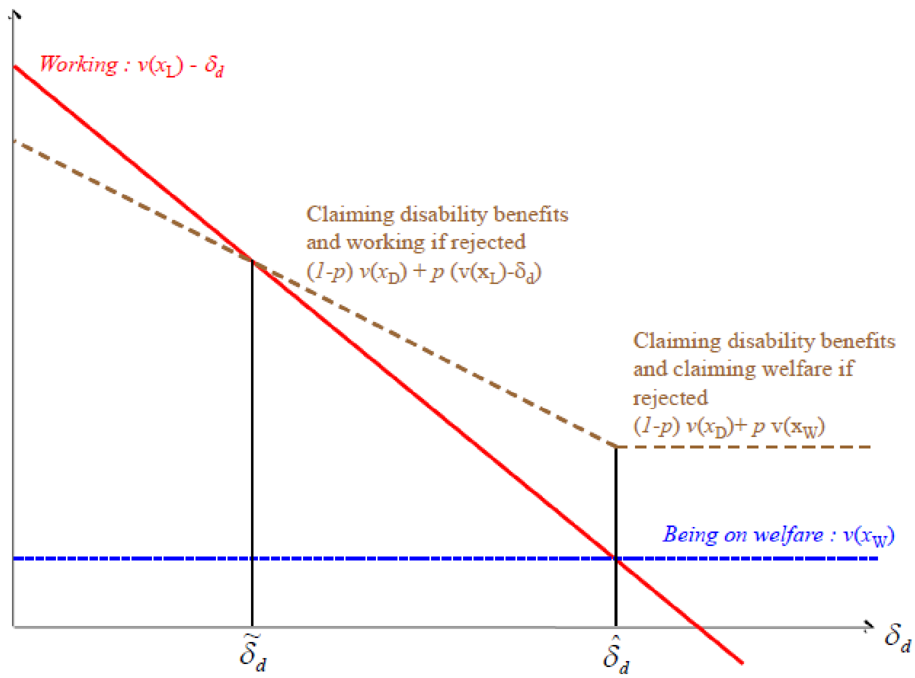

Figure 1: Utility levels and decisions of the disabled people.

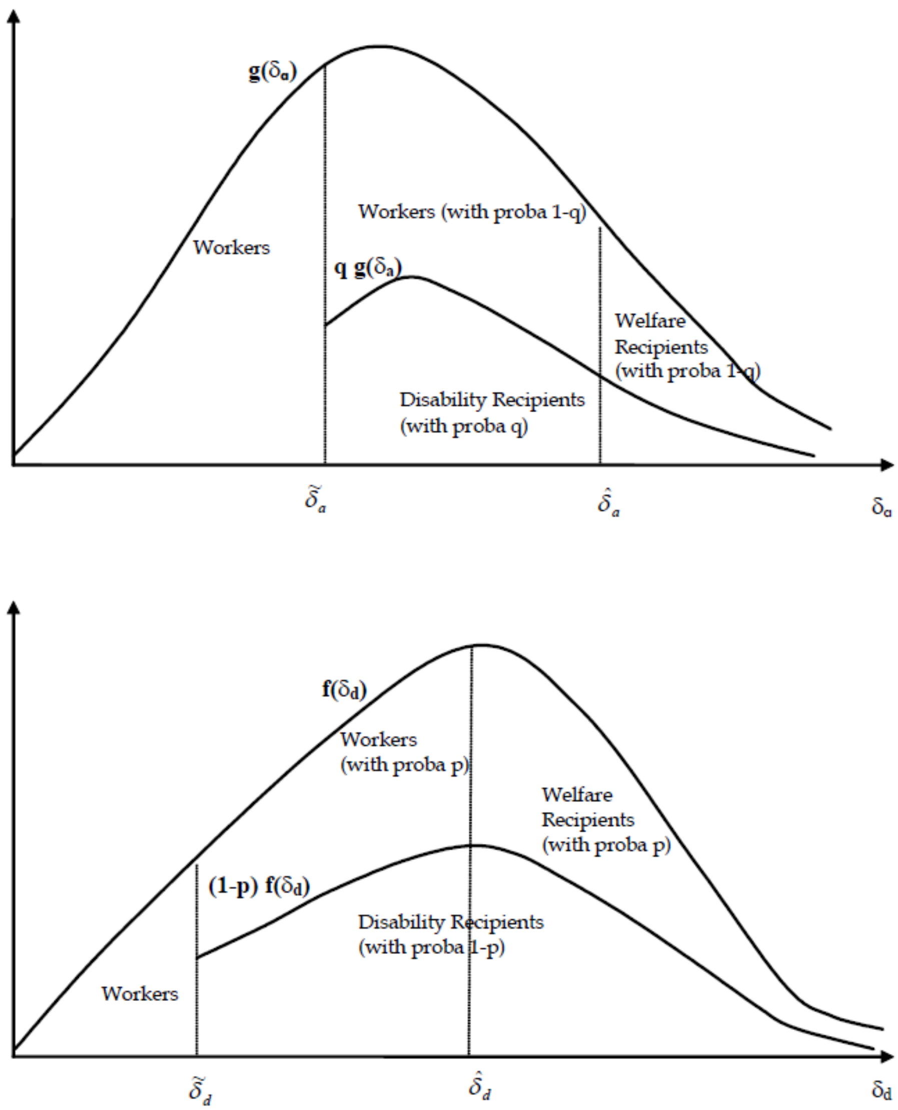

Figure 2: Labor supply, densities and threshold values.