When will workfare work? An optimal tax perspective

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Abstract

This paper analyzes work requirements as they have become standard in several Western welfare states. I extend a discrete version of the Mirrlees (1971) optimum income tax model by workfare. Whereas unproductive workfare is never part of a second-best tax-transfer-scheme, productive workfare can be an optimally chosen instrument. It turns out that optimality depends on the relation between the productivity of the work obligation and the related marginal rate of substitution. However, only unemployed persons can be subject to such work measures. Work requirements as well as transfers are uniform. Work obligations for people with gainful employment are never optimal. The second-best tax schedule has positive marginal tax rates everywhere. Hence, tax systems like the U.S. EITC are also suboptimal in the presence of workfare. This is also true when assuming workfare productivities that are positively correlated to the individual market wage. However, in such a scenario, discrete marginal tax rates can exceed a hundred percent at the bottom of the income scale. The implementation of workfare as part of an optimal tax mix does not only lead to an overall welfare increase but can even yield a Pareto improvement.

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1 Introduction

Since the 1970s, the number of people receiving public assistance has continuously increased in many Western countries such as the U.S., France, or Germany (Gough, Bradshaw, Ditch, Eardley & Whiteford 1997). In the last decade welfare reforms took place in several countries, and attention shifted from debates about the level of welfare expenditures to questions regarding the desirability and effectiveness of welfare programs (Lødemel 2005). Incentives to accept job offers and disincentives to live on benefit payments were implemented (Ditch & Oldfield 1999). One of these instruments are mandatory work-first programs. They first emerged in the United States in the 1980s whereas countries such as the United Kingdom, Denmark, or the Netherlands introduced such workfare in the 1990s, and recently, stronger efforts in that regard have been made in Germany (Ochel 2005). Following Lødemel and Trickey, I understand workfare as "programs or schemes that require people to work in return for social assistance benefits" (Lødemel & Trickey 2000). This definition contains three elements. Firstly, workfare is compulsory, i.e. non-compliance leads to a reduction or even a deletion of benefit payments. Secondly, the focus is on work and not on training or education. And thirdly, it is about policies tied to the lowest tier of public income support.

But apart from this spirit of punishment there is another important aspect of workfare. In line with inquiries of social exclusion in the EU ((Atkinson & Hills 1998), (Mayes 2001)), proponents of workfare in the U.S. assume that labor market integration is the key mechanism for lowering other risks of social exclusion ((Mead 1997), (Phelps 1997)). Hence, in an altruistic kind of attitude, workfare is supposed to be in the recipients' own interest as well. Besley and Coate point out that workfare is less stigmatizing than usual targeted welfare and thereby contributes to the political legitimacy of public assistance (Besley & Coate 1992*a*).

Empirical and experimental studies of workfare usually focus on questions like a possible reduction of the time on welfare or the minimization of public expenditures guaranteeing a certain welfare level. However, assessing the workfare as a potentially additional instrument of tax-transfer-schemes must not be based on such partial analysis. A general equilibrium analysis seems more apt. The disutility of workfare measures as well as of tax payments has to be balanced against the benefit of transfer recipients and society's gain by virtue of a potentially increased output due to productive workfare. In the present paper I will conduct such a comprehensive theoretical analysis using an optimal tax framework in the spirit of Mirrlees (Mirrlees 1971). Questions that will be addressed are: what drives optimality of workfare? Who may be subject to work requirements and what do such obligations optimally look like? Which role does workfare productivity play? How do the related tax schedules look and might negative marginal tax rates, as they are used in the U.S. EITC, be optimal when workfare is present?

Due to the complexity of optimal income tax models there are very few general insights, unless one makes very stringent assumptions both on preferences and the productivity distribution (for a comprehensive survey see Tuomala (Tuomala 1990) or Myles (Myles 1995)). The efficacy of workfare as an additional instrument in an optimal tax mix has been examined to some extent. The common starting point is the understanding of work requirements as an obligation that deters people with high potential wage rates from claiming assistance due to their high opportunity cost of time. In general, workfare turns out to be optimal when the loss of market production of those on workfare is outweighed by the described disincentive for the more able individuals. Chambers (Chambers 1989), but especially Besley and Coate (Besley & Coate 1992*b*), (Besley & Coate 1995), have carried out some analysis about workfare as a supplement to an income maintenance program. However, these authors do not perform an overall welfare maximization but restrict their attention to needy people. The aim is to minimize welfare costs under the condition that a minimum welfare level is guaranteed to this part of society. Their findings are somewhat heterogeneous as workfare shall be optimal if the minimum welfare level is measured in consumption units whereas it is not optimal if it is measured in utility. Similar results are derived by Cuff who restricts her model for only three different types of individual productivities (Cuff 2000). Brett deals with the question of optimal workfare as well (Brett 1998). Among other restrictions, he allows only for quasilinear preferences with the non-linearity in consumption, i.e. an exogenous increase in income would always lead to a reduction of working time but never to higher consumption. With regard to unions' claims for higher wages this preference structure seems to be not quite realistic. In the context of a discrete version of the Mirrlees model, Homburg has analyzed unproductive workfare (Homburg 2003*a*). In line with the literature, he found that such work requirements are never part of an optimal tax mix.

