On the Provision of Public Goods in an Economy with Union Wage Setting and Distortionary Taxation

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Abstract

This paper concerns public good provision under distortionary labor income taxation. The labor market is characterized by imperfect competition due to the influence of unions over wage formation. We show that a tradeoff between employment and hours of work per employee influences the welfare effect of an increase in the provision of the public good. This tradeoff means that the welfare gain of an increase in the hours of work, which is associated with the preexisting labor income tax, will be counteracted by a welfare cost in terms of lost employment. We also show how the welfare effect of an increase in the provision of the public good depends on whether the unions are able to directly affect the hours of work per employed union member, or if this influence only comes indirectly via the wage rate.

Keywords: Public goods, distortionary taxation, union wage setting.

JEL classification: H41, J51, J60

1 Introduction

This paper concerns public good provision, when the tax revenues are raised by distortionary labor income taxation. The basic idea is to extend the study of public good provision under distortionary taxation and endogenous hours of work to apply in an economy with union wage setting. Among other things, we show that a tradeoff between employment and hours of work per employee influences the welfare effect associated with an increase in the provision of the public good, as well as how this cost benefit rule depends on whether or not the unions are able to directly affect the hours of work by their members.

Starting with Pigou (1947), the provision of public goods under distortionary taxation has been subject to extensive research[1]. In most previous studies, a common assumption is that the labor market is perfectly competitive. To our knowledge, only a few previous studies have been concerned with public good provision under labor market imperfections. Andersen et al. (1996) consider the situation where a public good is financed by labor income taxation, and the wage rate is determined by a monopoly union. The hours of work per individual are assumed to be fixed. One of their main results is that even if the public good is pure waste, it is optimal to provide a positive amount of the public good if a tax financed public expansion reduces unemployment[2]. Bovenberg and van der Ploeg (1996) analyze the optimal mixture of labor income taxation, environmental taxation and public good provision in an economy, which is characterized by environmental damage of production and excess supply of labor. The main contribution of their study is to consider how the optimal policy mix responds to a change in the preferences for environmental quality. Aronsson and Sjögren (2001a) analyze public good provision simultaneously with the optimal mixture of linear

[1] See e.g. Atkinson and Stern (1974), Wildasin (1979, 1984), Christiansen (1981), King (1996), Wilson (1991), Boadway and Keen (1993) and Edwards et al. (1994).

[2] A similar result is derived by Santoni (1999).

taxes on labor income and capital income under imperfect competition in the labor market in an open economy with free capital mobility. Similarly, Aronsson and Sjögren (2001b) consider optimal nonlinear income taxation, commodity taxation and provision of a public good in case of imperfect competition in the labor market. They show how imperfect competition in the labor market will influence the policy rules via employment effects and, in the latter paper, via the role played by the self-selection constraint in the context of these policy rules.

In this paper, we consider cost benefit rules for public goods in case the preexisting taxes are not necessarily optimal from society's point of view. This idea has been used by Sandmo (1998) and Edwards (2001) to derive cost benefit rules for public goods under perfect competition[3]. Our analysis is based on the assumption that the labor market is characterized by imperfect competition as a result of the influence of unions over wage formation. In addition, most previous studies on public good provision under union wage setting assume that the hours of work per employee are either exogenous or determined by the standard labor supply condition, which means neglecting the possibility that rationing may occur both in terms of the number of employed persons and in terms of work hours[4]. This is somewhat surprising considering that unions may have had a considerable influence on work hours historically. In the literature on unionized labor markets, there seems to be no 'standard' approach about how the unions influence the hours of work, and the implications for fiscal policy design have largely been neglected.

[3]See also Dahlby (1998), who considers the marginal cost of public funds when the tax instruments are not necessarily optimally chosen.

[4]An exception is Aronsson and Sjögren (2001a), where union wage formation may give rise both to unemployment and rationing in terms of the hours of work per employee. However, the focus of their study is very different from the analysis carried out below, since they are studying public good provision in the context of a second best resource allocation. In addition, they do not explicitly address the consequences of allowing the unions to influence both the wage rate and the hours of work.

