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Optimal Workfare in Unemployment Insurance*

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Abstract

Most workers are only partially insured against unemployment. One reason is that high unemployment compensation creates a free rider problem when monitoring of job search behavior is limited; people who do not seek employment (non-workers) may nevertheless collect unemployment compensation. We show that unproductive workfare for unemployed workers may improve unemployment insurance if workers and non-workers value leisure differently. If they differ only with respect to productivity workfare has to be based on a productivity related task requirement (task workfare); a simple time requirement (time workfare) is not enough. Task workfare is simply a better screening device, also implying that task workfare Pareto dominates time workfare. Finally, we show that the scope for using workfare is larger the smaller are the transfers from workers to non-workers.

Keywords: Workfare, Unemployment Insurance.

JEL Classification Numbers: D6, D8, J65.

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1 Introduction

The use of workfare has increased in recent years and in general "activation" of recipients of various kind of public support is on the political agenda in many countries. Is there an economic argument for using workfare in general and specifically in relation to groups that are neither poor nor have weak abilities? This paper addresses this issue by analyzing the optimal use of workfare in unemployment insurance schemes.

Unemployment insurance (UI) improves welfare for risk adverse workers by smoothing income between periods of employment and unemployment. Nevertheless, workers appear to be under insured against unemployment in many countries. A standard explanation for this is the free-rider problem: voluntarily jobless persons (non-workers) can claim benefits because of imperfect monitoring of job search behavior. We show that workfare may facilitate better insurance for workers when job search behavior is private information. In fact, we show that unemployment insurance with workfare may Pareto dominate any system without workfare, even when workfare activities inflict disutility on workers without bringing about any valuable product.[1]

The intuition behind this result is as follows. If non-workers dislike work more than workers, effort-contingent UI benefits are more attractive to workers than to non-workers. Thus, the insurance of workers can be improved by raising UI benefits and require just enough effort in exchange to prevent non-workers from signing up as unemployed. It is then (constrained) Pareto optimal to use workfare if the increase in a worker's expected utility due to the better insurance is large enough to cover the utility loss from spending time on workfare when unemployed.

Traditionally workfare has been used in poverty alleviation programs[2]

[1] So, here workfare is like digging holds in the ground only to fill them up again.

[2] The origin of "workfare" goes back at least to the Mercantilistic period; e.g., in Denmark state organized forced labor came into use after the poverty legislation in 1587 (see E. Ladewig Petersen, 1980). In recent years workfare has been placed more central in

where the challenge is to give transfers to those with poor abilities without making it attractive for those with more fortunate abilities to forsake these. It is often suggested that these more fortunate types could be discouraged from doing so if benefits were accompanied by a work requirement. However, the overall conclusion from the literature on this issue (see Timothy Besley and Stephen Coate, 1992, 1995; Craig Brett, 1998; Paul Beaudry and Charles Blackorby, 1998) is that workfare is not an obvious mean to secure a minimum *utility* level for all if workfare does not involve some kind of net product to society; but that it may be used to provide a minimum *income* level (thereby disregarding the utility loss inflicted on people in workfare).[3]

In recent years the use of workfare has gone way beyond poverty alleviation programs and is now discussed in relation to joblessness in general. In the U.S. many UI experiments include elements of effort requirements, e.g., recipients of UI benefits have to show up at the Employment Service frequently or participate in part-time courses on how to search and apply for jobs (see Bruce D. Meyer, 1995). Activities like these expropriate time from unemployed workers and thus reduce their current utility, independently of whether or not their job search skills improve. This is also the case for Active Labor Market Programs in most European countries. These programs are now compulsory (or will be so in the future)[4] for long term unemployed such that they face effort requirements when receiving UI benefits.[5]

welfare and labor market policies. In U.S. very directly (see Gary Burtless, 1990; Judith M. Gueron, 1990; Daniel Friedlander, David H. Greenberg, and Philip K. Robins, 1997) and in Europe indirectly via Active Labor Market Policy (OECD, 1997).

[3]It is difficult to make Pareto improvements by using workfare in poverty alleviation programs since here workfare is basically used to increase the level of transfers from workers to non-workers. Beaudry and Blackorby (1998) does, however, provide a numerical example illustrating that it may be (ex ante) optimal to use workfare to secure a minimum utility level. This does though require heterogeneity along at least two dimensions.

[4]The countries of the European Union have committed themselves to require work or educational effort in return for UI benefits after the first year of unemployment (The European Council, 1997).

[5]In many countries participation in Active Labor Market Programs has been required for years but without actually being enforced. E.g., the Netherlands did not start to

Assuming that UI is provided for by the government[6] there is of course no need for workfare if the government can monitor job search behavior perfectly. UI benefit recipients are in general required to search but experiences from the last decades have shown that monitoring of job search behavior is bound to be limited. The consequences of this is either high taxes and low average income (when UI benefits are high) due to excessive (ab)use of the UI system[7] or under insurance (when UI benefits are low). Thus, the UI systems of the U.S. and Europe, with respectively low and high benefit levels,[8] may be seen as two different ways of coping with the same problem.