Although some studies indicate that workfare is unproductive, i.e. the low output is outweighed by the administration costs (Gueron 1990), Piven and Cloward give a convincing example of why workfare can be seen as productive: "In New York City, some 45,000 people ... sweep the streets and clean the subways ... They do the work once done by unionized municipal employees. But instead of a paycheck ... they get a welfare check". (Piven & Cloward 2001) p. ix. This is precisely the starting point for the present paper in which I deal with productive workfare. Using a discrete version of the Mirrlees model, our setting (see next section) is fairly general. I allow e.g. for an arbitrary number of productivity types and do not make any preference assumptions (apart from standard ones). What makes workfare so difficult to deal with in a fairly general model? The difference between our model and the standard Mirrlees model is the additional instrument of workfare as a third dimension in the maximization problem. By this, multidimensional screening problems may arise. They are rather hard to deal with because the crucial single-crossing property of the two dimensional case is not necessarily fulfilled. Already the much simpler model of Matthews and Moore reveals that such problems are difficult and, in fact, might not have a solution (Matthews & Moore 1987). Even in the latest literature on multidimensional screening is no solutions beyond the rather restrictive quasi-linear case are discussed (Basov 2005). Consequently, I will try a new track in order to describe tax-transfer-schemes optimally including work requirements. Usually, optimal control theory is used in the optimal tax literature and therefore a technique about which Homburg pointedly judges: "Control theory and calculus of variations ... have never pretended to be logically air-tight branches of mathematical optimization; both are more or less heuristic methods, too" ((Homburg 2003*b*), p. 286). The techniques used here are very much easier to understand and require far less calculations. Nevertheless, they give definitive answers since they rely on axiomatic methods. Moreover, they facilitate economic interpretations and allow the calculation of some illustrative simulations. The remainder of this paper is organized as follows. Section 2 presents the model. Its basic properties as well as the determinants for workfare being an optimal instrument of a second-best tax-transfer-scheme are analyzed in section 3. Section 4 is devoted to the characterization of workfare for the unemployed, and section 5 explains the optimal tax schedule, including workfare. Then, I extend the model in section 6 by introducing non-uniform workfare productivities and, finally, some illustrative examples are provided in section 7. Section 8 summarizes the findings and concludes.

2 The Model

In a first-best world workfare measures would be superfluous because taxes and transfers can be targeted to individual abilities. However, due to informational shortages about individual productivities, in a second-best world labor income will be taxed, taking it as a proxy for the unknown abilities. Tax-transfer-schemes have to be designed such that it is individually optimal to reveal one's productivity type. Here, work obligations may well serve as a way to reach this goal.

I consider a finite variant of the standard optimal non-linear taxation model (Homburg 2001) which will be referred to as the 'standard model'. This standard model is extended by productive work requirements. There are several types $h = 0, 1, ...H(H > 1)$, whose exogenous productivities and fractions are denoted as w^h and f^h, respectively. Productivities correspond to wage rates in the competitive labor market. We have $0 = w^0 < w^1 < ... < w^H$, where type 0 persons are disabled, i.e. unproductive. All individuals face a maximum total work time of $l^{\max} > 0$. By choosing a non-observable personal labor time l^h individuals generate $y^h = w^h l^h$ as an observable gross income.[1] The government can require people to do some workfare. To keep the model as general as possible, it is assumed that v^h hours of observable workfare can be imposed on each individual, even if mandatory work seems to be unsuitable for

[1] We will synonymously refer to this income as market income.

high income classes. The generated output of workfare per hour is π. Workfare productivity is assumed to be lower than market productivity, i.e. $\pi < w^1$. Due to their uniform dimension 'time' an additive connection of l and v is assumed, and the only restriction is that $l^h + v^h \leq l^{\max}$. As it is standard in taxation models, leisure is assumed to be non-inferior, implying that the expression in equation (17) in the appendix is negative. Since we have a one-period model, there are no intertemporal decisions as e.g. saving, and the entire net income will be directly consumed, amounting to $c^h \in \mathbf{R}_{0+}$. Consumption is assumed to be non-inferior as well, implying that the expression in equation (16) in the appendix is positive. As c is a composite good, its non-inferiority is not a restrictive assumption. Consequently, all bundles $(c^h, l^h + v^h)$ are points in $B = \mathbf{R}_{0+} \times [0, l^{\max}]$, and an allocation is a vector $(c^h, l^h + v^h)_{h=0,1,\ldots H}$ in B^{H+1}. The only type of taxation is the taxation of labor income. As in the standard model, the tax is defined as the difference between gross $y^h$and net income c^h. In case of strictly positive workfare the resulting income from this mandatory work does not count for gross income as it is not market income. The output generated through workfare as well as the tax revenue does not only serve for redistribution but also for financing an exogenous revenue requirement g, e.g. for public goods. Such a labor income tax distorts the optimal labor-leisure decision, and causes the famous wedge between gross and net income. It evokes not only income but also substitution effects.

All individuals have the same preferences, and the utility function u satisfies the usual properties (strictly monotonically increasing in c, strictly monotonically decreasing in l and v, $Hess\ u$ is negative definite, hence u is strictly concave on the entire domain[2], and at least in the interior twice continuously differentiable). The marginal rate of substitution of a person with productivity w^h is defined as $mrs^h(c^h, l^h + v^h) = -u_2(c^h, l^h + v^h)/u_1(c^h, l^h + v^h)$.

[2]Due to the additive connection of l and v we have $u_l = u_v$ and hence for convenience we will denote partial derivatives with sub-indices that refer to the respective arguments, i.e. $u_l = u_v =: u_2$ and $u_c =: u_1$. From the criterion about the definity of determinants we get: $u_{11} < 0$ and $u_{11}u_{22} - u_{12}u_{21} > 0$. Consequently, $u_{22} < 0$.

The social planner's problem reads:

$$\begin{aligned}
\max_{(c^h, l^h+v^h)_{h=0\ldots H} \in B^{H+1}}! \quad EU &= \sum_{h=0}^{H} u(c^h, l^h + v^h) f^h \\
\text{s.t. (i) } g &\leq \sum_{h=0}^{H} \left((y^h - c^h) f^h + v^h \pi f^h \right) \qquad (1) \\
\text{(ii) } u(c^k, l^k + v^k) &\geq u\left(c^h, \frac{y^h}{w^k} + v^h \right) \ \forall\, h, k \text{ and } \frac{y^h}{w^k} + v^h \leq l^{\max}.
\end{aligned}$$

Thus, the government maximizes expected utility of a person choosing a tax-transfer-scheme from behind a veil of ignorance, subject to the budget constraint (i), and subject to the self-selection constraints (ii). These constraints ensure that no person can make herself better off by mimicking somebody else.[3] Notice that imitation in workfare is not possible as not the output is decisive for workfare but the time spent in this work requirement. Solutions to (1) induce truthful reporting of abilities.

