Charity and Redistributive Taxation in a Unionized Economy

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Abstract

European economies are characterized by unionized labor markets and governmental redistribution of income. This paper studies a model where those two features are combined with the possibility for individuals to make charitable contributions to the poor. The model exhibits equilibrium unemployment that increases with the degree of altruism. It is shown that a more progressive income tax can both reduce the unemployment rate and improve the public budget. These results are driven by charity increasing wage pressure and the altruistic rich failing to internalize the effect of their donations on the wage setting behavior of the unions.

Keywords: Equilibrium Unemployment, Tax-Transfer System, Charity, Trade Unions.

JEL-Classification: J50, H24.

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1 Introduction

In rich Europe, poverty rates of 10 % and more are common.[1] Among the main determinants of the poverty risk in european countries, becoming unemployed is a major one, both because it reduces a person's disposable income today and because it reduces a person's probability to be in employment tomorrow. The unemployed are characterized by a poverty rate of about 50 percent and, conversely, a substantial fraction of the poor population has a personal background of long-term unemployment.

Income support for the poor typically comes in form of publicly provided transfers like unemployment benefits, social assistance, and minimum pensions. While the generosity of the welfare state is crucial for the living conditions of the poor, the government is not the only source of aid. Private giving, often channeled by a multitude of non-profit organizations, also contributes to improve the living conditions of the poor. By way of an example, the Catholic and Evangelical Churches have welfare agencies that offer a number of health and social services explicitly directed at the needy; their provision is partly financed by private giving and often involves volunteering. Thanks to their flexibility and discretion, philanthropic organizations can succesfully complement governmental action in order to raise the poor's well-being. Hence, even in welfare states, the economic perspectives of those who become unemployed and face a considerable poverty risk depend not only on the safety net financed by the government but also on the support from privately-sponsored charities.[2]

The current paper explores the implications of private support of the unemployed poor in a simple model economy characterized by unionized labor markets and a progressive tax-transfer system, i.e. institutional features that are typical for european economies.

[1] Poverty line defined at 60 percent of median disposable income adjusted for family size. See e.g. Hauser and Nolan (1999) and Sainsbury and Morissens (2002) for evidence on several countries.

[2] According to the AAFRC Trust for Philanthropy, in the United States total yearly donations to human services amount to about 20 billions USD. This sum is close to the yearly expenditure for governmental food stamp programs. While the relative weight of charity in Europe is not as large, it is increasing; see Salamon *et al.* (1999) and Andreoni (2006) for cross-country comparisons and Anheier and Seibel (2001) for a case study on Germany.

Private giving is endogenous and generated by an operative altruistic motive. Altruism is modelled as in Arrow's (1981) celebrated essay, where it is derived from reasonable axioms on individual preferences over income distributions. In the current model, individuals can use their post-fisc income to make charitable contributions to support the poor. The trade unions are endowed with wage setting power, and correctly anticipate how market incomes are redistributed by both the government and voluntary contributions to the poor.

The model exhibits equilibrium unemployment that increases with the degree of altruism. Its main result has that a more progressive income tax reduces the unemployment rate. Furthermore, it is always possible to design a progressive tax reform such that the public budget is improved.

In the setting considered in this paper, the results mentioned above are robust and have a natural explanation. They are driven by the fact that individuals fail to internalize the effect of their donations on the wage setting behavior of the unions. Charitable contributions improve the standard of living of the poor and thus reduce the utility loss caused by losing a job. Therefore, donations turn out to increase wage pressure by the unions, and equilibrium unemployment is higher.[3] Since the marginal utility of own consumption is lower for the rich, the rich are those who donate. A more progressive income tax, by hitting the top incomes, reduces the average propensity to give to charities. Thereby, it reduces wage pressure and leads to a higher employment level.

Although it is rather straightforward, this link between income taxation and unemployment has not been explored so far[4], possibly because charity is not perceived as an important determinant of the expected utility of the unemployed in european countries. However, even if that perception were correct, the model developed in this paper would

[3]Therefore, it is the expectation of altruistic behavior toward the poor that makes the unions demand higher wages and finally increases the number of those who are poor. As such, the link put forward by the current model is a variant of Buchanan's (1975) Samaritan's dilemma.