We show that workfare based on a time requirement or on a task requirement may (Pareto) improve UI systems. This occurs if workers and non-workers differ sufficiently with respect to preferences for leisure. If workers and non-workers differ only with respect to productivity it is never optimal to use "time workfare"; but it may still be optimal to use "task workfare". In general, task workfare Pareto dominates time workfare. Finally, we show that the smaller are the transfers from workers to non-workers the larger is the scope for using workfare.

The paper is organized as follows. Section 2 and 3 describe the model and analyze the complete information case. Section 4 derives the optimal insurance scheme with and without workfare and characterizes how the optimal use of workfare depends on the difference between workers and non-workers

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sanction people who did not participate before 1992 (Gerard J. van den Berg et al., 1998).

[6]In almost all countries UI is provided for by the government. A few countries do have union-administrated insurance funds but they are subsidized to such an extent that they are nearly indistinguishable from government-administrated systems (see Bertil Holmlund, 1998). For a theoretical explanation of why UI is not offered by the private sector see Henry Chiu and Edi Karni (1998).

[7]For instance, 40 percent of persons receiving UI benefits or social assistance (with job search requirements) in the early nineties in Denmark were not unemployed according to the ILO criteria, see Peder Pedersen and Nina Smith (1995) pp. 197-198. For more than a half of the persons the reason is that they do not search actively. Others simply report that they do not want a job.

[8]In 1994/5 the net replacement ratio for a single worker in the first year of unemployment was around 1/3 in the US and 2/3 in the EU (John P. Martin, 1996).

and on the initial transfer level. Section 5 compares time workfare and task workfare, and lastly Section 6 concludes.

2 The Model

We consider a population consisting of two types, A and B. Let η and $1-\eta$ be the fractions of these two types respectively in the population, where $0<\eta<1$. The utility of individual i is given by

$$u_i = v\left(I_i - \phi_i \ell_i\right), \quad i \in \{A, B\},$$

where I_i is income, ℓ_i is forgone leisure, and ϕ_i represents valuation of leisure relative to income which may differ between the two types. This implies that the incentives to work are high for given I_i and ℓ_i when ϕ_i is low. We assume that the utility function, v, is C^2 and fulfills $v'(\cdot)>0$, $\lim_{x\to 0} v'(x)=\infty$, and $v''(\cdot)<0$, where the strict concavity implies that the agents have preferences for smoothing income net of disutility of work between different states.

The timing of events is as follows. First, a person decides whether or not to join the labor force. Second, all members of the labor force receive a job offer with probability $\rho \in (0,1)$ which they either accept or reject, and if they reject they remain jobless. The net wage per unit of working time in an ordinary job for type i is given by $w_i - t$ where w_i is an exogenous wage rate and where t is a tax on employed workers used to finance the benefit system. Since income and leisure are perfect substitutes the labor supply, ℓ_i, is either zero hours or the maximum number of hours, normalized to one. We assume that $w_A \geq w_B$ and $\phi_A \leq \phi_B$ such that type A is always more eager to work than type B.

Unemployed workers receive an unemployment compensation package $\{b, \ell^e\}$, consisting of a monetary transfer, b, and an effort requirement, ℓ^e, measured in time units. Thus, to collect benefits unemployed have to spend a certain amount of time on workfare activities (time workfare). Alternatively, it may be possible to require certain productivity related tasks of UI recipients in exchange of benefits (task workfare) which we analyze in Section 5. Those outside the labor force receive $\underline{b}$ in social assistance which is not accompanied by any effort requirements.[9] We are only interested in the cases where transfers are sufficiently high, $\underline{b} > w_B - \phi_B$, so that type B strictly prefers not to work.

Suppose workers (type A) join the labor force and receive the package $\{b, \ell^e\}$ if unemployed and that non-workers (type B) are outside the labor market receiving $\underline{b}$. Then the utility of non-workers is $u(\underline{b})$ whereas the expected utility of workers is

$$E(u_A) = \rho v (w_A - t - \phi_A) + (1-\rho) v (b - \phi_A \ell^e). \tag{1}$$

A compensation and transfer policy has to fulfill the budget constraint

$$\eta [\rho t - (1-\rho) b] - (1-\eta) \underline{b} \geq 0, \tag{2}$$

where the first term is the net expected revenue of workers whereas the last term is the costs of social assistance to non-workers. We are interested in whether maximizing the expected utility of workers for a given minimum utility level of non-workers,

$$v(\underline{b}) \geq \underline{u}, \tag{3}$$

gives a solution with workfare, $\ell^e > 0$, when receiving a job offer is private information. If so, it implies that the solution Pareto dominates any other solution without workfare. We will restrict ourselves to only look at

$$\underline{u} \leq \bar{u} \equiv v(\eta\rho [w_A - \phi_A]),$$

implying that workers get at least as much utility as non-workers. This excludes uninteresting cases where social assistance is higher than UI benefits.

[9] It is never Pareto optimal to require effort of type B. It would be possible to reduce the effort requirement and the benefit level of type B keeping their utility fixed while increasing utility of type A through a lowering of the tax level.