The paper contributes to the literature in primarily two ways. The first is by characterizing the cost benefit rule for provision of a public good, when unions have an influence over wage formation. Despite the fact that unions have been important institutions in the European labor markets for a long time, only a few previous studies have been concerned with public good provision under union wage setting. Our paper generalizes the study of public good provision by simultaneously addressing (i) union wage setting, (ii) distortionary taxation, (iii) endogenous hours of work and (iv) policy reform. The second is by showing that the welfare effect associated with an increase in the provision of a public good depends on whether the unions are able to directly affect the hours of work per employed union member, or if this influence only comes indirectly via the choice of wage rate.

Section 2 contains the model to be used in the analysis. In section 3, we derive the cost benefit rules for public goods under imperfect competition in the labor market. We shall also compare the results with the corresponding cost benefit rule that will arise if the labor market is competitive. Section 4 summarizes the results.

2 The Model

There are M individuals in the economy with identical preferences. The utility function is written $u = u(c, z, g)$, where c is private consumption, z leisure and g a public good. The utility function is assumed to be increasing in each argument and strictly quasiconcave. If employed, the budget constraint facing an individual can be written as

$$wl(1 - \tau) + \pi - c = 0 \tag{1}$$

where w is the wage rate, l the hours of work, τ the labor income tax rate and π profit income. In a similar way, for an unemployed individual, the budget constraint is given by

$$q + \pi - c = 0 \tag{2}$$

in which q is a fixed unemployment benefit.

There are many identical competitive firms producing a homogenous good by using labor as the only variable production factor. Since the firms are identical, we describe the production side in terms of a single competitive firm. The objective function can be written

$$\prod = f(L) - wL \tag{3}$$

where L is total employment measured as the hours of work per individual times the number of employed persons, N. The function $f(\cdot)$ is the production function, which is assumed to be increasing and strictly concave in the variable production factor. Each firm behaves as if l and w are fixed. At an aggregate level, the number of employed individuals are determined by

$$f_L(L) - w = 0 \tag{4}$$

The profits are shared equally among individuals in the sense that $\pi = \Pi/M$. This means that the profit income from the sector where an individual is employed makes up a very small part of π.

The labor market is characterized by the influence of unions over wage formation. We assume that the wage formation process is decentralized in the sense that the unions are firm-specific. Since each firm is small relative to the economy as a whole, this means that each union treats π as exogenously given. To simplify the analysis as much as possible, we describe each local labor market by using the monopoly union model[5], which means that

[5] A review of models used to describe unionized labor markets is given by Oswald (1985). The monopoly union model is a special case of the more general right-to-manage model, where the union and the firm bargain over the wage rate, and the firm then chooses the employment conditional on the wage rate. As long as the wage rate exceeds the market clearing wage rate, the qualitative results to be derived below are not particularly

each firm-specific union chooses the wage rate subject to the firm's labor demand function, while the firm then chooses the number of persons to employ conditional on the wage rate.

Although our description of the labor market may seem to be a straight forward application of the monopoly union model, it is by no means obvious how the union treats the hours of work by its members. In fact, most previous studies on unionized labor markets have disregarded the hours of work per employee. We will consider two situations; (i) employed individuals are not rationed in their hours, meaning that they choose their hours of work optimally conditional on the wage rate, and (ii) employed individuals are rationed in their hours of work. The first situation is implemented by assuming that each union chooses the wage rate conditional on the hours of work per employee, and the union members choose their hours of work conditional on the wage rate, whereas the second is implemented by assuming that each union chooses both the wage rate and the hours of work for its members.

Since the firms are identical in all important respects, the decentralized wage formation process with local monopoly unions in each firm specific labor market is equivalently described in terms of a single union treating π as exogenous. By defining the labor demand function, measured in terms of the number of persons to be employed, by solving equation (4) for N, we have $N = N(w, l)$. If the unions act in accordance with the expected utility framework - a common assumption when applying the monopoly union model - the objective will be to maximize

$$\frac{N}{M}u(wl(1-\tau)+\pi, z, g) + [1 - \frac{N}{M}]u(q+\pi, T, g) \tag{5}$$

subject to $N = N(w, l)$, where T is a time endowment.

sensitive to whether the wage rate is chosen by a monopoly union or the outcome of a more general bargaining model. This made us choose the monopoly union model over the more computationally burdensome right-to-manage model.