From a technical point of view, strictly positive workfare has three effects: 1) output effects which are positive as workfare is productive; 2) utility effects which are negative as utility is strictly monotonically decreasing in workfare; and 3) incentive effects that cannot be assessed generally. Analyzing workfare as a potential part of an optimal tax mix means analyzing these three effects and their interaction.

3 Workfare in second-best allocations

For each $g > 0$ sufficiently small there exists a solution to (1). The existence of an optimum can be guaranteed, even if it is on the boundary, whereas parts of the literature cannot do so (e.g. Guesnerie and Seade who assume open sets (Guesnerie & Seade 1982)). Of course, the existence crucially depends on the

[3] This includes disabled people, i.e. persons with $w^0 = 0$. As Boadway had pointed out their opportunity cost of participating in workfare measures is higher than it is for the employables (Boadway 1998). Hence, to separate them from the employables, workfare programs have to be accomapnied by appropriate instruments to tag them as disabled. The resulting tax scheme is one under partial information as analyzed by Homburg and Lohse (Homburg & Lohse 2005).

level of the required g. A maximum tax revenue as under a first-best system of $g^{\max} = l^{\max} \sum w^h f^h$ is impossible in a second-best world, due to the violation of self-selection constraints. Hence, g has to be chosen in a way that the revenue can be achieved without such violations.

There is a widely held belief, especially of unions and left politicians, that the potentially additional instrument of workfare leads to a welfare decrease. However, a core insight of optimization theory is that extending the set of variables in a maximization problem always weakly increases the target value, with a strong increase if the added variables are non-zero. Consequently, the extension of the optimal tax-transfer-scheme through workfare yields a weak welfare increase in comparison to the standard model.

With regard to individual utility the subsequent lemma can be stated.

Lemma 1 *In each feasible allocation $k > h$ implies $u(c^k, l^k + v^k) \geq u(c^h, l^h + v^h)$.*

Proof. By construction $w^k > w^h$. Then the following relationship must hold: $u(c^k, l^k + v^k) \geq u(c^h, y^h/w^k + v^h) \geq u(c^h, y^h/w^h + v^h) \equiv u(c^h, l^h + v^h)$, where the first inequality stems from the self-selection constraint and the second from the different wage rates. ■

Hence, utility increases weakly in productivity.

People with zero market income, i.e. unemployed persons, are of a particular socio-political interest. It is well known that in the standard model it might be optimal to have some unemployment. Considering a person k with $w^k > 0$ but $y^k = 0$, a priori it is unclear, whether persons $h < k$ can have a strictly positive market income or not. As an analogue to Mirrlees' famous Proposition 1 ((Mirrlees 1971), p. 171), the following lemma answers the question for a tax scheme allowing for workfare.

Lemma 2 *If a person k with $w^k > 0$ has $y^k = 0$, then for all $h < k$ $y^h = 0$ is optimal.*

Proof. Suppose $y^k = 0$, but $y^h > 0$ were optimal. Then $u^k \geq u(c^h, y^h/w^k + v^h)$ and $u^h \geq u(c^k, v^k) \equiv u^k$ are the adjoint self-selection constraints. According to

Lemma 1 $u^k \geq u^h$, and consequently $u^k = u^h$. But as $w^k > w^h$ by construction, we have $u(c^h, y^h/w^k + v^h) > u^k$, which violates k's self-selection constraint. ■

A reverse statement for people with regular employment can be given as well.

Lemma 3 *If a person h has $y^h > 0$, then for all $k > h$ $y^k > 0$ is optimal. Moreover, $y^k \geq y^h$.*

Proof. Suppose $y^k = 0$ were optimal. Then $u(c^h, l^h + v^h) \geq u(c^k, v^k) \equiv u^k$ and $u(c^k, v^k) \geq u(c^h, y^h/w^k + v^h)$ are the self-selection constraints for persons h and k, respectively. Hence, $u(c^h, l^h + v^h) \geq u(c^h, y^h/w^k + v^h)$. However, this relation can never be satisfied because $l^h \equiv y^h/w^h$ and by construction we have $w^k > w^h$. Consequently, $y^k > 0$. The monotonicity results from the standard model. ■

To sum up, lining up all types of productivity, any second-best allocation is virtually separated into two parts. The first part comprises all unemployed people and the second part all people with regular employment. For this second part, the usual properties of the standard model carry over.

After these preliminary statements I now turn to the central point of our analysis: when is workfare optimal, what determines any optimality, and who may be subject to work requirements? Recall the literature's insight that unproductive work obligations are never optimal ((Brett 1998), (Cuff 2000), (Homburg 2003*a*)). I will elucidate that the situation is rather different when the required work exhibits a certain productivity.

First, the situation of unemployed people will be considered. Then $u(c, v) = \bar{u}$ implicitly defines an indifference curve $c(v)$ in a c-v-space. As its derivative is given by $c'(v) = -u_2(c, v)/u_1(c, v) = mrs(c, v)$, indifference curves are monotonically increasing. The following proposition concerns the question if people without gainful employment should be on workfare.

Proposition 1 *Let $y^h = 0$ and $w^h > 0$. If there exists a π with $mrs(c^h, 0) < \pi < w^1$, then $v^h = 0$ is suboptimal.*

Proof. Suppose $y^h = v^h = 0$ were optimal for some $h > 0$. Increasing c^h and v^h along person h's indifference curve will leave utility of imitation by any other

individual unchanged, because y^h vanishes by assumption. Hence mimicking presents no problem.
At the margin, the increase costs $mrs(c^h, 0)$ and yields π. With π large enough, an output surplus emerges. This surplus can be used to yield a Pareto-improvement, contradicting the hypothesis. ■

This proposition states that productive workfare for unemployed can be optimal, provided that some conditions are satisfied. The first kind of condition is obvious. π has to be sufficiently high, but still lower than the first strictly positive wage rate. Hence, this proposition about the optimality of workfare comprises the non-optimality of unproductive workfare as well. Such a kind of workfare corresponds to $\pi = 0$, which is always below the related marginal rate of substitution. The second kind of condition is somewhat more hidden. The marginal rate of substitution in the absence of any work, $mrs(c^h, 0)$, has to be lower than the first strictly positive wage rate. As simulations show, this condition may be violated if the society is relatively wealthy in the sense that wage rates are high except the one of person h and per capita tax revenue g is rather low. Of course, one might still introduce some optimal productive workfare but occupations in this required work have to exhibit a productivity higher than market productivity w^1. This would imply the superiority of state organized work compared to market work, and would support the idea of a socialist world. History has proven this idea to be wrong.
After this general statement about the optimality of productive workfare it remains to find an optimal condition. This is done by the following proposition.