3 Complete Information

To illustrate the incentive problems arising under incomplete information we start by analyzing the complete information case. Here, it is possible to condition the receipt of any package on the claimants type and also on whether or not the person has received and accepted a job offer. Thus, the package $\{b, \ell^e\}$ is only offered to workers (type A) and only if they do not get a job offer. Now, the problem is to maximize (1) subject to the budget constraint (2), the minimum utility requirement (3), the non-negativity requirements $b \geq 0$, $\underline{b} \geq 0, t \geq 0$, $\ell^e \geq 0$, and the individual rationality constraints that nobody get less utility than $\underline{u}$. This gives a solution characterized by (see Appendix)

$$\ell^e = 0, \quad v\left(\underline{b}\right) = \underline{u}, \quad t = \frac{1}{\rho}\frac{1-\eta}{\eta}\underline{b} + \frac{1-\rho}{\rho}b,$$

and

$$w_A - t - \phi_A = b.$$

From these equations it is possible to derive

Proposition 1 (i) *There is no workfare under complete information.* (ii) *Workers are perfectly insured against unemployment.* (iii) *UI benefits are strictly above social assistance as long as the minimum utility requirement is below its maximum.* (iv) *An increase in the minimum utility level increases social assistance, increases the tax level, and reduces UI benefits.*

Proof. (ii) follows from the last of the above equations. (iii) follows from the above equations and $\underline{u} < \bar{u}$. This is seen by inserting $\eta\rho\left[w_A - \phi_A\right]$ into $\underline{b}$ in the above equations giving exactly $\underline{b} = b$. A lower $\underline{u}$ implies lower $\underline{b}$ and larger b. (iv) follows from total differentiation of the above equations and equation (3). $\square$

Obviously, there is no point in putting unemployed workers on unproductive workfare as there is no need for screening under complete information. The relationship $w_A - t - \phi_A = b$ implies that utility is equalized across the two states "employment" and "unemployment" for workers such that they are perfectly insured against unemployment. Finally, UI benefits fall and taxes increase when the minimum utility requirement, $\underline{u}$, increases as this raises the transfers from workers to non-workers.

When social assistance is below UI benefits (i.e., $\underline{b} < b$), it is clear that non-workers have an incentive to join the labor force in order to obtain the high benefit level, b, if they can avoid working. For instance, this will be the case when it is impossible to observe if a person has been offered a job. It is such type of incomplete information we now turn to.

4 Incomplete Information

We now assume that it is impossible to observe whether a person is willing to work or not (i.e., of type A or type B) and to observe if a person has obtained a job offer. This yields the following additional constraints to the maximization problem of the previous section:

$$v\left(w_A - t - \phi_A\right) \geq v\left(b - \phi_A \ell^e\right), \tag{4}$$

$$v\left(\underline{b}\right) \geq v\left(b - \phi_B \ell^e\right). \tag{5}$$

The first constraint states that workers should prefer employment to unemployment reflecting that it is impossible to observe whether a worker has rejected a job offer in order to stay on benefits. The second constraint is an incentive compatibility constraint stating that non-workers should prefer $\underline{b}$ to the package $\{b, \ell^e\}$.

4.1 Without Workfare

Before analyzing the desirability of using workfare in UI benefit schemes, it is worthwhile to ask what is the optimal UI benefit level for workers if workfare cannot be used. To illustrate the main point of this section we do not need any minimum utility level which is therefore set equal to zero, $\underline{u} = 0$. Thus, we maximize (1) subject to (2), (4), (5), and $\ell^e = 0$ with respect to b, $\underline{b}$, and t. The solution is characterized by (see Appendix)

$$b = \underline{b}, \qquad t = b\frac{1-\rho\eta}{\rho\eta},$$

and

$$\frac{v'(b)}{v'(w_A - t - \phi_A)} = \frac{1-\eta\rho}{(1-\rho)\eta} > 1.$$

From these equations it is possible to establish

Proposition 2 *Without workfare and without a minimum utility requirement, workers prefer to have* (*i*) *less than full insurance against unemployment and* (*ii*) *a positive social assistance (utility) level of non-workers.*

Proof. (*i*) It follows from the last of the above equations that $w_A - t - \phi_A > b$ when $\eta < 1$. (*ii*) It follows from the above equations that $b = \underline{b} > 0$. □

The reason that workers only become partly insured against unemployment when there are non-workers in the population (i.e., $\eta < 1$) is that more insurance implies higher transfers from workers to non-workers. With perfect insurance, the marginal loss of less insurance is zero due to the envelope theorem whereas the marginal gain is a direct reduction in transfers/taxes. Therefore, full insurance is never optimal. The second result states that workers prefer to give non-workers transfers (although they do not care about them) in the presence of incomplete information; otherwise workers would not get any insurance themselves. Hence, non-workers obtain positive utility without a minimum utility requirement.

