A joint Initiative of Ludwig-Maximilians-Universität and Ifo Institute for Economic Research

Working Papers

TAXING MOBILE CAPITAL WITH LABOR MARKET IMPERFECTIONS*

Wolfram F. Richter
Kerstin Schneider

CESifo Working Paper No. 477

May 2001

CESifo
Center for Economic Studies & Ifo Institute for Economic Research
Poschingerstr. 5, 81679 Munich, Germany
Tel.: +49 (89) 9224-1410
Fax: +49 (89) 9224-1409
e-mail: office@CESifo.de

* The authors like to thank S. Boeters C. Fuest, H Holländer, St. Homburg, B. Huber, K. Wälde and two referees for valuable comments.

CESifo *Working Paper No. 477*
May 2001

TAXING MOBILE CAPITAL WITH LABOR MARKET IMPERFECTIONS

Abstract

Taxing internationally mobile factors of production has been dismissed as an inefficient means of raising tax revenue. This paper addresses the question of whether it is efficient to tax capital at source when labor markets and the taxation of lumpsum income suffer from imperfections. Four reasons for taxing capital are identified: (i) institutional constraints rendering any taxation of profit income infeasible; (ii) market power in the demand for labor; (iii) market power in the supply of labor if it increases with the employment of capital; (iv) unemployment benefits that are not tied to net real wages. It is argued that the case for taxing capital is not particularly strong. By reinterpreting capital as energy the results are applicable to the discussion about ecological tax reforms.

JEL Classification: H2.

Keywords: Optimal taxation, factor mobility, labor market imperfections, ecological tax reform.

Wolfram F. Richter
University of Dortmund
Department of Economics
44221 Dortmund
Germany
Wolfram.richter@wiso.uni-dortmund.de

Kerstin Schneider
University of Dortmund
Department of Economics
44221 Dortmund
Germany

1. Introduction

There are good reasons to leave the competitive rewards to internationally mobile factors untaxed and to tax immobile factor incomes like labor income instead. However, as the discussion about ecological tax reforms shows, the political debate about the taxation of internationally traded factors is still ongoing. Advocates of green tax reform argue that taxing energy - an internationally traded factor - and using the tax revenue to reduce the distortions of the existing tax system is welfare enhancing. In fact, the European Commission (1997) recommends to tax the use of energy and to recycle the revenue to reduce labor costs, hoping to take away some pressure from the labor market. Can this proposal be simply dismissed as being inappropriate to cope with employment problems? Or does unemployment force us to revise the received wisdom about the optimal taxation of production factors?

The literature on optimal taxation has produced some strong result*s* on how to design second-best tax systems. In a seminal paper Diamond and Mirrlees (1971) have identified very general conditions under which production efficiency is desirable. Applied to the problem at hand, their theorem requires that the government of a small open economy raises all required revenue solely through the taxation of income as it accrues to residents. The competitive rewards to mobile factors like capital should remain untaxed. This result stands even if immobile factors are not perfectly inelastically supplied, i.e., even if the taxation of immobile factors creates deadweight loss. In other words, taxes on capital are not an efficient means to alleviate the effective tax burden on labor.

However, two conditions are necessary for the validity of the theorem. First, there must not be pure profits accruing to private households. If pure profits exist, it has to be feasible to tax them up to one hundred percent. The second requirement is that the non-availability of lumpsum taxes is the only source of inefficiency in the economy.

Mirrlees (1972) qualifies the first condition. He argues, that it imposes a *weaker* constraint on the theorem than one may think at first sight. It is only pure rent income that has to be extracted through taxation. Pure rent income, however, is rare. Consider for example an economy with internationally mobile firms. Here profits direct the locational choices of the firms. To the extent that these profits are competitive rewards, they do not

have to be extracted by the government for the production-efficiency theorem to hold (Gordon, 1992). This paper explicitly considers the existence of pure rent income and studies the implications of different income tax regimes on the optimal treatment of capital.