Proposition 2 *Let* $y^h = 0$ *and* $w^h > 0$. *If* v^h *with* $0 < v^h < l^{\max}$ *is optimal, then*

$$\pi = mrs(c^h, v^h). \tag{2}$$

Proof. Suppose $\pi > mrs(c^h, v^h)$ were optimal. Then a small increase of workfare by ϵ yields additional output $\epsilon\pi$, and costs $\epsilon \cdot mrs(c^h, v^h)$ for utility compensation. As the additional output exceeds the costs there is a surplus that can be used for a Pareto-improvement. Consequently, the situation was not optimal.

Suppose $\pi < mrs(c^h, v^h)$ were optimal. Then a small reduction of workfare by δ costs $\delta\pi$ as forgone output and yields $\delta \cdot mrs(c^h, v^h)$ as saved utility compensation. Since the forgone output is smaller than the saved consumption, there is a surplus for a Pareto-improvement. Hence, the situation is not optimal. ■

This proposition states the optimality condition for workfare in a second-best tax-transfer-scheme: at an interior optimum the productivity of workfare must equal the marginal rate of substitution. Reciprocally, if the productivity falls short of the marginal rate of substitution then even productive workfare is not optimal. Thus, to ensure the optimality of workfare, a strictly positive productivity of mandatory work is only necessary but not sufficient. In a second-best tax-transfer-scheme, workfare has to be implemented such that its productivity equals the individual marginal rate of substitution.
After having clarified that workfare can be optimal for unemployed, the employed people remain to be analyzed. Can workfare be optimal for someone who already has a gainful employment? For answering this question, I use Homburg's "agent monotonicity II" ((Homburg 2003*a*), p. 80): let person h be indifferent between the triples (c, y, v) and $(c + \epsilon, y, v + \delta)$ with $\epsilon, \delta > 0$. Then, people with $w > w^h$ prefer bundles with more workfare. To see this, consider the derivative of the utility function $u(c, y/w + v)$ with respect to the wage rate w which is $u_w = -u_2 y/w^2$. Differentiating u_w with respect to v for constant utility and income and a suitably adjusted consumption yields

$$\frac{du_w\left(c(v), y/w + v\right)}{dv} = \left(\frac{u_2}{u_1}u_{12} - u_{22}\right)\frac{y}{w^2} \geq 0, \tag{3}$$

where the implicit function $c(v)$ and the definition of the marginal rate of substitution were used. The derivative is positive which is due to a property that rests upon an assumption about preferences that has not played a role in optimal taxation yet: the non-inferiority of consumption. As it is shown in the appendix the non-inferiority of consumption makes the term in brackets positive (see equation (16)). Indifference curves in an u-w-space are steeper for more workfare. Hence, if a person h is indifferent between two bundles, i.e. at his wage w^h two curves intersect, then all people with higher wage rates choose the bundle with more workfare as it provides higher utility to them. Since c is a composite good, the assumption of non-inferiority seems to be suitable and the following proposition can be stated.

Proposition 3 *If $y^h > 0$ for some h, then $v^h = 0$ is optimal.*

Proof. Consider the optimum of the standard model which is equivalent to an optimum of our model in the case that $v^k = 0$ for all k. Such an optimum possesses the chain property.[4] Suppose $y^h > 0$ and $v^h > 0$ were optimal for some h. The workfare v^h is a small work requirement that was introduced in combination with an appropriate increase of h's consumption to keep her utility constant. Person $h+1$ was indifferent between her own bundle and that one of h. But from agent monotonicity II it follows that now person $h+1$ strictly prefers h's new bundle including the workfare. This violates $h+1$'s self-selection constraint and contradicts the hypothesis. ■

Thus, in any second-best tax-transfer-scheme it holds that people with gainful employment are optimally not on workfare. This is economically intuitive but has been unclear *a priori.* The core problem in a second-best world is to avoid that high productive persons mimic people with lower productivity because such imitations in turn would imply a lower degree of redistribution and hence lower welfare. The usual way to circumvent such problems of imitation is a distorting labor tax. However, productive workfare marks a potential alternative. The three propositions have clarified when this alternative should be used. The economic intuition is straightforward. The incentives of workfare for unemployed are positive as they prevent the more productive from mimicking those without a job. However, work obligations for people with gainful employment have negative incentive effects as the more productive even get an incentive to imitate those with a regular and a public employment. In this case implementing work requirements would signify a crowding-out of market work in favor of public work.

The propositions above have focused on the situation of a single person, taking her status of employment as a reference point (either unemployed or not). In

[4] The chain property states that all downward adjacent self-selection constraints are binding. By this, all remaining downward as well as all upward self-selection constraints are satisfied automatically.

the following two corollaries, I will concentrate somewhat on the reverse, taking the question whether a person is on workfare (Corollary 1) or not (Corollary 2) as our starting point.