[4]See e.g. the very comprehensive volume by Agell and Sorensen (2006) on tax policies and labor markets.

still be relevant for two reasons. Firstly, income disparities are on the rise in several european countries. On the one hand, partly as a consequence of welfare cuts, poverty rates have increased and even absolute poverty has increased in some countries.[5] On the other hand, top incomes have substantially risen, and income concentration is predicted to increase in the next few years.[6] Income polarization might bring about a novel situation in Europe, one where the lot of the unemployed significantly depends upon support from private organizations.

Secondly, the link put forward in this paper does not hinge upon the precise magnitude of private giving to the poor, but on its mere existence. That is to say, the effect of enhanced progressivity on overall unemployment that arises in this model is generated as soon as the rich have an operative altruistic motive at the margin. By definition, this occurs also when donations from the rich make a tiny fraction of the transfers received by the poor.

The literature on trade union behavior has pointed out a different mechanism through which tax progression affects equilibrium unemployment. As noted by Lockwood and Manning (1993), Corneo (1994) and Koskela and Vilmunen (1996), if wage income is subject to a progressive income tax, making the latter more progressive implies that, for a wage-negotiating union, the price of a higher take-home wage increases in terms of foregone employment. Then, the unions' demand for higher wages will decrease and employment will increase.

Several empirical studies have tried to assess the wage-moderating effect of tax progression. While most earlier studies, that used time-series data, supported the view that progressivity fosters employment in unionized economies, later studies based on individual

[5] For Germany, Frick *et al.* (2005) report results for the period 1985-2003; relative poverty increased over the last five years and reached a maximum of 15.3 % in 2003. Becker and Hauser (2004) document a rise of absolute poverty rates between 2000 and 2002, followed by a moderate decline in 2003.

[6] For evidence on the long-run evolution of income concentration in several countries, see Atkinson and Piketty (2006). Bach *et al.* (2007) document a sharp increase of income concentration in Germany during the period 1992-2001.

data have yielded mixed results.[7] The link put forward in the current paper provides a complementary reason as to why tax progression may have favorable employment effects in economies with unionized labor markets. Empirically, one might discriminate between the two effects by separatedly estimating the effect from local progressivity: at the income level of union members - which is the relevant measure for the Lockwood and Manning (1993)'s type of model; and at the income level of philanthropists - which is the relevant measure for the current model.

2 The model

The model economy is populated by $W + K$ individuals, indexed by $i = 1, ...W + K$. The population consists of W workers and K capitalists. Each worker is only endowed with labor and inelastically supplies one unit of it to the firm sector. Capitalists are only endowed with entitlements in the firms' profits. There are F firms, indexed by $f = 1, ...F$ that produce a homogeneous consumption good according to $Q_f = AL_f^{\alpha}$, where L_f is employment in firm f, $\alpha \in (0, 1)$, and $A > 0$. Each capitalist receives $1/K$ of the profit of every firm.

Each firm faces a pool of workers, from which the firm can hire. Each pool contains W/F workers and is represented in wage negotiations by a trade union. Without significant loss of generality, the union has the entire bargaining power. It sets the wage so as to maximize the expected utility of the workers in the pool. The firm then chooses the employment level so as to maximize its profit.

Individuals have common preferences about their own and their fellow human beings' level of consumption. Preferences are supposed to satisfy Arrow's (1981) axioms; therefore, they can be represented by the following von Neumann-Morgenstern utility function:

$$U_i = u(c_i) + \sum_{j \neq i} v(c_j). \tag{1}$$

[7] See e. g. Tranaes *et al.* (2006), who also review the previous empirical literature.

The variable c_i denotes individual i's consumption. The functions u and v are strictly increasing and concave and satisfy $u'(c) > v'(c)$, $\forall c$. This notably implies that individuals are altruistic; however, starting from an equal distribution between individual i and some other individual, i would prefer to shift some income to himself. In what follows, it will be assumed that $u(c) = \epsilon \log(c)$ and $v(c) = \log(c)$, where $\epsilon > 1$ can be interpreted as the degree of selfishness. Altruism asymptotically vanishes when ϵ goes to infinity.

Market income is redistributed by means of a tax-transfer system. The unemployed receive a welfare payment z that is financed by income taxes paid by the employees and the capitalists; z is posited to be smaller than the net wage. The income tax schedule is $T(y) = t_1 y$ for incomes between 0 and some threshold $\overline{y}$, and $T(y) = t_1 \overline{y} + t_2(y - \overline{y})$ for incomes larger than $\overline{y}$, where the marginal tax rates t_1 and t_2 are between zero and one; the income tax is progressive if and only if $t_2 > t_1$.