Consider first the situation where employed individuals are not rationed in their choice of hours of work. Suppose that the union treats the hours of work as exogenous and chooses the wage rate conditional on the hours of work. The first order condition for the wage rate is given by

$$\frac{\partial N}{\partial w}[u^e - u^u] + N u_c^e l(1-\tau) = 0 \tag{6}$$

where $u^e = u(wl(1-\tau), z, g)$ and $u^u = u(q+\pi, T, g)$ are the utilities of employed and unemployed, respectively. Conditional on the wage rate chosen by the union, employed individuals obey the first order condition for the hours of work

$$u_c^e w(1-\tau) - u_z^e = 0 \tag{7}$$

where $u_c^e = \partial u^e(c,z,g)/\partial c$ and $u_z^e = \partial u^e(c,z,g)/\partial z$. We have used that $l = T - z$. Taken together, equations (4), (6) and (7) describe the equilibrium in the labor market. We will return to the characteristics of the labor market below and relax the assumption that employed individuals behave in accordance with their labor supply condition.

The government collects tax revenues to finance the benefit to the unemployed and the public good. The budget constraint facing the government is written

$$\tau w N l - (M-N)q - g = 0 \tag{8}$$

For later use, note finally that by combining equations (1), (2), (3) and (8), we obtain the resource constraint

$$f(Nl) - g - Nc^e - (M-N)c^u = 0 \tag{9}$$

meaning that output is used for public and private consumption.

3 The Main Results

Suppose that the private sector has made optimal choices of hours of work, the wage rate and the number of employed persons conditional on the tax rate, the unemployment income and the public good. In the general equilibrium, therefore, we have $l = \widetilde{l}(\tau, q, g)$, $w = \widetilde{w}(\tau, q, g)$ and $N = \widetilde{N}(\tau, q, g)$. We assume that the benefit to the unemployed is constant throughout the analysis, which means that an increase in the public good necessitates an increase in the income tax rate. By substituting the behavioral equations into the budget constraint of the government, we obtain

$$\tau\widetilde{w}(\tau, q, g)\widetilde{N}(\tau, q, g)\widetilde{l}(\tau, q, g) - [M - \widetilde{N}(\tau, q, g)]q - g = 0 \tag{10}$$

Equation (10) implicitly defines the income tax rate as a function of the public good and the benefit to the unemployed. Substituting $\tau = \tau(q, g)$ into the behavioral equations gives

$$l^0 = \widetilde{l}(\tau(q, g), q, g) = l(q, g)$$

$$w^0 = \widetilde{w}(\tau(q, g), q, g) = w(q, g)$$

$$N^0 = \widetilde{N}(\tau(q, g), q, g) = N(q, g)$$

As a matter of notational convention, we use the superindex "0" to denote that the private sector has made an optimal choice conditional on that the tax rate adjusts to retain the balance of the government's budget constraint.

Our concern is here to derive a cost benefit rule for the public good conditional on this initial, and possibly arbitrary, tax and expenditure policies. In accordance with Sandmo (1998), we assume a utilitarian social welfare function;

$$W^0 = N^0 u(c^{e,0}, T - l^0, g) + [M - N^0]u(c^{u,0}, T, g) \tag{11}$$

in which $c^{e,0} = w^0 l^0(1-\tau) + \pi^0$ and $c^{u,0} = q + \pi^0$. Since $\pi^0 = \Pi^0/M$, it will also be a function of q and g.