The second condition seems to impose stronger constraints on the validity of the theorem and is the focus of this paper. It can hardly be argued that the labor market in most industrialized countries and in particular in those countries that suffer from high rates of unemployment is perfectly competitive. Depending on the exact nature of the problem in the labor market that may or may not be resolved through government intervention, third-best tax systems have to be designed. Whether they follow the same simple rules as second-best tax systems remains to be seen and is the subject of the present analysis.

There exists a host of plausible explanations why the labor market fails to clear. We do not attempt to argue that one theory reflects the existing imperfections better than another. Hence, a model framework is constructed that can easily be fitted to accommodate different labor market setups. To keep the model analytically tractable, the rest of the model is kept at a minimum complexity. Distributional issues, for example, are ignored in the analysis.

It should be noted at the outset that we do not study possible efficiency gains from *marginal* tax reforms. Instead, we derive *optimal* tax systems in the presence of labor market imperfections. The chosen modeling framework explicitly allows us to separate efficiency losses from the payment of unemployment compensation and inefficiencies from non-competitive behavior in the labor market. It turns out that choosing this strategy produces surprisingly unambiguous results that prove to be helpful to get a better understanding of the literature on green taxes.

In Section 2 optimal taxation subject to perfectly competitive labor markets is revisited. In Sections 3 to 5 various kinds of market imperfections are introduced. In Section 3 the inefficiency is caused by the market power of firms, and in Section 4 workers, represented by a union, exert market power. In both cases workers are not compensated by the government for resulting underemployment. For simplicity, we consider the admittedly extreme cases of a monopsony in the labor market - representing

labor markets with upward sloping labor supply curves - and a monopoly union that is setting wages subject to a downward sloping labor demand curve. In section 5 labor markets are again competitive. The payment of unemployment compensation imposes an institutional constraint, and we ask how alternative designs of transfer payments affect the efficient taxation of capital. Section 6 applies the results to the discussion of green taxes, and Section 7 concludes.

Assuming perfectly competitive labor markets, the main results are: With no positive lumpsum income accruing to private households, production efficiency is desirable and capital should remain untaxed (Proposition 1). For households to earn wage income only, it must be feasible to tax any lumpsum income up to one hundred percent. If wage income is taxable and profit income cannot be taxed, it is efficient to tax capital (Proposition 2). Finally, with a uniform income tax in place, subsidizing capital turns out to be optimal (Proposition 3). Propositions 4 to 6 and Propositions 8 to 10 generalize Propositions 1 to 3. The first set applies to a regime with monopolized labor demand. It turns out that a monopsony in the labor market strengthens the case for taxing capital. For monopolized labor supply it all depends on how market power varies with the employment of capital (Propositions 7 to 10). If the market power of labor supply decreases, one obtains an argument for subsidizing capital. Looking at the design of the transfer system, it is shown that only if unemployment benefits are indexed to net (real) wages, Propositions 1 to 3 require no further qualification (Proposition 11). If unemployment benefits are indexed to gross wages the employment of capital exerts a fiscal externality, which can be internalized by taxing capital (Proposition 12). Hence it is not simply a matter of equitable taxation to index transfers to net wages; it is dictated by efficiency considerations.

The presented results are easily applied to the discussion about double dividends from green taxes. One only has to interpret energy as an internationally traded factor of production.

2. Institutional constraints in the taxation of lumpsum income

Consider a small open, one-sector economy with three factors of production. Labor, *l*, is internationally immobile but labor supply is endogenously determined by the households. Capital, *k*, is a mobile factor and traded at a fixed (real) price, *q*. The factor *k* is interpreted as capital, but note that it may well be interpreted as energy. Assume that residents are endowed with some exogenous amount of capital $\bar{k}$. Since *q* is fixed, residents earn exogenous factor income $I \equiv q\bar{k}$. And finally there is a third factor, *f*, which is in fixed supply. The fixed factor *f* could be interpreted as land, or like in De Mooij and Bovenberg (1998) as fixed capital. Output serves as a numéraire good. The production function *F(l,k)=F(l,k,f)* is linear homogeneous in *l*, *k*, and *f*. Since *f* is fixed it is suppressed in the notation whenever no ambiguities result. Let $F_{ii} < 0 < F_{ij}\ \forall i \neq j = l,k,f$. Subscripts denote partial derivatives, i.e., $F_l = \partial F(l,k)/\partial l$. Constant returns to scale imply