The sequence of events is as follows. At date $t = 0$ the government announces $(z, \overline{y}, t_1, t_2)$. At date $t = 1$, all trade unions set their wage level. At date $t = 2$ the firms choose their employment levels; redundancies are randomly distributed across the workforce inside each pool and production occurs. At date $t = 3$ each individual is permitted to give any amount of his income away to any other individual. At date $t = 4$ individuals consume their post-fisc, post-charity income.

3 Determination of equilibrium

The model is analyzed by backward induction, i.e. agents hold rational expectations.

3.1 Charity game

Let x_i denote the post-fisc income of individual i. This income can be used for consumption or gifts to other individuals. The amount given by an individual i to an individual j is denoted by $g_{ij} \geq 0$. Individual consumption, after all gifts have been given and received is

$$c_i = x_i + \sum_{k \neq i} g_{ki} - \sum_{j \neq i} g_{ij}. \tag{2}$$

Each individual i chooses g_{ij} for all $j \neq i$ so as to maximize his utility function (1), taking as given the gifts made by all other individuals, which determine all consumption levels according to (2).

As shown by the above equations, the individuals' decision problems are interdependent. Taking the non-negativity of gifts into account, a Nash equilibrium of the charity game has $-u'(c_i) + v'(c_j) \leq 0$ and $u'(c_i) = v'(c_j)$ if $g_{ij} > 0$ for all i and j.

The charity game was first studied by Arrow (1981) and all his results carry over to the current model. Specifically, there is a unique allocation of consumption that is supported as a Nash equilibrium. In that equilibrium, the set of givers, defined as $\{i | g_{ij} > 0 \text{ for some } j\}$, and the set of receivers, defined as $\{i | g_{ji} > 0 \text{ for some } j\}$, are disjoint. Moreover, all receivers consume the same amount, which is the minimum consumption level in the population, and the consumption level of any giver is strictly larger than the minimum.

Of course, depending on parameter values, the set of givers and the set of receivers may be empty. In such a trivial equilibrium, post-fisc income and consumption coincide. I consider the case in which the equilibrium is nontrivial.

Since individuals have identical preferences, the set of givers includes all individuals with the highest post-fisc income and the set of receivers includes all individuals with the lowest post-fisc income. Let x^K and x^L respectively denote the post-fisc income of capitalists and employees. Hereafter, I assume that the parameters are such that the equilibrium level of pre-fisc income of the capitalists is strictly larger than $\overline{y}$, which is in turn strictly larger than the pre-fisc income of employees.[8] Then, one has $x^K > x^L > z$ and in a nontrivial equilibrium capitalists privately support the unemployed. As a

[8] Hence, the capitalists are posited to be the rich. This assumption is consistent with empirical findings on the composition of market incomes at top fractiles of the income distribution. See e.g. Table 6 in Bach *et al.* (2007).

consequence,

$$u'(c^K) = v'(c^U), \tag{3}$$

where c^K is the consumption level of a capitalist and c^U is consumption of an unemployed. Furthermore, I assume that the parameters are such that the employees are neither givers nor receivers.[9]

By (3) and the assumption that u and v are logarithmic one has

Proposition 1 *In equilibrium, the ratio between the highest and the lowest consumption level in the population is equal to* ϵ*:*

$$\frac{c^K}{c^U} = \epsilon. \tag{4}$$

Thus, the degree of selfishness determines the consumption of the capitalists relative to the consumption of the unemployed. Let $g > 0$ denote the amount that every unemployed receives on average from a capitalist. Then,

$$c^U = z + Kg \tag{5}$$

and

$$c^K = x^K - Ug, \tag{6}$$

where U is the total number of unemployed in the economy. By (4), (5) and (6), the total charity received by an unemployed is

$$Kg = K\frac{x^K - \epsilon z}{\epsilon K + U}. \tag{7}$$

The received charity is increasing with x^K and K, and it is decreasing with ϵ, z and U.

[9] Otherwise, the model would generate predictions that are not in line with observation. If the employees received charity, in equilibrium they would obtain the same consumption level as the unemployed. If the employees made charitable contributions to the poor, they would have the same consumption level as the capitalists.