By using equations (9) and (11), we can derive the following result[6];

Proposition 1*If employed individuals are not rationed in their hours of work, the cost benefit rule for the public good can be written as*

$$\begin{aligned}\frac{\partial W^0}{\partial g} &= N^0\frac{\partial u^{e,0}}{\partial g} + (M-N^0)\frac{\partial u^{u,0}}{\partial g} + u_c^{e,0}[-1 + N^0\tau w^0\frac{\partial l^0}{\partial g}] \\ &\quad + \frac{\partial N^0}{\partial g}[(u^{e,0} - u^{u,0}) + u_c^{e,0}(\tau w^0 l^0 + q)] \\ &\quad + (u_c^{e,0} - u_c^{u,0})(M-N^0)\frac{\partial w^0}{\partial g} l^0 N^0 \frac{1}{M} \qquad (12)\end{aligned}$$

Proof: See the Appendix.

The first two terms in the first row of equation (12) represent the benefit associated with an increase in the public good. The remaining two terms in the first row are the cost associated with a reduction in the private consumption and the welfare effect via the preexisting labor income tax, respectively. In the second row, we summarize the welfare effects associated with the change in the number of employed persons. The first term within the bracket measures the utility gain from being employed, while the second is the change in the tax revenues following if one additional individual becomes employed. Both these terms are multiplied by the change in

[6]We have derived equation (12) on the basis of the assumption that the union chooses the wage rate conditional on the hours of work per employee. An alternative assumption would be that the union is acting Stackelberg leader by explicitly recognizing how the hours of work change in response to an increase in the wage rate. Although such a change of assumption will influence the resource allocation, it does not necessarily change the form of the cost benefit rule. As long as the individuals can freely choose their hours of work conditional on the wage rate, the cost benefit rule for the public good can be written in the form of equation (12), even if the union is acting Stackelberg leader in the choice of wage rate.

the number of employed persons, which means that they will contribute to increase (decrease) the welfare level if $\partial N/\partial g > 0$ (< 0).

To fully understand the second row, note that the employment is determined by the labor demand at the wage rate chosen by the union, $N^0 = N(w^0(q,g), l^0(q,g))$, which means that the change in employment can be written

$$\frac{\partial N^0}{\partial g} = \frac{\partial N^0}{\partial w}\frac{\partial w^0}{\partial g} + \frac{\partial N^0}{\partial l}\frac{\partial l^0}{\partial g} \tag{13}$$

Equation (13) implies that g influences N^0 via two distinct channels; w^0 and l^0. The latter is interpretable as an interaction effect between the number of employed persons and the hours of work per employee. This interaction effect is negative, $\partial N^0/\partial l < 0$, meaning that the welfare gain (cost) of an increase (decrease) in the hours of work per employee, which is associated with the preexisting labor income tax in the first row of equation (12), will be counteracted by a welfare cost (gain) in terms of lost employment.

The third row, finally, reflects redistribution and is associated with the influence of the public good on profit income, i.e. $\partial\pi/\partial g = -(\partial w/\partial g)lN/M$. For purposes of interpretation, let us assume that $c^e > c^u$ implies $u_c^e < u_c^u$. The interpretation is that if an increase in the public good increases (decreases) profit income, the utility gain (loss) facing the unemployed is greater than the utility gain (loss) facing the employed, which contributes to increase (decrease) the welfare level. The latter effect will be of minor importance if the income effects are small: it vanishes in case the utility function is quasi-linear in private consumption.

Let us relax the assumption that employed individuals can freely choose their hours of work conditional on the wage rate. If the union chooses the hours of work for its members, equation (7) is replaced by the first order condition

$$\frac{\partial N}{\partial l}[u^e - u^u] + N[u_c^e w(1-\tau) - u_z^e] = 0 \tag{14}$$

meaning that the equilibrium in the labor market is described by equations (4), (6) and (14). Given the wage rate, equation (14) implies that the union chooses fewer hours of work than would be chosen by the individual himself/herself, since the union also recognizes that an increase in the hours of work reduces the number of employed persons.