$$lF_{kl} + kF_{kk} < 0 \text{ and } F_{ll}F_{kk} - F_{lk}^2 > 0. \qquad (1)$$

Let *w* denote (real) labor cost and θ a source-based tax/subsidy on capital. Firms maximize profits $\pi \equiv \max\left[F(l,k) - wl - (1+\theta)qk\right]$. It is assumed that these profits completely accrue to domestic residents. This assumption is less innocuous than it might appear at first sight, because the existence of profits accruing to foreigners renders a positive tax on capital optimal (Huizinga and Nielsen, 1997).

Government expenditures require to finance an exogenously fixed budget, *g*. Revenue can be raised either through taxing capital (at source) or through taxing income according to the residence principle. In the present model households earn income from three sources. They earn wage income wl, capital income *I*, and profit income π. Assuming that the government can always levy a tax on wage income, after-tax wage income is given by $(1-\tau)wl$, and $\omega \equiv (1-\tau)w$ denotes the after-tax wage. Let net lumpsum income be denoted by $\rho(\pi + I)$, where $1-\rho$ is the tax rate on lumpsum income. In the following we distinguish between three tax regimes. In a uniform income tax regime $\rho \equiv 1-\tau$ and $\rho' = d\rho/d\tau = -1$. If only wages can be taxed and lumpsum income remains untaxed, we have $\rho \equiv 1$. Finally, we also consider the case in which all positive lumpsum income is taxed away, such that $\rho \equiv 0$ holds. In this case, there are no

constraints on the taxation of (positive) lumpsum income. Note that this does not mean that a lumpsum tax is available. A true lumpsum tax would allow the tax planner to leave households with negative lumpsum income. This is ruled out by assumption and the reason why the tax system is not first-best in the present paper. With a wage tax and the unrestricted taxation of positive lumpsum income, $\rho' = 0$.

Ignoring distributional issues, we let the utility function be quasi-linear with $U(c,l) \equiv c - V(l)$ and $V'(l) > 0, \quad V''(l) > 0$ for $l > 0$. All income is spent on consumption, hence $c = \omega l + \rho(\pi + I)$. Households maximize utility by choosing labor supply, and the first-order condition is $\omega = V'(l)$. Assuming a quasi-linear utility function greatly simplifies the analysis without biasing the results. In fact, except for Propositions 5 and 6 all results may easily be generalized, as will be discussed below.

To derive efficient tax structures, assume that a social planner maximizes the utility of a representative household. She chooses $\theta, \tau, \omega, k, l$ in order to

maximize $\quad \omega l + \rho(\pi + I) - V(l)$ (2)

subject to

$$\omega = V'(l) \qquad (\lambda) \quad (3)$$

$$(1-\tau)F_l = \omega \qquad (\alpha) \quad (4)$$

$$F_k = (1+\theta)q \qquad (\beta) \quad (5)$$

$$\frac{\tau}{1-\tau}\omega l + \theta qk + (1-\rho)(\pi + I) = g\,, \qquad (\gamma) \quad (6)$$

with $\pi \equiv F - \frac{\omega l}{1-\tau} - (1+\theta)qk.$

The constraint (3) requires the after-tax wage to equal the marginal disutility of work. Equations (4) and (5) characterize profit-maximizing firms. Finally, the government budget constraint is written down in (6). $\lambda, \alpha, \beta, \gamma$ indicate Lagrangean multipliers. Note that the lumpsum tax function, $\rho = \rho(\tau)$, is no policy instrument. As mentioned earlier, the paper differentiates between three tax regimes that are exogenously given but does neither allow the planner to choose between the three regimes nor to

optimize in ρ.[1] Clearly, in the absence of any constraints, the planner would choose to finance government expenditures solely by taxing lumpsum income. In what follows, we assume that the planner is forced to choose a positive wage tax rate, $\tau > 0$, in the optimum. This means that revenue requirements are sufficiently large, so that the marginal cost of public funds, γ, exceeds one. Propositions 1 to 3 show that optimal tax policy depends critically on the ability of the government to skim off positive lumpsum income. Solving the tax-planner's maximization problem gives

Proposition 1: If there is no restriction in the taxation of positive lumpsum income, $\rho \equiv 0$, it is optimal to leave capital untaxed, $\theta = 0$.