3.2 Unionized labor markets

Given the wage level w_f, firm f chooses its employment level $L_f \in [0, W/F]$ so as to maximize its profit, given by

$$\Pi_f = AL_f^{\alpha} - w_f L_f. \tag{8}$$

Assuming that the solution to this maximization problem is interior, the resulting labor demand function is

$$L_f = \left(\frac{\alpha A}{w_f}\right)^{\frac{1}{1-\alpha}}. \tag{9}$$

This relationship is correctly anticipated by the trade union, that sets the wage so as to maximize the expected utility of the workers in the local pool. Each local union is posited to be small, i.e. it takes the behavior of all other unions and hence the income distribution in the rest of the economy as given.

A worker in pool f is employed with probability $L_f F/W$ and is unemployed with the complementary probability. If employed, he achieves utility

$$\epsilon \log[(1-t_1)w_f] + (L_f - 1)\log[(1-t_1)w_f] + \left(\frac{W}{F} - L_f\right)\log\left(c^U\right) + \Phi,$$

where the first term is utility from own consumption and the remaining terms capture altruism: the second one is determined by the consumption level of employees in the firm, the third one by consumption of the unemployed in the firm's pool, and third one by consumption of everybody else.[10]

An unemployed worker obtains utility

$$\epsilon \log\left(c^U\right) + L_f \log[(1-t_1)w_f] + \left(\frac{W}{F} - L_f - 1\right)\log\left(c^U\right) + \Phi.$$

[10] That is,

$$\Phi = \sum \log c_j,$$

where the sum is over all capitalists and all workers who do not belong to the pool of firm f.

Computing the expected utility, after eliminating constant terms and multiplicative coefficients, one finds that the union's maximization problem boils down to

$$\max_{w_f} L_f \left\{ \log[(1-t_1)w_f] - \log\left(c^U\right) \right\},$$

subject to (9). Interestingly, the degree of altruism has no direct impact on the wage demanded by the trade union. It only matters indirectly by its effect on the expected consumption level of the unemployed. This implies that workers would still agree on the same wage policy even if they had heterogeneous preferences over others' consumption levels.

Proposition 2 *In every firm the union sets the following wage:*

$$w = \frac{e^{1-\alpha}}{1-t_1} c^U. \tag{10}$$

Proof: The FOC of the union's maximization problem reads

$$w_f^{\frac{2-\alpha}{\alpha-1}} \left\{ 1 - \frac{1}{1-\alpha} \log\left[\frac{(1-t_1)w_f}{c^U} \right] \right\} = 0,$$

which implies (10). Straightforward computations show that the SOC is satisfied. QED

3.3 General equilibrium

In the general equilibrium, the consumption level of the unemployed is endogenously determined. From (5) and (7) one has

$$c^U = z + K \frac{x^K - \epsilon z}{\epsilon K + U}, \tag{11}$$

which shows that the consumption level of the unemployed linearly increases with the post-fisc income of the capitalists. In turn, that income level is determined by the tax schedule according to

$$x^K = (1-t_2)y^K + (t_2 - t_1)\overline{y}, \tag{12}$$

where y^K is the pre-fisc income of capitalists. Hence, the consumption level of the unemployed turns out to linearly increase with the pre-fisc income of the capitalists.

In order to determine y^K, recall that all firms use the same technology and pay the same wage in equilibrium. Hence, the profit is the same for all firms and denoted by π. Then,

$$y^K = \frac{\pi F}{K}. \tag{13}$$

As the production function is homogeneous of degree α, it must be the case that

$$\pi = (1-\alpha) A L_f^{\alpha}. \tag{14}$$

Substituting (9) into (14), and recursively into (13), (12), and (11), yields

$$c^U = z + K \frac{(1-t_2) H w^{\frac{\alpha}{\alpha-1}} + (t_2 - t_1)\overline{y} - \epsilon z}{\epsilon K + U}, \tag{15}$$

where H is a strictly positive constant defined as

$$H \equiv \frac{F A^{\frac{1}{1-\alpha}} \left(\alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}} \right)}{K}.$$

We are now in a position to determine the wage curve of the economy. Inserting (15) into (10), one obtains

$$w = \frac{e^{1-\alpha}}{1-t_1} \left[z + K \frac{(1-t_2) H w^{\frac{\alpha}{\alpha-1}} + (t_2 - t_1)\overline{y} - \epsilon z}{\epsilon K + U} \right]. \tag{16}$$

This equation describes the relationship between equilibrium wage and equilibrium unemployment, as stemming from the wage setting behavior of the unions and taking the determination of the utility level of the unemployed into account.