4.2 With Workfare

Now, we turn to the main question of the paper. Given some minimum utility requirement, $\underline{u}$, does there exist a package $\{b, \ell^e\}$ with unproductive workfare, $\ell^e > 0$, that Pareto dominates the best package without workfare? To answer this question, we maximize (1) subject to (2), (3), (4), and (5) with respect to b, $\underline{b}$, t, and ℓ^e. The solution is characterized by (see Appendix)

$$t = \frac{1}{\rho}\frac{1-\eta}{\eta}\underline{b} + \frac{1-\rho}{\rho}b,$$
$$\underline{b} = b - \phi_B \ell^e,$$

and

$$\ell^e > 0, \quad \frac{v'(w_A - t - \phi_A)}{v'(b - \phi_A \ell^e)} = 1 - \frac{\phi_A}{\phi_B},$$

or

$$\ell^e = 0, \quad \frac{v'(w_A - t - \phi_A)}{v'(b)} > 1 - \frac{\phi_A}{\phi_B},$$

and

$$v(\underline{b}) = \underline{u}, \quad \frac{v'(w_A - t - \phi_A)}{v'(b - \phi_A \ell^e)} > \frac{1-\rho}{1-\rho+\frac{1-\eta}{\eta}},$$

or

$$v(\underline{b}) > \underline{u}, \quad \frac{v'(w_A - t - \phi_A)}{v'(b - \phi_A \ell^e)} = \frac{1-\rho}{1-\rho+\frac{1-\eta}{\eta}}.$$

The first two equations follow from the budget constraint (2) and the incentive compatibility constraint (5) both being binding. The next two equations reveal that workfare may or may not be part of a solution depending on the parameters of the model. Finally, the last equations show that the minimum utility requirement may or may not be binding which is what one should expect given the results in the previous section. From these equations, we get

Proposition 3 *There exists $\tilde{u} \in (0, \bar{u})$ such that for each utility level of non-workers, $\underline{u} \leq \tilde{u}$, workers strictly prefer an unemployment insurance scheme with workfare, $\ell^e > 0$, if and only if workers and non-workers differ sufficiently in their valuation of leisure, $\frac{\phi_B}{\phi_A} > \frac{1-\rho\eta}{1-\eta}$.*

Proof. See Appendix. □

This is the main result. It states that unproductive workfare for unemployed workers may yield a Pareto improvement from an initial situation without workfare and that the scope for using workfare is larger the smaller are the transfers from workers to non-workers (i.e., the smaller is $\underline{u}$). Introducing workfare can only create a gain for workers if it is possible to raise there UI benefits, b, more than the utility loss inflicted upon them because of the effort they have to deliver when unemployed, $\phi_A \ell^e$. This is possible when non-workers value leisure more than workers. Then the effort requirement needs only be relatively small to discourage non-workers from joining the labor force such that the disutility inflicted on workers is relatively small. Hence, b can increase more than $\phi_A \ell^e$. The proposition shows that the difference in valuation of leisure between workers and non-workers has to be sufficiently large, that is $\frac{\phi_B}{\phi_A} > \frac{1-\rho\eta}{1-\eta} > 1$, before workfare is used.

If η is large then the fraction of non-workers in the population is small implying that it is relatively cheap to have a high transfer level compared to the utility loss from workfare that has to be inflicted upon all unemployed workers in order to discourage the few non-workers from claiming UI benefits. In this case the difference in valuation of leisure has to be large for workers to prefer UI with workfare.

Contrary, if ρ is large then unemployment among workers is small implying that the utility loss among workers of being on workfare is small relative to the number of non-workers discouraged from claiming UI benefits. Thus, a high ρ reduces the required difference in valuation of leisure between the two types and makes workfare more preferable.

If the minimum utility requirement, $\underline{u}$, is high then transfers are high. This implies that the UI benefit level can be high before conflicting with the incentive compatibility constraint even without workfare. In this situation the marginal gain from more insurance is relatively small compared to the costs of higher taxes and when $\underline{u}$ becomes sufficiently large it is no longer optimal to use workfare. Furthermore, it follows that

Corollary 1 *Workfare is Pareto inefficient* (i) *if workers and non-workers differ only with respect to productivity,* w_i*, or* (ii) *if the minimum utility requirement is equal to the maximal possible level,* $\underline{u} = \bar{u}$*.*

Proof. Both (i) and (ii) follow directly from the above proposition. $\square$

The first result is best understood by looking at the incentive compatibility constraint (5) when $\phi_A = \phi_B \equiv \phi$. This gives $v(\underline{b}) = v(b - \phi\ell^e)$ showing that a rise in ℓ^e only gives the possibility of raising b so as to keep the utility of an unemployed worker unchanged. The only change then is an increase in the tax level which unambiguously reduces the utility of the worker. Thus, it is never Pareto optimal to require work in exchange for benefits as a way of separating the two types when they only differ with respect to productivity.

When the minimum utility requirement is equal to the maximal possible level, $\underline{u} = \bar{u}$, the utility of non-workers and employed and unemployed workers are identical even without effort requirement: $v(w_A - t - \phi_A) = v(b) = v(\underline{b})$. In such a "perfectly equalitarian" society workfare is, of course, never optimal. Introducing effort requirement would make it possible to transfer more of the worker's income from periods of employment to periods of unemployment but they would not want that as they are already perfectly insured.