Proposition 1 is a special case of Proposition 8 below. Hence the proof is postponed. The result is well known from the literature, e.g. Gordon (1986), Bucovetsky and Wilson (1991), and Bovenberg and de Mooij (1994b). It is an application of the production-efficiency theorem of Diamond and Mirrlees (1971). Proposition 1 demands that taxes are entirely levied according to the residence principle. The returns to capital should remain untaxed at source. The reason is that mobile capital is perfectly elastically supplied and immobile labor is not. Thus any source taxes on mobile factors would only be shifted to immobile factors. Even if labor is elastically supplied, it is more efficient to tax labor directly rather than to levy a source tax on capital which is shifted by market forces. Note that factor demand elasticities are irrelevant for the validity of this result.

The effects of capital taxation on employment and welfare are easily determined in the basic model. It turns out that the sign of θ is pivotal. Employment and welfare may well be enhanced with increasing capital taxes but only if the initial tax on capital is negative. In other words, if capital is subsidized initially, it is employment and welfare

[1] A fourth alternative tax regime, which has been pointed out by a referee, could be one in which profits are taxed at the same rate as the return to capital. We choose not to follow this line because the paper is motivated by the discussion of ecological tax reform. It is hard to argue why energy should be taxed at the same rate as profits. This is obviously different if the focus is on capital. In fact, it is difficult to differentiate between pure profits and the return to capital in practice. A tax regime in which π and *qk* are taxed at the same rate amounts to a comprehensive business income tax. In the present model it is easy to show that the existence of positive profits entails a positive comprehensive business income tax. This result, however, is known and implicitly derived in Mintz and Tulkens (1996).

enhancing to reduce the subsidy. Given that capital is taxed, increasing the tax rate, however, unambiguously reduces employment and welfare.

Assuming that a government can tax wages but not positive lumpsum income, we obtain

Proposition 2: With a pure wage tax, $\rho \equiv 1$, it is optimal to tax capital, $\theta > 0$.

Since Proposition 2 is a special case of Proposition 9, the proof of Proposition 2 follows from the proof of Proposition 9 below. The result of Proposition 2 is in line with Huizinga and Nielsen (1997) and De Mooij and Bovenberg (1998). It shows that a capital tax serves as an instrument to skim off profit income that is not directly taxable.

The third tax scenario considered is one in which all income - labor and lumpsum income - is taxed according to the residence principle at a uniform rate. To prove Proposition 3, and later on Proposition 10, a further condition has to hold, namely

$$G \equiv lF_{lk} + kF_{kk} + \left(F - lF_l - kF_k\right)F_{lk}/F_l \geq 0. \qquad (7)$$

For linear homogeneous F (7) is equivalent to $kF_{lk}/F_l \geq kF_{fk}/F_f$. This means that the elasticity of the marginal product of the fixed factor with respect to capital must not exceed the elasticity of the marginal product of labor with respect to capital for (7) to hold. In other words, the elasticity of complementarity between capital and labor has to be higher than between capital and the fixed factor. De Mooij and Bovenberg (1998) interpret k as energy and f as fixed capital. (7) then amounts to assuming that labor is a poorer substitute for energy than capital. According to De Mooij et al. this is supported by empirical evidence. Moreover, $G \equiv 0$ if the direct elasticity of substitution is constant (CES). Given (7), we obtain

Proposition 3: With a uniform income tax, $\rho \equiv 1 - \tau$, and $I > 0$ it is optimal to subsidize capital, $\theta < 0$.