The labor demand curve of the economy can be obtained by (9). Since all firms behave identically, we have $w_f = w$ and $L_f = (W - U)/F$. Substituting these relationships into (9) yields

$$U = W - F \left(\frac{\alpha A}{w} \right)^{\frac{1}{1-\alpha}}. \tag{17}$$

Equations (16) and (17) determine the equilibrium levels of wage and unemployment.

Proposition 3 *(i) There exists a unique equilibrium level of unemployment* $U^* > 0$. *(ii) Equilibrium unemployment decreases with the degree of selfishness,* ϵ.

Proof: See the Appendix.

Interestingly, altruism is bad for employment in a unionized economy with philanthropy. The intuition is straightforward. If the altruistic motive is operative for the rich and they become more altruistic, charities will receive more money from them and thereupon increase their help for the poor. Thus, the utility level anticipated by workers in case of unemployment will increase. This creates an incentive for the trade unions to demand higher wages and tolerate a higher unemployment rate.

A comparison with the model in Arrow (1981) is instructive. In that model, voluntary gifts to the poor are suboptimally low because the individuals do not internalize the effect of their gifts upon the other individual's welfare. This externality is the unique distortion in Arrow's model. In the current framework, a second distortion is involved, namely local monopoly unions. Individuals do not internalize the effect of their gifts upon the wage setting policy of the trade unions. Since more generous gifts induce a stronger wage pressure, voluntary gifts to the poor may be considered too large because they are detrimental to production efficiency.

4 Employment effects of taxes

The budget of the government is given by:

$$B = t_1 w(W - U) + [t_2(y^K - \overline{y}) + t_1\overline{y}]K - zU,$$

where the three terms on the RHS respectively are the revenue from the taxation of wage income, the revenue from the taxation of profit income, and the public expenditure

for the unemployed. The policy variables $(z, \overline{y}, t_1, t_2)$ are supposed to be such that the government's budget constraint $B \geq 0$ is satisfied. We now examine the impact of each policy variable on equilibrium unemployment:

Proposition 4 *Unemployment is an increasing function of z and t_1 and a decreasing function of t_2; unemployment increases with $\overline{y}$ if and only if $t_2 > t_1$.*

Proof: See the Appendix.

The intuition behind the effects from z and t_1 is the same as in standard models of wage bargaining. The novel insight is that unemployment is decreasing in the top marginal tax rate, t_2. An increase in the top tax rate decreases the post-fisc income of the rich without affecting the take-home wage of the employees. As a consequence, the rich decrease their donations to charities and the unemployed poor attain a lower level of consumption. This effect dampens wage pressure by the unions and increases the aggregate employment level. Exactly the same intuition lies behind the employment effect from $\overline{y}$.

The positive employment effect of the top marginal tax rate is entirely due to its impact on charitable contributions. Since the rich derive their income from pure profits, if an operative altruistic motive were absent, a marginal tax on those profits would merely transfer resources from the rich to the government, with no implications for allocative efficiency. In the current framework, taxing pure profits matters for allocative efficiency because profits are spent in a way that turns out to distort the labor allocation.

The employment effects of the tax parameters can be summarized by

Corollary *Tax progression is good for employment.*

It is easy to see that, generally, there always exist ways of increasing progressivity, i.e. $t_2 - t_1$, such that the government's budget B is not worsened. A simple strategy is to keep t_1 constant and to raise t_2. Then, we have:

Proposition 5 *Increasing the top marginal tax rate increases the revenue from taxation of wage income, increases the revenue from taxation of profit income, and reduces public expenditures for the poor.*

Proof: See the Appendix.

5 Conclusion

The present paper has offered a simple general equilibrium model of a unionized economy where the unemployed supplement their transfers from the government with support from private philanthropy. It has been shown that a progressive income tax is good for employment and improves production efficiency. Raising the top marginal tax rate can both reduce the unemployment rate and improve the public budget. These results are driven by the following three facts: charity indirectly increases wage pressure; the rich are those who donate to charities; and, finally, the altruistic rich fail to internalize the effet of their donations on the wage setting behavior of the unions.