Corollary 1 *If $v^h > 0$ for some h, then $y^h = 0$ is optimal.*

Proof. Suppose $v^h > 0$ and $y^h > 0$ were optimal. But according to Proposition 3 any strictly positive income implies $v^h = 0$. This contradicts the hypothesis. ■

Corollary 2 *If $v^k = 0$ and $v^h > 0$ for $k > h$, then $y^k > 0$ is optimal.*

Proof. An optimal $v^h > 0$ implies $y^h = 0$ according to Corollary 1, and $\pi = mrs(c^h, v^h)$ according to Proposition 2.
Suppose $y^k = 0$ were optimal. Let $k = h + 1$. Then $\pi < mrs(c^{h+1}, 0)$ because $v^{h+1} = 0$ is optimal by construction. Consequently, $mrs(c^h, v^h) < mrs(c^{h+1}, 0)$. The marginal rate of substitution increases in workfare,

$$\frac{\partial mrs}{\partial v} = -\left(\frac{u_{22}}{u_1} - u_2\frac{u_{12}}{u_1^2}\right) = \frac{1}{u_1}\left(\frac{u_2}{u_1}u_{12} - u_{22}\right) \geq 0 \tag{4}$$

because the term in brackets on the right hand side is positive due to the assumption of non-inferiority of consumption (equation (16) in the appendix). Moreover, the rate increases in consumption as well

$$\frac{\partial mrs}{\partial c} = -\left(\frac{u_{21}}{u_1} - u_2\frac{u_{11}}{u_1^2}\right) = -\frac{1}{u_1}\left(u_{21} - \frac{u_2}{u_1}u_{11}\right) \geq 0 \tag{5}$$

because the term in brackets on the right hand side is negative due to the assumption of non-inferiority of leisure (equation (17) in the appendix). This leads to the fact that c^{h+1} is strictly larger than c^h. However, $h + 1$'s bundle is not incentive compatible with respect to h as $u(c^h, v^h) < u(c^{h+1}, 0)$, where h can reach both bundles. Such a situation is suboptimal. Hence, the hypothesis of $y^{h+1} = 0$ being optimal is wrong. But if $y^{h+1} > 0$, then by Lemma 3 $y^k > 0$ which contradicts the hypothesis. ■

To sum up, in a second-best world, workfare and gainful employment are mutually exclusive. For people with regular market income, distortionary taxation remains the superior instrument to avoid imitations. However, in case of the unemployed, workfare might be the better alternative.

4 Workfare for the bunched

Up to now, it has been analyzed what are the determinants for optimal workfare measures and who should optimally be on workfare. It has become clear that workfare can only be optimal for unemployed people. A more technical name for unemployment was invented by Seade. He coined the term "bunching at the bottom" ((Seade 1977), p. 215). This expression literally illustrates what happens: persons of different wage rates are optimally bunched together at the bottom of the income scale, i.e. at zero income. Despite their different productivities, it is optimal to give them a uniform consumption-leisure-bundle. The phenomenon of bunching occurs rather often in optimal tax models ((Lollivier & Rochet 1983) (Weymark 1986)). Questions that will be answered in this section are, whether some or all unemployed are subject to workfare measures, whether they are confronted with a uniform or a non-uniform work obligation, and, hence, whether bunching can be overcome by introducing workfare measures or not.

A first insight regarding the individual utility levels of all jobless persons is given by the subsequent lemma.

Lemma 4 *$h \leq k$, $y^k = 0$ and $y^{k+1} > 0$ imply $u^h = u^k$.*

Proof. According to Lemma 2 $y^k = 0$ implies $y^h = 0$. From the related self-selection constraints $u(c^h, v^h) \geq u(c^k, v^k)$ and $u(c^k, v^k) \geq u(c^h, v^h)$ follows the hypothesis. ■

Hence, in a second-best tax-transfer-scheme workfare has to be implemented such that all unemployed persons enjoy the same utility level. Lemma 4 allows for heterogeneous work requirements combined with different levels of consumption which would abolish bunching. However, such a policy would not be optimal.

Proposition 4 *Let π be uniform and $h \neq k$. Then there are no $v^h, v^k > 0$ with $v^h \neq v^k$.*

Proof. Given $v^h, v^k > 0$, Corollary 1 requires $y^h = y^k = 0$. Suppose $v^k > v^h > 0$. By Lemma 4 $c^k > c^h$. Consider the convex combination $\widetilde{v} = 0,5(v^h + v^k)$ and

$\widetilde{c} = 0,5(c^h + c^k)$. Owing to the strictly convex preferences $u(\widetilde{c}, \widetilde{v}) \succ^h u^h$ and $u(\widetilde{c}, \widetilde{v}) \succ^k u^k$. Such a redistribution is possible because it has no output consequence, and it can be carried out until $v^h = v^k$ and $c^h = c^k$. To avoid problems of imitation by other types, consumption is assessed such that the utility level of the initial situation is reached, i.e. $c < \widetilde{c}$ with $u(c, \widetilde{v}) = u^h = u^k$. The remaining excess output can be redistributed to achieve a Pareto improvement. Hence, the initial situation was not optimal. ■

If workfare is optimal for at least one individual in the sense of Proposition 1, then such work requirements have to be imposed on all unemployed. The amount of obliged work must be the same for all of them. As a consequence of Lemma 4, they also receive the same transfer. Therefore, bunching at the bottom is preserved and now extended by a work obligation.
The intuition for a uniform work requirement under a uniform workfare productivity is the following. In a first-best world it is optimal that all individuals enjoy the same consumption. The more productive have to work more because their leisure is relatively more costly. In a second-best world with a uniform workfare productivity, market productivities do not matter for the people in question. Since leisure costs are the same to all unemployed, they all are given the same amount of leisure. Consequently, they are exposed to the same work requirements.

5 Second-best tax schedules with workfare

As already mentioned when explaining the model, optimal tax and transfers follow implicitly as

$$T^h = y^h - c^h. \tag{6}$$

A positive value indicates a tax payment to the government and a negative value is a benefit payment from the government. In addition, work obligations are characterized by

$$v^h = \begin{cases} \overline{v} \geq 0 \text{ if } y^h = 0 \\ 0 \text{ if } y^h > 0 \end{cases}. \tag{7}$$

Triples c^h, y^h, v^h for all h characterize second-best tax-transfer-schemes with workfare. The discrete marginal tax rates m^h are defined for all $y^h \neq y^{h-1}$ as

$$m^h = \frac{T^h - T^{h-1}}{y^h - y^{h-1}}. \tag{8}$$

The discrete marginal tax rate is the relevant marginal rate with respect to redistributive aspects. For conventional reasons we will denote the local (or implicit) marginal tax rates by T'^h. They are given by

$$T'^h = 1 + \frac{u_2(c^h, l^h + v^h)}{u_1(c^h, l^h + v^h)} \frac{1}{w^h}. \tag{9}$$