Since Proposition 3 can be subsumed as a special case of Proposition 10, the proof is postponed. Proposition 3 relates to Richter and Schneider (1999), and can be interpreted as follows. The uniform income tax is an instrument that taxes profit income, π, capital

income, I, and wage income. Let us ignore profit income for a moment, which leaves us with two sources of income. The source-based subsidy on capital can be interpreted as an instrument to discriminate indirectly between labor and capital income. Raising the uniform income-tax rate marginally produces benefits and costs. On the one hand, there are costs from distorting labor supply, and on the other hand, there are benefits from skimming off lumpsum income without causing distortions. The costs of taxation are reduced if the marginal revenue is used to subsidize capital. The subsidy induces an inflow of capital, which positively affects labor demand. Note that even if the exogenous component I is zero, it may still be optimal to subsidize capital. This is the case if G is strictly positive which, however, excludes a CES production technology.

Let us now consider profit income. As known from Proposition 2, it is optimal to indirectly reduce profits by taxing capital, given that earned profit income cannot be taxed. This insight contrasts with the subsidization result of Proposition 3. Obviously, the reason for indirectly reducing profits by taxing capital must be dominated by other considerations if a uniform income tax is in place. This is indeed the case. A regime with income and capital taxation allows to choose between skimming off profit income directly and reducing the generation of profits indirectly via capital taxation. Given (7), the former is the more efficient way to do.

A variety of assumptions of the model in Section 2 has been relaxed in the literature to test the robustness of the production-efficiency theorem.[2] Imperfect labor markets, however, have - to our knowledge - not explicitly been the subject of such a test. Hence, this paper addresses the question to what extent labor market imperfections invalidate Propositions 1-3. In the following sections different scenarios of the labor market are integrated, and the optimal tax on capital is determined. To get a better understanding of the forces at work, only rather polar labor market distortions are studied. In particular, only labor markets in which one side – demand or supply – can exert market power are studied. Figure 1 illustrates the imperfections modeled in Sections 3-5. First, a monopsony in the labor market is discussed. Second, it is assumed that labor supply is controlled by a monopoly union. In Section 5, we finally study some general effects of unemployment compensation and transfer payments on optimal tax structures.

[2] See discussion in Atkinson and Stiglitz (1980, p.472).

Insert Figure 1.

3. Monopsony in the labor market

Assume that the labor market is not competitively organized. Instead it is controlled by a monopsonist. A monopsonist is not facing a horizontal labor supply curve, but an upward sloping market supply curve.[3] To expand her work force, the monopsonist has to pay higher wages.

The monopsonist maximizes profits by choosing capital, labor, and the wage rate subject to the labor supply function:

$$\max_{k,l,w} \quad \left[F(k,l) - wl - (1+\theta)qk\right]$$

subject to $\quad (1-\tau)w = V'(l)$.

Solving this maximization, we obtain (5) and

$$(1-\tau)F_l = \omega + lV'' \ . \qquad (\alpha) \quad (4')$$

The monopsonist hires labor up to the point where the marginal product equals marginal cost. In doing so, she drives a wedge, $lV''/(1-\tau)$, between the marginal product of labor and labor cost. Rewriting the wedge, we get $lV''/(1-\tau) = w/\eta^s$, where η^s is the elasticity of labor supply. Thus the wedge and hence the inefficiency is decreasing in the elasticity of labor supply. If labor supply is perfectly elastic, the monopsonist cannot exert monopoly power.

The tax planner solves (2)-(6), where (4') is substituted for (4). Note that to solve for the optimal tax on capital, it suffices to optimize with respect to $\theta, \tau,$ and k. Necessary conditions are

$$\frac{\partial}{\partial \theta}: \quad \beta = (\gamma - 1)\rho k \ , \qquad (8)$$

[3] For a survey of the literature on monopsony models see Boal and Ransom (1997). Boal and Ransom argue that the single buyer assumption is clearly not very plausible. However, there are more plausible models that give rise to monopsony power.

$$\frac{\partial}{\partial \tau}: \quad \alpha = (\gamma - 1)\left[\rho \frac{\omega l}{(1-\tau)^2 F_l} - \rho'(\pi + I)/F_l \right], \text{ and} \tag{9}$$

$$\frac{\partial}{\partial k}: \quad \gamma\theta q = (\gamma - 1)\left[\rho \frac{l^2 V'' F_{lk}}{(1-\tau)F_l} - \rho(lF_{lk} + kF_{kk}) + \rho'(1-\tau)(\pi + I)\frac{F_{lk}}{F_l} \right]. \tag{10}$$

Setting $\rho = \rho' = 0$ in (10) gives

Proposition 4: If there is no restriction in the taxation of positive lumpsum income, $\rho \equiv 0$, it remains optimal to leave capital untaxed.