5 Time vs. Task Workfare

In the preceding analysis we have followed previous papers by assuming that workfare is a time requirement (time workfare). It would, however, also be possible to require that benefit recipients perform a particular task. This would not change any of the previous results if both workers and non-workers use the same amount of time to perform the task; that is, if the task is unrelated to their productivity in an ordinary job. Of course, there exist tasks that high productivity persons can perform faster than low productivity persons. If such tasks are required in exchange for benefits (task workfare) the previous results no longer apply.

Suppose that benefit recipients have to perform a particular task, T, which depend on their productivity such that the time required to perform the task is given by

$$\ell_i^e = T/w_i.$$

With this type of workfare Proposition 3 is replaced by

Proposition 4 *There exists $\tilde{u} \in (0, \bar{u})$ such that for each utility level of non-workers, $\underline{u} \leq \tilde{u}$, workers strictly prefer an unemployment insurance scheme with task workfare, $T > 0$, if and only if workers and non-workers differ sufficiently with respect to productivity or valuation of leisure, $\frac{\phi_B/w_B}{\phi_A/w_A} > \frac{1-\rho\eta}{1-\eta}$.*

Proof. The utility loss of a person in task workfare is $\phi_i \frac{T}{w_i}$ compared to $\phi_i \ell^e$ in time workfare. This implies that the proof of Proposition 3 applies if the terms $\phi_i \ell^e$ are replaced with $\phi_i \frac{T}{w_i}$ and the maximization is done with respect to T instead of ℓ^e. □

Thus, the scope for using workfare is enlarged if it is possible to demand a productivity related task instead of a simple time requirement in exchange for benefits. In fact, contrary to time workfare, it may be Pareto optimal to use task workfare if workers and non-workers differ only with respect to productivity. This occurs if the productivity of workers is sufficiently higher than non-workers, $\frac{w_A}{w_B} > \frac{1-\rho\eta}{1-\eta}$. The intuition is simply that task workfare implicitly requires more time of less productive persons implying that effort-contingent UI benefits are less attractive to non-workers than workers although they have the same valuation of leisure. Thus, task workfare is a better screening device than time workfare and in general we have

Proposition 5 *Task workfare Pareto dominates time workfare.*

Proof. Consider an optimal solution under time workfare $\{\ell^e, b, \underline{b}, t\}$ and a task workfare UI system where the task is set such that non-workers use the same amount of time on workfare in the two systems, $\ell_B^e = \ell^e$, implying that $T = \ell^e w_B$. Then $\ell_A^e = T/w_A \leq \ell^e$ implying that workers use less time on workfare under task workfare. Thus, the only difference is that less utility loss is inflicted on workers in workfare and consequently that task workfare Pareto dominates time workfare. $\square$

6 Conclusion

We have demonstrated that the use of workfare for UI recipients, as embedded in the latest labor market reforms/experiments, may improve the insurance against unemployment. The particular element of workfare that we have focused on is effort commitment; recipients are required to perform specific tasks or to spend a certain amount of time in workfare in order to collect benefits, and these activities inflict disutility on the participants. To make the point more transparent we have assumed that the activities themselves do not bring about any valuable product; nevertheless, they can (Pareto) improve the unemployment insurance system.[10]

When preferences are known, the UI problem is straightforward: with risk adverse workers the UI scheme should simply smooth the income perfectly between employed and unemployed workers and no workfare should

[10]The assumption that workfare activities are not productive is of course an extreme assumption. However, there is also substantial costs associated with setting up and running a workfare system. So strictly speaking, what we assume is that costs and benefits cancel out. If workfare provides a net product there is of course much greater scope for using it (see Brett, 1998).

be required. But if preferences and job search behavior cannot be observed the optimal UI does not yield full insurance; non-workers claim UI benefits so that only part of the tax revenue goes to unemployment compensation. And this is where workfare becomes useful. If workers and non-workers have different preferences for leisure the effort requirement of workfare is going to affect them differently. This may facilitate better income smoothing for workers by keeping non-workers from claiming UI benefits rather than social assistance. Thus, workfare may improve an UI scheme in this case, and the smaller are the transfers from workers to non-workers the larger is the scope for using workfare. When transfers are high, the work requirement of unemployed workers needed to prevent non-workers from claiming the UI package has to be high as well, and workfare becomes less preferable.

We have also shown that it is never possible to (Pareto) improve unemployment insurance by the use of time requirements if workers and non-workers differ only with respect to productivity. In this case, workfare is not a useful screening device as workers and non-workers experience the same disutility of being on workfare. This is compatible with the findings on workfare in poverty alleviation programs (cf. Besley and Coate, 1992, 1995). However, if productivity related tasks can be required then workfare may be part of an optimal unemployment insurance scheme even when workers and non-workers differ only with respect to productivity. This arises because a task requirement is a better screening device which also implies that it is better to base a UI workfare system on task requirements than on time requirements.