These are the crucial marginal tax rates when considering incentive aspects.
Despite the difficulty of optimal income tax models, there is a certain tradition for using them to gain some political insights. Consider e.g. the important U.S. policy instrument for fighting poverty, the Earned Income Tax Credit (EITC). From a technical point of view parts of the EITC correspond to negative (discrete) marginal tax rates. Diamond (Diamond 1980) and later Saez (Saez 2002) have allegedly proven that such negative marginal tax rates can be optimal. But as Saez used a model, where all persons have the same productivity but different preferences, his results do not carry over to the Mirrlees framework. On the contrary, the non-negativity of marginal tax rates is one of the very few general results of the standard model (Hellwig 2005). It even holds if the labor-leisure choice is a pure participation decision (Homburg 2002).
But how is the situation in the presence of workfare? As work requirements are widespread in the U.S., maybe negative marginal tax rates are optimal when work obligations are imposed at the same time? The following proposition clarifies this issue.

Proposition 5 *For any income y^h*
a) The implicit marginal tax rate is non-negative, $T'^h \geq 0$,
b) The discrete marginal tax rate is strictly positive, $m^h > 0$.

Proof. a) Let $v^h = 0$. Then, the non-negativity of the implicit marginal tax rates results from the standard model. The well-known 'no distortion at the top' induces the weak inequality.
Let $v^h > 0$. Then, by Corollary 1 $y^h = 0$. Dividing the optimality condition of workfare (2), $\pi = mrs(c^h, v^h)$, by $w^h > 0$, substituting in the definition of the

implicit marginal tax rate, and rearranging terms yields

$$T'^h = 1 - \frac{\pi}{w^h}. \tag{10}$$

As $\pi < w^h$ for $w^h > 0$ by construction, the implicit tax rate in (10) is strictly positive.

b) Notice, that m^h is only defined if at least $y^h > 0$. Suppose $m^h < 0$ were optimal. Then either (i) $y^h - y^{h-1} < 0$ or (ii) $T^h - T^{h-1} < 0$. Ad (i): $y^{h-1} > 0$ and $y^h = 0$ would violate Lemma 2. $y^{h-1} > y^h > 0$ would violate Lemma 3. Hence, (i) is not possible. Ad (ii): $T^h - T^{h-1} < 0$ is equivalent to $y^h - c^h < y^{h-1} - c^{h-1}$. In turn, this happens if 1) $y^h < y^{h-1} \wedge c^h = c^{h-1}$, or 2) $y^h < y^{h-1} \wedge c^h < c^{h-1}$, or 3) $y^h < y^{h-1} \wedge c^h > c^{h-1}$, or 4) $y^h = y^{h-1} \wedge c^h > c^{h-1}$, or 5) $y^h > y^{h-1} \wedge c^h > c^{h-1}$. The cases 1), 2), and 3) would violate Lemma 3. As it is concluded after Lemma 2 and Lemma 3, in the case of strictly positive income some standard results can be applied. One of these is the chain property, i.e. all downward adjacent self-selection constraints are bindung. Consequently, cases 4) and 5) cannot be optimal because person h would strictly prefer his bundel to the one of person $h-1$. This contradicts the hypothesis. ■

The non-negativity of marginal tax rates, discrete as well as local rates, remains a valid feature of second-best tax-transfer-schemes even in the presence of workfare. Hence, from an optimal tax perspective the EITC is suboptimal.

6 Extension: Non-uniform workfare productivities

Up to now, a uniform workfare productivity π was assumed. However, one might also think of work obligations in which the output per time varies with the individual productivities w^h. This leads to a non-uniform workfare productivity $\pi^h = \varphi(w^h)$ with $\varphi(\cdot)$ being a monotonically increasing and contracting transformation of w^h, i.e. $0 \leq \varphi(w^h) < w^h$. Denoting now the individual workfare productivity with π^h, almost all the lemmata and corollaries as well as the propositions in section 3 and 5 remain valid. However, Proposition 4 is not true anymore. In fact, work requirements turn out to be substantially different under this scenario.

Proposition 6 *Let $\pi^i = \varphi(w^i)$ be non-uniform and $k > h$. Then, at the optimum, there is no $v^k > 0$ with $v^k \leq v^h$.*

Proof. Firstly, suppose $v^h = 0$. Then the claim is trivially true. Secondly, suppose $v^h > 0$, i.e. $0 < v^k \leq v^h$ were optimal. Then, by Corollary 1, $y^h = y^k = 0$, and by Lemma 4, $c^k \leq c^h$ as $u^k = u^h$. As both pairs of consumption and leisure lie on the same indifference curve $mrs^k \leq mrs^h$. Both work requirements are supposed to be set optimally. Therefore, workfare for k as well as for h must satisfy the optimality condition (2), i.e. $mrs^k = \pi^k$ and $mrs^h = \pi^h$. Consequently, $\pi^k \leq \pi^h$. But by the very definition of the non-uniform workfare productivity, we have $\pi^k > \pi^h$ because $w^k > w^h$. This contradicts the hypothesis. ■

Proposition 6 states that under a non-uniform workfare productivity, workfare increases monotonically in the wage rate. Those individuals who have a higher market productivity have also a higher productivity in required work. They are forced to do more workfare than those individuals with lower productivities. Still, workfare productivity has to exceed a certain individual threshold as stated by the optimality condition (2) to be part of an optimal tax mix.

The economic intuition for heterogenous work requirements is as follows. Due to their higher productivity, unemployment of the more productive is more costly to society in terms of forgone output. Hence, for the same level of well-being like the other unemployed, the more productive have to do more workfare. As this mandatory work is observable none of the unemployed can escape this obligation by imitating someone else. Employed people are more productive (Lemmata 2 and 3). They do not have an incentive to mimic the unemployed because utility increases weakly in type (Lemma 1) In comparison to the standard model with bunching at the bottom, the introduction of workfare will inhibit bunching. This can occur in total if workfare is already optimal for the lowest unemployed type. Notice that the statement of Lemma 4 that all unemployed people have the same utility, is still valid. Although, the more productive are required to spend more time in workfare, they are only compensated for their disutility.