It is beyond the scope of this paper to examine the empirical relevance of the relationships predicted by the model. With regard to its main results, there are several respects in which they could be extended and should be qualified. I conclude by reviewing three key issues.

First, Arrow (1981) is not the only possible model of altruistic preferences and one might wonder whether the results derived in the current paper survive under alternative assumptions. An approach to altruism which has received considerable attention is warm-glow giving, where an individual's donation directly increases the donor's utility.[11] In terms of the current model, the utility function (1) would be replaced by $U_i(c_i, g_i)$, where g_i is the individual's voluntary contribution to a fund that is equally redistributed to the unemployed. It is not difficult to see that if g_i is a normal good, which is an assumption that is consistent with the empirical evidence, the results of this paper carry over to that

[11] See e.g. Andreoni (2006).

alternative specification of preferences. Under mild conditions on $U_i(c_i, g_i)$, there exists an equilibrium in which only the rich donate, i.e. have $g_i > 0$, and the unions have an incentive to "exploit" the donors by raising the wage. Under the normality assumption, a higher tax on the rich will reduce their private giving, moderate wage demands by the unions, increase employment, and improve the budget.

Second, the current model restrictively posits that a more progressive income tax only hits pure profits that accrue to firm owners. This assumption was made for the sake of clarity: since taxing pure profits is nondistortionary, the wage-setting implications of tax progressivity in presence of private giving to the poor could be shown in a crystal-clear way without having them confounded with further incentive effects. In reality, however, increasing the tax burden on high incomes is likely to produce a variety of distortionary effects, e.g. on labor supply.[12] To the extent that such behavioral responses to increased progressivity impinge upon the aggregate labor demand, their employment and fiscal effects should be added to those put forward in the current model.

Third, one might take a political-economy perspective and endogenize the government's decision about the tax-transfer system. This extension may shed light on the effect of different constituencies on the mix of public and private support for the poor. If the government represented the interests of the workers, one may conjecture that the government would set a tax schedule with a marginal tax rate of 100 percent for incomes larger than the wage, so as to transfer as much as possible of the firms' profits to the workers. Then, the capitalists would receive the same post-fisc income as the employees; charitable giving would be likely to disappear and the poor would entirely be supported by governmental transfers. However, even a worker-dominated government might decide to implement an equilibrium with private giving if the latter entails less distorsions than governmental redistribution.[13] It would be interesting to see whether plausible circum-

[12] This constitutes a venerable area of research at the intersection of public economics and labor economics. See e.g. Sandmo (1983) for an early theoretical treatment and Moffitt and Wilhelm (1998) for an empirical analysis.

[13] This case is forcefully argued by Ferris and West (2003).

stances exist under which the government underprovides assistance to the poor, so as to promote charitable contributions by the capitalists. Finally, in the spirit of Dur (2001), one might study the case where the government can revise the tax-transfer system after the wages are set, but before charitable contributions, and the government cannot pre-commit to a tax-transfer system. This may shed further light on the implications of the government's credibility problem for the design of fiscal policy.

Appendix

Proof of Proposition 3

Part (i): The equilibrium wage and unemployment are a solution to the equation system given by (16) and (17). The latter is the demand curve, which implicitly defines the wage as a strictly increasing function of the unemployment level. The wage equals the competitive wage if $U = 0$ and tends to infinity if $U \to W$.

Equation (16) is the wage curve and implicitly defines the wage as a strictly decreasing function of the unemployment level. To see this, rewrite the wage curve as

$$w(1-t_1)(\epsilon K + U) = e^{1-\alpha}\left\{K\left[(1-t_2)Hw^{\frac{\alpha}{\alpha-1}} + (t_2-t_1)\overline{y}\right] + zU\right\}. \tag{18}$$

Differentiation with respect to w and U yields

$$\left[(1-t_1)(\epsilon K+U) + \frac{\alpha}{1-\alpha}e^{1-\alpha}K(1-t_2)Hw^{\frac{1}{\alpha-1}}\right]dw = \left[ze^{1-\alpha} - w(1-t_1)\right]dU. \tag{19}$$

The term in square bracket on the LHS is strictly positive. The term in square bracket on the RHS is strictly negative if $w(1-t_1) > ze^{1-\alpha}$. By (10) and (5), $w(1-t_1) = (z+Kg)e^{1-\alpha}$. Hence, the term in square bracket on the RHS is strictly negative; it follows that $dw/dU < 0$.