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7 Appendix

7.1 Complete Information

The constrained maximization problem is given by

$$\begin{aligned} L &= \rho v\left(w_A - t - \phi_A\right) + (1-\rho)\, v\left(b - \phi_A \ell^e\right) \\ &\quad +\lambda_1 \left[\eta\left[\rho t - (1-\rho)\, b\right] - (1-\eta)\, \underline{b}\right] \\ &\quad +\lambda_2 \left[v\left(\underline{b}\right) - \underline{u}\right] \end{aligned}$$

giving the following derivatives

$$\frac{\partial L}{\partial b} = (1-\rho)\, v'\left(b - \phi_A \ell^e\right) - \lambda_1 \eta\, (1-\rho)\,, \tag{6}$$

$$\frac{\partial L}{\partial \underline{b}} = -\lambda_1 (1-\eta) + \lambda_2 v'\left(\underline{b}\right), \tag{7}$$

$$\frac{\partial L}{\partial t} = -\rho v'\left(w_A - t - \phi_A\right) + \lambda_1 \eta \rho, \tag{8}$$

$$\frac{\partial L}{\partial \ell^e} = -\left(1-\rho\right) \phi_A v'\left(b - \phi_A \ell^e\right) < 0. \tag{9}$$

It follows immediately from the last equation that $\ell^e = 0$. Setting equation (6) equal to zero gives

$$\lambda_1 = \frac{v'(b)}{\eta} > 0.$$

Inserting this into (8) yields

$$w_A - t - \phi_A = b.$$

Finally, by inserting λ_1 into (7), we have

$$\frac{\partial L}{\partial \underline{b}} = -v'(b)\, \frac{1-\eta}{\eta} + \lambda_2 v'\left(\underline{b}\right) = 0$$

$\Leftrightarrow$

$$\lambda_2 = \frac{v'(b)}{v'\left(\underline{b}\right)} \frac{1-\eta}{\eta} > 0,$$

implying that $v\left(\underline{b}\right) = \underline{u}$.

7.2 Incomplete Information Without Workfare

It is clear from (5) that $b = \underline{b}$. Now, the constrained maximization problem is given by

$$\begin{aligned} L &= \rho v\left(w_A - t - \phi_A\right) + (1-\rho)\, v\left(b\right) \\ &\quad + \lambda_1 \left[\eta\left[\rho t - (1-\rho)\, b\right] - (1-\eta)\, b\right] \\ &\quad + \lambda_2 \left[v\left(w_A - t - \phi_A\right) - v\left(b\right)\right], \end{aligned}$$

giving the derivatives

$$\frac{\partial L}{\partial b} = (1-\rho)\, v'\left(b\right) - \lambda_1 \left(\eta\left(1-\rho\right) + (1-\eta)\right) - \lambda_2 v'\left(b\right),$$

$$\frac{\partial L}{\partial t} = -\rho v'\left(w_A - t - \phi_A\right) + \lambda_1 \eta\rho - \lambda_2 v'\left(w_A - t - \phi_A\right).$$

Setting the first expression equal to zero and isolating λ_1 gives

$$\lambda_1 = \frac{1-\rho}{1-\eta\rho} v'\left(b\right) - \lambda_2 \frac{1}{1-\eta\rho} v'\left(b\right).$$

Inserting λ_1 into the second first order condition yields

$$\lambda_2 = \frac{(1-\rho)\frac{v'(b)}{v'(w_A - t - \phi_A)} - \frac{1-\eta\rho}{\eta}}{\frac{v'(b)}{v'(w_A - t - \phi_A)} + \frac{1-\eta\rho}{\eta\rho}}.$$

Assuming $\lambda_2 > 0$ implies from constraint (4) that $w_A - t - \phi_A = b \Rightarrow$

$$\lambda_2 = -\left(1-\eta\right)\rho < 0$$

contradicting that $\lambda_2 > 0$. Thus, constraint (4) is not binding and $\lambda_2 = 0$. Inserting this into the above expression for λ_1 gives

$$\lambda_1 = \frac{1-\rho}{1-\eta\rho} v'\left(b\right) > 0,$$

which inserted into $\partial L / \partial t$ together with $\lambda_2 = 0$ yields

$$\frac{v'\left(b\right)}{v'\left(w_A - t - \phi_A\right)} = \frac{1-\eta\rho}{(1-\rho)\,\eta}.$$

7.3 Incomplete Information With Workfare

It should be clear that there always exists a solution to the maximization problem: The constraints (2), (3), (4), (5), the non-negativity requirements $b \geq 0,\ \underline{b} \geq 0,\ t \geq 0,\ \ell^e \geq 0$, and the individual rationality constraints

$$v\left(w_A - t - \phi_A\right) \geq \underline{u},$$

$$v\left(b - \phi_A \ell^e\right) \geq \underline{u},$$

$$v\left(\underline{b}\right) \geq \underline{u},$$

forms a non-empty compact set. However, because the constraints are not quasiconcave functions, we cannot a priori be sure that a vector $(b, \underline{b}, t, \ell^e)$ fulfilling the first order conditions is a global maximum. Thus, we have to go through all possible cases of binding and non-binding constraints. It is immediately clear that the first constraint is binding in a solution. If this was not the case, it would be possible to reduce the tax rate t, thereby increasing utility at no costs. Unfortunately, it is impossible to determine whether the other constraints are binding or not without looking at the whole problem. Thus, we have to investigate 8 cases depending on whether constraints (3), (4), and/or (5) are binding.