Notice, that it may well occur, that a more productive person is not obligated to do any work requirement, whereas a less productive individual is forced to do some workfare. In the diction of Proposition 6 $v^k = 0$ and $v^h > 0$. However, for this case Corollary 2 states, that the more productive is regularly employed, i.e. $y^k > 0$.

A striking result concerns the discrete marginal tax rate at the bottom end of the income distribution. The most productive type of individuals that is on workfare, denoted as $\underline{k}$, may receive a public transfer that is larger than the net income of the first person with gainful employment, denoted $\overline{k}$, i.e. $c^{\underline{k}} > c^{\overline{k}}$. This implies that the discrete marginal tax rate is well above one hundred percent, $m^{\overline{k}} > 1$ (see Table 4 in the next section).

7 Illustrations

Consider an economy with six different types of wage rates, where the lower classes are narrow and the higher classes are wider and therefore have more weight in the distribution of the productivities. Assume a utility function $u(c^h, l^h + v^h) = [\ln(c^h) + \ln(500 - l^h - v^h) - 12] \cdot 10000$ with 500 being the maximum time per month. The per-capita revenue is $g = 550$, i.e. the tax system is not purely redistributive but serves also for financing public goods. Table 1 depicts the standard second-best optimum. This optimum corresponds to an optimum in our setting with $\pi = 0$.

As one can see, marginal tax rates are high at the bottom of the income scale and decrease monotonically. The local marginal tax rate vanishes at the very top of the income scale, and the discrete marginal tax rates are positive everywhere. There is induced unemployment, since some of the productive poor are bunched together with the disabled at zero income (the well known bunching at the bottom). Here, any work requirement with productivity $\pi < 1 = w^1$ is allowed to be implemented. Due to transaction costs persons with productivities between zero and one do not succeed in finding a gainful employment. They have zero productivity by convention. Table 2 displays the economy, where a work obligation with productivity $\pi = 0.9$ is introduced.

In line with Proposition 1 such a work obligation is optimal for the unemployed.

Table 1: Standard Optimum

h	w	f	c	y	v	mrs	T	m	T′	u
0	0	2%	343	0	0	0.69	−343	–	–	512
1	1	3%	343	0	0	0.69	−343	–	31%	512
2	2	5%	343	0	0	0.69	−343	–	66%	512
3	4	45%	705	1028	0	2.9	323	65%	27%	512
4	7	30%	1212	2061	0	5.9	849	51%	16%	4253
5	10	15%	1887	3113	0	10.0	1226	43%	0%	7829
									EU =	**2732**

Table 2: Workfare with $\pi = 0.9$

h	w	f	c	y	v	mrs	T	m	T′	u
0	0	2%	392	0	63	0.9	−392	–	–	516
1	1	3%	392	0	63	0.9	−392	–	10%	516
2	2	5%	392	0	63	0.9	−392	–	55%	516
3	4	45%	707	1030	0	2.9	323	70%	27%	516
4	7	30%	1213	2061	0	5.9	848	51%	15%	4265
5	10	15%	1890	3114	0	10.0	1224	43%	0%	7838
									EU =	**2739**

The optimality condition (2) turns up with $mrs^0 = mrs^1 = mrs^2 = 0.9 = \pi$, and a uniform work requirement of $v = 63$ is imposed. The marginal tax rates remain positive. Welfare, denoted by EU, increases slightly. Even more, we have Pareto improvement as not only taxpayers are better off but also people on workfare, i.e. transfer recipients. The latter are granted higher transfer in turn for their work obligation.

Finally, the economy's optimal tax-transfer-scheme is considered when productivity in workfare is non-uniform with $\pi^h = \varphi(w^h) = \sqrt{2.5w^h + 1} - 1$. The resulting optimum is given in the following Table 3.

With productivity in workfare depending on individual productivity w^h now,

Table 3: Workfare with non-uniform π I

w	π	**f**	**c**	**y**	**v**	mrs	**T**	**m**	**T′**	**u**
0	0	2%	344	0	0	0.69	−344	–	–	544
1	0.87	3%	387	0	56	0.87	−387	–	13%	544
2	1.45	5%	500	0	156	1.45	−500	–	27%	544
4	2.32	45%	709	1031	0	2.9	322	80%	27%	544
7	3.30	30%	1215	2059	0	5.9	844	51%	16%	4298
10	4.10	15%	1890	3109	0	10.0	1219	43%	0%	7866
									EU =	**2768**

optimal work obligations are heterogeneous and increasing. Although all unemployed have the same utility, the more productive among them take higher workfare because of cooperative behavior. Marginal tax rates are again positive. In comparison to the standard optimum of Table 1 the implementation of non-uniformly productive workfare has increased overall utility. Again, we have a Pareto improvement. Whereas the overall increase is logical, and by this a usual result, the Pareto improvement is not.

Consider an economy with twenty equally distributed types of wage rates. Again, $u(c^h, l^h + v^h) = \ln(c^h) + \ln(500 - l^h - v^h)$ and $g = 550$. Workfare productivities are non-uniform according to $\pi^h = \varphi(w^h) = \sqrt{2.5w^h + 1} - 1$. Table 4 depicts the resulting optimum.

Consider the persons with wage rates $w^5 = 5$ and $w^6 = 6$. Whereas the first person is unemployed and subject to workfare measures of $v^5 = 154$, the latter is in gainful employment. This person has a market income of $y^6 = 853$, corresponding to a working time of around $l^6 = 142$. The person on workfare has less leisure than the more productive type performing a regular job. However, the latter person has a lower net income than the unemployed ($c^6 = 898 < 927 = c^5$) and, consequently, faces a discrete marginal tax rate of $m^6 = 103\%$.[5] Apart from that, a second issue deserves attention. The person with wage rate $w^6 = 6$ is

[5] The negative implicit marginal tax rate T'[1] as well as all implicit marginal tax rates for unemployed persons are meaningless.