To make a distinction between equilibria, we will in this case use the superindex "r" to denote that the private sector has made an optimal choice conditional on that the tax rate adjusts to retain the balance of the government's budget constraint. The welfare function is written

$$W^r = N^r u(c^{e,r}, T - l^r, g) + [M - N^r] u(c^{u,r}, T, g)$$

By analogy to the analyses carried out above, we can derive the following result;

Proposition 2*If the employed individuals are rationed in their hours of work, the cost benefit rule for the public good can be written*

$$\begin{aligned} \frac{\partial W^r}{\partial g} &= N^r \frac{\partial u^{e,r}}{\partial g} + (M - N^r) \frac{\partial u^{u,r}}{\partial g} + u_c^{e,r}[-1 + N^r \tau w^r 1 \frac{\partial l^r}{\partial g}] \\ &\quad + \frac{\partial N^r}{\partial w} \frac{\partial w^r}{\partial g} [u^{e,r} - u^{u,r}] + \frac{\partial N^r}{\partial g} u_c^{e,r} [\tau w^r l^r + q] \\ &\quad + (u_c^{e,r} - u_c^{u,r})(M - N^r) \frac{\partial w^r}{\partial g} l^r N^r \frac{1}{M} \end{aligned} \tag{15}$$

The terms on the right hand side of equation (15) have the same interpretations as their counterparts in equation (12). However, there is one important difference between the two equations, which is seen from the second row. In equation (15), the interaction effect between the number of employed persons and the hours of work per employee is weaker than in equation (12). This interaction effect is only associated with part of the employment effect in equation (15). The reason is that both the union and the government recognize that a change in the hours of work per employee will influence employment, whereas the private agents do not consider the

employment effect when they choose the hours of work themselves. Therefore, when the union chooses the hours of work, part of the interaction effect of the public good that otherwise arises between the number of employed persons and the hours of work per employee will vanish as a consequence of optimization.

By comparing equations (12) and (15), it is clear that the two cost benefit rules may give rise to different conclusions about the welfare effect of an increase in the public good. For instance, consider the situation where an increase in the public good reduces the hours of work per employee as a consequence of the higher tax rate, whereas employment increases. Even if we were to assume that this welfare effect is positive in the context of equation (12) it may, nevertheless, be negative in the context of equation (15), where part of the employment increase associated with a reduction in the hours of work does not affect the welfare change measure.

Note finally that the cost benefit rule for the public good under perfect competition follows as the special case of equations (12) and (15), where $M = N$. By using the superindex "*" to denote the private equilibrium in the competitive economy conditional on that the tax rate adjusts to retain the balance of the government's budget constraint, we can derive;

Corollary 1: *Under perfect competition, the cost benefit rule for the public good reduces to read*

$$\frac{\partial W^*}{\partial g} = M\frac{\partial u^{e,*}}{\partial g} + u_c^{e,*}[-1 + M\tau w^*\frac{\partial l^*}{\partial g}] \tag{16}$$

The main difference between perfect competition and union wage setting is that all individuals are employed under perfect competition, meaning that all changes in employment refer to the hours of work. In addition, note that the welfare effect associated with the preexisting distortion from the labor

income tax might be stronger under perfect competition than under union wage setting, since employment is higher in the former case.

4 Summary and Discussion

This paper concerns public good provision in an economy with distortionary labor income taxation. Contrary to most previous studies on public goods, we assume that the labor market is imperfectly competitive. If the equilibrium is characterized by unemployment, changes in the provision of the public good will influence the welfare level via changes in employment as well as via changes in the hours of work per employee. There is a tradeoff between the employment and the hours of work per employee in the sense that the welfare gain (cost) of an increase (decrease) in the hours of work, which is associated with the preexisting labor income tax, is counteracted by a welfare cost (gain) in terms of employment. In addition, this interaction effect, or tradeoff, depends on whether the union can directly affect the hours of work per employed union member, or if this influence only comes indirectly via the choice of wage rate. There is a tendency for a union to choice fewer hours of work per employee than would be the outcome, if the individuals are allowed to freely choose their hours of work conditional on the wage rate. This means, since the unions recognize that a change in the hours of work per employee may affect the employment, that part of the employment effect that is otherwise associated with an increase in the public good is offset if the unions can directly affect the hours of work per employed union member.