The constrained maximization problem is given by

$$\begin{aligned} L &= \rho v\left(w_A - t - \phi_A\right) + (1-\rho)\, v\left(b - \phi_A \ell^e\right) \\ &\quad + \lambda_1 \left[\eta \left[\rho t - (1-\rho)\, b\right] - (1-\eta)\, \underline{b}\right] \\ &\quad + \lambda_2 \left[v\left(\underline{b}\right) - \underline{u}\right] \\ &\quad + \lambda_3 \left[v\left(w_A - t - \phi_A\right) - v\left(b - \phi_A \ell^e\right)\right] \\ &\quad + \lambda_4 \left[v\left(\underline{b}\right) - v\left(b - \phi_B \ell^e\right)\right], \end{aligned}$$

giving the following derivatives

$$\begin{aligned} \frac{\partial L}{\partial b} &= (1-\rho)\, v'\left(b - \phi_A \ell^e\right) - \lambda_1 \eta\, (1-\rho) \\ &\quad - \lambda_3 v'\left(b - \phi_A \ell^e\right) - \lambda_4 v'\left(b - \phi_B \ell^e\right), \end{aligned} \tag{10}$$

$$\frac{\partial L}{\partial \underline{b}} = -\lambda_1 (1-\eta) + \lambda_2 v'(\underline{b}) + \lambda_4 v'(\underline{b}), \tag{11}$$

$$\frac{\partial L}{\partial t} = -\rho v'(w_A - t - \phi_A) + \lambda_1 \eta \rho - \lambda_3 v'(w_A - t - \phi_A), \tag{12}$$

$$\begin{aligned} \frac{\partial L}{\partial \ell^e} &= -(1-\rho)\phi_A v'(b - \phi_A \ell^e) + \lambda_3 \phi_A v'(b - \phi_A \ell^e) \\ &\quad + \lambda_4 \phi_B v'(b - \phi_B \ell^e). \end{aligned} \tag{13}$$

As argued previously λ_1 is always positive. The following two subsections show that the combination $\lambda_3 > 0$ and $\lambda_4 > 0$ and the combination $\lambda_3 > 0$ and $\lambda_4 = 0$ are impossible. It is clear that one of the constraints have to bind implying that the solution is characterized by $\lambda_3 = 0$ and $\lambda_4 > 0$. The third subsection analyses this combination.

7.3.1 Excluding the combination $\lambda_3 > 0$ and $\lambda_4 > 0$

If constraint (4) and (5) are binding then

$$w_A - t - \phi_A = b - \phi_A \ell^e, \tag{14}$$

and

$$\underline{b} = b - \phi_B \ell^e. \tag{15}$$

Isolating λ_1 from equation (12) gives

$$\lambda_1 = \frac{v'(w_A - t - \phi_A)}{\eta} + \lambda_3 \frac{v'(w_A - t - \phi_A)}{\eta \rho}.$$

Thus, $\lambda_1 > 0$ as $\lambda_3 \geq 0$. Inserting λ_1 into equation (10) and using (14) and (15) yield

$$\lambda_4 = -\lambda_3 \frac{1}{\rho} \frac{v'(b - \phi_A \ell^e)}{v'(\underline{b})},$$

which contradicts that $\lambda_3 > 0$ and $\lambda_4 > 0$ at the same time.

7.3.2 Excluding the combination $\lambda_3 > 0$ and $\lambda_4 = 0$

From equation (10), we get

$$\lambda_3 = (1-\rho) - \lambda_1 \frac{\eta (1-\rho)}{v' (b - \phi_A \ell^e)}.$$

Inserting this into equation (12) yields

$$\lambda_1 = \frac{v' (b - \phi_A \ell^e)}{\eta \left(\rho \frac{v'(b-\phi_A \ell^e)}{v'(w_A - t - \phi_A)} + (1-\rho) \right)} > 0.$$

Inserting λ_1 in the above equation yields

$$\lambda_3 = (1-\rho) \left(1 - \frac{1}{\rho \frac{v'(b-\phi_A \ell^e)}{v'(w_A - t - \phi_A)} + (1-\rho)} \right).$$

Constraint (4) binds implying that $w_A - t - \phi_A = b - \phi_A \ell^e$. Inserting this relationship into the above equation gives $\lambda_3 = 0$ contradicting that $\lambda_3 > 0$.

7.3.3 The Solution

It is clear that one of the constraints (4) and (5) has to bind. It then follows from the two previous subsections that the solution must be characterized by $\lambda_3 = 0$ and $\lambda_4 > 0$. We know examine this combination.