Table 4: Workfare with non-uniform π II

w	π	**c**	**y**	**v**	*mrs*	**T**	**m**	**T′**	**u**
0	0	642	0	0	1.28	−642	–	–	6799
1	0.87	642	0	0	1.28	−642	–	−28%	6799
2	1.45	682	0	29	1.45	−682	–	28%	6799
3	1.92	784	0	90	1.92	−784	–	36%	6799
4	2.32	863	0	128	2.32	−863	–	42%	6799
5	2.67	927	0	154	2.67	−927	–	46%	6799
6	3.00	898	853	0	2.51	−45	103%	58%	6799
7	3.30	1025	1182	0	3.09	157	61%	56%	7351
8	3.58	1165	1521	0	3.76	355	59%	53%	7969
9	3.85	1318	1867	0	4.51	549	56%	50%	8628
10	4.10	1486	2220	0	5.35	734	53%	47%	9313
11	4.34	1669	2580	0	6.29	911	49%	43%	10014
12	4.57	1869	2947	0	7.35	1077	45%	39%	10725
13	4.79	2088	3319	0	8.53	1231	41%	34%	11441
14	5.00	2326	3696	0	9.86	1369	37%	30%	12160
15	5.20	2586	4077	0	11.33	1492	32%	24%	12879
16	5.40	2868	4463	0	12.97	1595	27%	19%	13597
17	5.60	3173	4852	0	14.79	1679	21%	13%	14313
18	5.78	3504	5244	0	16.79	1739	16%	7%	15026
19	5.96	3863	5639	0	19.00	1776	12%	0%	15735
								EU =	**9799**

employed, but still receives some transfer. The transfer can be interpreted as a wage subsidy. Hence, work obligations and wage subsidies can be part of an optimal tax mix at the same time.

8 Conclusion and Evaluation

This paper has analyzed productive work requirements as they have become standard in several Western welfare states. Extending a discrete version of the Mirrlees optimum income tax model by workfare, I identified, when workfare will work. The productivity in the work obligation must exceed a certain threshold as it is characterized in Proposition 1. The amount of workfare is optimally set in a way that workfare productivity equals the marginal rate of substitution between leisure and consumption of those persons who are called to do the work. However, only unemployed persons can be subject to such work measures. Work obligations for people with gainful employment are never optimal. The work requirements are uniform. As utility of all unemployed persons must be the same, transfers are granted in a way that bunching at the bottom is preserved. The tax schedule exhibits positive marginal tax rates everywhere. Hence, tax systems like the U.S. EITC are also suboptimal in the presence of workfare. This is also true when assuming workfare productivities that are positively correlated to the individual market wage. However, in such a scenario, work requirements are non-uniform. The most productive unemployed is subject to the highest work obligation. In this context, discrete marginal tax rates can exceed a hundred percent at the bottom of the income scale. In sum, productive workfare turned out to be a valuable instrument to the social planner. The analysis shows that its worldwide use is justified. The implementation of workfare always leads to weak increase of overall welfare, and it may even yield a Pareto improvement.

For further research, the most promising extensions of the present model are the following. Firstly, it would be interesting to take account of moonlighting among unemployed. In such a world, workfare might serve to induce opportunity costs to those without gainful employment. Consequently, a new optimality condition for workfare being part of an optimal tax mix might arise. Secondly, one should have a look at the forces that yield a Pareto improvement when intoducing workfare. When understanding the mechanics behind this result it will be hard to find arguments against workfare as a standard part of an optimal tax transfer scheme.

9 Appendix

Consider a person that maximizes her utility $u(c, l)$ subject to a budget constraint $c = wl + e$, with e being an exogenous income. Notice that workfare is not part of the individual problem because it is imposed by the government. Differentiating the corresponding Lagrangian $L = u(c, l) + \lambda(wl + e - c)$ yields the following first order conditions:

$$\frac{\partial L}{\partial \lambda} = wl + e - c = 0, \tag{11}$$

$$\frac{\partial L}{\partial c} = u_1 - \lambda = 0, \tag{12}$$

$$\frac{\partial L}{\partial l} = u_2 + \lambda w = 0. \tag{13}$$

The Jacobian of this system reads

$$J = \begin{pmatrix} 0 & -1 & w \\ -1 & u_{11} & u_{12} \\ w & u_{21} & u_{22} \end{pmatrix}. \tag{14}$$

By multiplying the first row and the first column by $-\lambda$, the matrix J can be transformed to

$$J^* = \begin{pmatrix} 0 & u_1 & u_2 \\ u_1 & u_{11} & u_{12} \\ u_2 & u_{21} & u_{22} \end{pmatrix} \tag{15}$$

whose determinant has the same sign as the one of J. The matrix J^* is the bordered Hessian of the utility function u. Recall that $u \in C^2$ is strictly concave by assumption and therefore as well pseudoconcave as quasiconcave. A function is pseudoconcave if the largest $(n-1)$ leading principal minors of the Hessian alternate in sign, with the smallest of these, i.e. the third order leading principal minor, positive ((Simon & Blume 1994), p. 530). Here, the leading principal minor is at the same time the smallest and corresponds to the determinant of J^*. Therefore $\det J^* > 0$, and consequently $\det J > 0$.

By assumption, consumption and leisure are non-inferior goods. Implicitly differentiating and substituting in form the first order conditions yields:

$$\frac{\partial c}{\partial e} = -\frac{\begin{vmatrix} 0 & 1 & w \\ -1 & 0 & u_{12} \\ w & 0 & u_{22} \end{vmatrix}}{|J|} = \frac{u_{12}\frac{u_2}{u_1} - u_{22}}{|J|} \geq 0, \tag{16}$$

$$\frac{\partial l}{\partial e} = -\frac{\begin{vmatrix} 0 & -1 & 1 \\ -1 & u_{11} & 0 \\ w & u_{21} & 0 \end{vmatrix}}{|J|} = \frac{u_{21} - \frac{u_2}{u_1}u_{11}}{|J|} \leq 0. \tag{17}$$

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