5 Appendix

Differentiating equation (11) with respect to g, we obtain

$$\frac{\partial W^0}{\partial g} = \frac{\partial N^0}{\partial g}[u^{e,0} - u^{u,0}] + N^0[u_c^{e,0}\frac{\partial c^{e,0}}{\partial g} - u_z^{e,0}\frac{\partial l^0}{\partial g} + u_g^{e,0}] \qquad \text{(A1)}$$

$$+[M - N^0][u_c^{u,0}\frac{\partial c^{u,0}}{\partial g} + u_g^{u,0}]$$

Then, differentiating equation (9) with respect to g gives

$$f_L^0[N^0\frac{\partial l^0}{\partial g}+\frac{\partial N^0}{\partial g}l^0]-1-\frac{\partial N^0}{\partial g}[c^{e,0}-c^{u,0}]-N^0\frac{\partial c^{e,0}}{\partial g}-[M-N^0]\frac{\partial c^{u,0}}{\partial g} = 0 \quad \text{(A2)}$$

By solving equation (A2) for $\partial c^{e,0}/\partial g$, substituting into equation (A1), while using equations (1), (2), (3) and (7), we obtain equation (12). ■

References

[1]Andersen, T.M., Sandemann Rasmussen, B. and Rose Sörensen, J. (1996) Optimal Fiscal Policy in Open Economies with Labor Market Distortions. *Journal of Public Economics* **63**, 103-117.

[2]Aronsson, T. and Sjögren, T. (2001) Optimal Taxation and Provision of Public Goods in a Unionized Economy. Umea Economic Studies no 560.

[3]Aronsson, T. and Sjögren, T. (2001) Income Taxation, Commodity Taxation and Provision of Public Goods under Labor Market Imperfections. Umea Economic Studies no 568.

[4]Atkinson, A.B. and Stern, N.H. (1974) Pigou, Taxation and Public Goods. *Review of Economic Studies* **41**, 119-128.

[5]Bovenberg, A.L. and van der Ploeg, F. (1996) Optimal Taxation, Public Goods and Environmental Policy with Involuntary Unemployment. *Journal of Public Economics* **62**, 69-83.

[6]Boadway, R. and Keen, M. (1993) Public Goods, Self-Selection and Optimal Taxation. *International Economic Review* **34**, 463-478.

[7]Christiansen, V. (1981) Evaluation of Public Projects under Optimal Taxation. *Review of Economic Studies* **47**, 447-457.

[8]Dahlby, B. (1998) Progressive Taxation and the Social Marginal Cost of Public Funds. *Journal of Public Economics* **67**, 105-122.

[9]Edwards, J. (2001) Cost Benefit Rules for Public Good Provision with Distortionary Taxation. CES working paper no 544.

[10]Edwards, J., Keen, M. and Tuomala, M. (1994) Income Tax, Commodity Tax and Public Good Provision. *Finanzarchiv* **51**, 472-497.

[11]King, M.A. (1986) A Pigouvian Rule for the Optimal Provision of Public Goods. *Journal of Public Economics* **30**, 273-291.

[12]Oswald, A.J. (1985) The Economic Theory of Trade Unions: An Introductory Survey. *The Scandinavian Journal of Economics* **87**, 160-193.

[13]Pigou, A.C. (1947) *A Study in Public Finance.* MacMillan: London.

[14]Sandmo, A. (1998) Redistribution and the Marginal Cost of Public Funds. *Journal of Public Economics* **70**, 365-382.

[15]Santoni, M. (1999) Fiscal Policy and Welfare in a Small Open Economy with Imperfect Competition. *Bulletin of Economic Research* **51**, 287-317.

[16]Wildasin, D.E. (1979) Public Good Provision with Optimal and Nonoptimal Commodity Taxation. *Economics Letters* **4**, 59-64.

[17]Wildasin, D.E. (1984) Optimal Public Good Provision with Distortionary Taxation. *Economic Inquiry* **22**, 227-243.

[18]Wilson, J.D. (1991) Optimal Public Good Provision with Limited Lump-sum Taxation. *American Economic Review* **81**, 153-166.