From equation (12), we get

$$\lambda_1 = \frac{v' (w_A - t - \phi_A)}{\eta} > 0.$$

Inserting λ_1 in equation (10) gives

$$\lambda_4 = (1-\rho) \left(\frac{v' (b - \phi_A \ell^e) - v' (w_A - t - \phi_A)}{v' (b - \phi_B \ell^e)} \right).$$

It then follows that $\lambda_4 > 0$ if

$$v' (b - \phi_A \ell^e) > v' (w_A - t - \phi_A). \tag{16}$$

Inserting λ_4 into equation (13) yields

$$\frac{\partial L}{\partial \ell^e} = \left(1 - \frac{\phi_A}{\phi_B} - \frac{v' (w_A - t - \phi_A)}{v' (b - \phi_A \ell^e)} \right) (1-\rho) \phi_B v' (b - \phi_A \ell^e).$$

$\ell^e > 0$ if $\frac{\partial L}{\partial \ell^e} = 0$ giving

$$\frac{v'(w_A - t - \phi_A)}{v'(b - \phi_A \ell^e)} = 1 - \frac{\phi_A}{\phi_B},$$

and $\ell^e = 0$ if $\frac{\partial L}{\partial \ell^e} < 0$ giving

$$\frac{v'(w_A - t - \phi_A)}{v'(b)} > 1 - \frac{\phi_A}{\phi_B}.$$

It then follows that the inequality in (16) is satisfied if one of the two above equations is satisfied implying that $\lambda_4 > 0$. Inserting λ_1 and λ_4 into equation (11) and using constraint (5) yield

$$\frac{\partial L}{\partial \underline{b}} = \lambda_2 v'(\underline{b}) + (1-\rho) v'(b - \phi_A \ell^e) - \left(1 - \rho + \frac{1-\eta}{\eta}\right) v'(w_A - t - \phi_A) = 0$$

$\Leftrightarrow$

$$\lambda_2 = \frac{\left(1 - \rho + \frac{1-\eta}{\eta}\right) v'(w_A - t - \phi_A) - (1-\rho) v'(b - \phi_A \ell^e)}{v'(\underline{b})}$$

$\Rightarrow \lambda_2 > 0$ if

$$\frac{v'(w_A - t - \phi_A)}{v'(b - \phi_A \ell^e)} > \frac{1-\rho}{1 - \rho + \frac{1-\eta}{\eta}},$$

and $\lambda_2 = 0$ if

$$\frac{v'(w_A - t - \phi_A)}{v'(b - \phi_A \ell^e)} = \frac{1-\rho}{1 - \rho + \frac{1-\eta}{\eta}}.$$

7.3.4 Proof of Proposition 3

Using the budget constraint (2) and constraint (5), yielding $b = \underline{b} + \phi_B \ell^e$, imply that:

$\ell^e > 0$ if

$$f(\underline{b}, \ell^e) \equiv \frac{v'\left(w_A - \frac{1-\eta\rho}{\eta\rho}\underline{b} - \phi_A - \frac{1-\rho}{\rho}\phi_B \ell^e\right)}{v'(\underline{b} + (\phi_B - \phi_A)\ell^e)} = 1 - \frac{\phi_A}{\phi_B}, \tag{17}$$

and $\ell^e = 0$ if

$$f(\underline{b}, 0) = \frac{v'\left(w_A - \frac{1-\eta\rho}{\eta\rho}\underline{b} - \phi_A\right)}{v'(\underline{b})} > 1 - \frac{\phi_A}{\phi_B}. \tag{18}$$

$\lambda_2 > 0$ if

$$f\left(\underline{b}, \ell^e\right) = \frac{v'\left(w_A - \frac{1-\eta\rho}{\eta\rho}\underline{b} - \phi_A - \frac{1-\rho}{\rho}\phi_B \ell^e\right)}{v'\left(\underline{b} + \left(\phi_B - \phi_A\right)\ell^e\right)} > \frac{1-\rho}{1-\rho+\frac{1-\eta}{\eta}},$$

and $\lambda_2 = 0$ if

$$f\left(\underline{b}, \ell^e\right) \equiv \frac{v'\left(w_A - \frac{1-\eta\rho}{\eta\rho}\underline{b} - \phi_A - \frac{1-\rho}{\rho}\phi_B \ell^e\right)}{v'\left(\underline{b} + \left(\phi_B - \phi_A\right)\ell^e\right)} = \frac{1-\rho}{1-\rho+\frac{1-\eta}{\eta}}.$$

It follows from equations (17) and (18) that $f\left(\underline{b}, \ell^e\right) \geq 1 - \phi_A/\phi_B$. It furthermore follows from the condition in the proposition that

$$1 - \phi_A/\phi_B > \frac{1-\rho}{1-\rho+\frac{1-\eta}{\eta}},$$

implying that $\lambda_2 > 0 \Rightarrow v\left(\underline{b}\right) = \underline{u}$.

Note that $f_{\underline{b}}\left(\underline{b}, \ell^e\right) > 0$, $\lim_{\underline{b}\to 0} f\left(\underline{b}, 0\right) = 0$, and $f_{\ell^e}\left(\underline{b}, \ell^e\right) > 0$. Now, if $\underline{u} \to 0$ then $\underline{b} \to 0$ implying from equations (17) and (18) that the solution is characterized by $\ell^e > 0$. If $\underline{u} = \bar{u}$ then $\underline{b} = \eta\rho\left[w_A - \phi_A\right] \Rightarrow$

$$f\left(\eta\rho\left[w_A - \phi_A\right], 0\right) = 1,$$

in which case (17) and (18) imply that $\ell^e = 0$. Continuity then implies that there exists $\tilde{u} \in (0, \bar{u})$ such that $\ell^e > 0$ for $\underline{u} \leq \bar{u}$. QED.