Since the wage demanded by the union at $U = 0$ is larger than the competitive wage and the wage given by the demand curve goes to infinity as $U \to W$, there exists a unique (U^*, w^*), with $U^* \in (0, W)$, that simultaneously solves (16) and (17).

Part (ii): The degree of selfishness only affects U^* through the wage curve. It is straightforward to verify that an increase of ϵ shifts the wage curve downwards in the space (U, w). Since the demand curve is upwards sloping, increasing ϵ reduces both U^* and w^*. Q.E.D.

Proof of Proposition 4

The policy variables $(z, \overline{y}, t_1, t_2)$ only affect U^* through the wage curve. Differentiating (18) with respect to w and z yields

$$\left[(1-t_1)(\epsilon K+U)+\frac{\alpha}{1-\alpha}e^{1-\alpha}K(1-t_2)Hw^{\frac{1}{\alpha-1}}\right]dw = e^{1-\alpha}Udz. \tag{20}$$

Hence, an increase of z shifts the wage curve upwards in the space (U, w). Since the demand curve is upwards sloping, increasing z increases U^*.

Differentiating (18) with respect to w and t_1 yields

$$\left[(1-t_1)(\epsilon K+U)+\frac{\alpha}{1-\alpha}e^{1-\alpha}K(1-t_2)Hw^{\frac{1}{\alpha-1}}\right]dw = [w(\epsilon K+U)-e^{1-\alpha}K\overline{y}]dt_1. \tag{21}$$

An increase of t_1 shifts the wage curve upwards and increases U^* iff

$$w(\epsilon K+U) > e^{1-\alpha}K\overline{y}. \tag{22}$$

To see that (22) holds, use (10) to rewrite it as

$$c^U\left(\epsilon+\frac{U}{K}\right) > \overline{y}(1-t_1).$$

By (5) and (4), the above inequality is equivalent to

$$c^K+\frac{zU}{K}+Ug > \overline{y}(1-t_1),$$

which can be transformed using (6) and (12) into

$$y^K-t_1\overline{y}-t_2(y^K-\overline{y})+\frac{zU}{K} > \overline{y}-t_1\overline{y}.$$

Hence, (22) holds iff

$$(1-t_2)(y^K-\overline{y})+\frac{zU}{K} > 0,$$

which is clearly satisfied.

Differentiating (18) with respect to w and t_2 yields

$$\left[(1-t_1)(\epsilon K+U)+\frac{\alpha}{1-\alpha}e^{1-\alpha}K(1-t_2)Hw^{\frac{1}{\alpha-1}}\right]dw = -[e^{1-\alpha}K(y^K-\overline{y})]dt_2.$$

Hence, an increase of t_2 shifts the wage curve downwards and reduces U^*.

Differentiating (18) with respect to w and $\overline{y}$ yields

$$\left[(1-t_1)(\epsilon K+U)+\frac{\alpha}{1-\alpha}e^{1-\alpha}K(1-t_2)Hw^{\frac{1}{\alpha-1}}\right]dw=e^{1-\alpha}K(t_2-t_1)d\overline{y}.$$

Hence, an increase of $\overline{y}$ shifts the wage curve upwards and increases U^* iff $t_2>t_1$. QED

Proof of Proposition 5

By (9), revenue from taxation of wage income can be written as

$$t_1w(W-U)=t_1F\alpha A\left(\frac{W-U}{F}\right)^{\alpha}.$$

Since U decreases with t_2, increasing the latter unambiguously increases the tax revenue.

By (13) and (14), revenue from taxation of profit income can be written as

$$[t_2(y^K-\overline{y})+t_1\overline{y}]K=t_2\left[\frac{F}{K}(1-\alpha)A\left(\frac{W-U}{F}\right)^{\alpha}-\overline{y}\right]K+t_1\overline{y}K.$$

Since U decreases with t_2 and $y^K>\overline{y}$, increasing the top marginal tax rate unambiguously increases the tax revenue.

Finally, expenditures for the poor, zU, decreases with t_2 because U diminishes if t_2 is increased. QED

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