Proposition 4 shows that if monopsony profits can be taxed just like other lumpsum income, capital should remain untaxed. This is well in line with the literature. A monopsonist earns private profits and, given that profits can be taxed, the production-efficiency theorem applies.[4] The inefficiency in the labor market does not affect the validity of Proposition 1. The next two scenarios consider situations in which monopsony profits cannot be skimmed off completely. First look at a tax regime in which wage income is the only income taxable at the household level.

Proposition 5: With a pure wage tax, $\rho \equiv 1$, it is optimal to tax capital.

To see this, set $\rho = 1$ and $\rho' = 0$ in (10), and the result follows. Proposition 5 generalizes Proposition 2. Recall the interpretation of Proposition 2: A tax on capital can serve as an indirect means to skim off profits, when profits are not directly taxable. The existence of monopsony profits only strengthens the reason for taxing capital. This effect is captured by the expression $\rho \frac{l^2 V'' F_{lk}}{(1-\tau)F_l}$ in (10), which does not appear if there is perfect competition in the labor market. For given employment, *l*, the monopsony wedge, $F_l - w = lV''/(1-\tau)$, increases in τ. Hence shifting taxes from labor to capital helps to reduce the monopsony wedge and to increase labor market efficiency. If capital and labor

[4] Dasgupta and Stiglitz (1972) show that production efficiency is desirable even if non-constant returns to scale in the private sector give rise to profits, as long as profits can be taxed up to one hundred percent.

were substitutes, $F_{lk} < 0$, taxing capital would have an increasing effect on the monopsony wedge. In this case the optimal sign of θ would be ambiguous. Note to derive (10) we did not use the fact that labor and the net wage rate are endogenous variables.

Koskela, Schöb, and Sinn (1998) derive a result which is related to Proposition 5. Their model is more complex than ours. It allows for imperfectly competitive behavior in both, the product and the labor market. The authors are able to prove that taxing the internationally mobile factor boosts employment, provided that the elasticity of substitution between labor and the mobile factor is not too inelastic. Because the model is rather complex, it is not really clear which specific assumption is driving the result. However, Koskela et al. assume that profits cannot be taxed, which according to our Proposition 5 calls for a tax on capital.

Let us now turn to a uniform income tax regime:

Proposition 6: Consider a uniform income tax with $\rho \equiv 1 - \tau$. In the optimum

(i) θ is positive if $I = 0$ and if production is CES;

(ii) the sign of θ is ambiguous if $I > 0$ or $G > 0$.

The proof of Proposition 6 follows immediately from rewriting (10):

$$\gamma\theta q = (\gamma - 1)(1 - \tau)\left[\frac{l^2 V'' F_{lk}}{(1-\tau)F_l} - G - I\frac{F_{lk}}{F_l}\right] \qquad (10')$$

From Proposition 3 we know that it is efficient to subsidize capital if positive lumpsum income is subject to a uniform income tax. This is captured by the last two terms in the square brackets in (10'). The first term is the monopsony effect, which works in the opposite direction, i.e., favoring a tax on capital. Reducing monopsony power requires to tax capital and to use the revenue to lower τ. In general, nothing can be said about the sign of θ, unless we know which effect is dominating. This is captured by statement (ii) of Proposition 6. With a CES technology and no exogenous capital income the ambiguity is resolved. The last two terms in brackets in (10') vanish. Only the monopsony effect determines the sign of θ. This is part (i).

Propositions 5 and 6 are the only results in the paper, where assuming quasi-linearity of utility is important. Without the assumption of quasi-linearity the after tax

monopsony wedge, $(1-\tau)(F_l - w)$, is no longer only a function of labor, *l*. Instead, it also depends on τ and θ. As a consequence, tax policy affects labor supply via income effects. This complication is ruled out by quasi-linearity.

Summarizing Propositions 5 and 6, we conclude that the existence of monopsony profits is a reason for taxing capital. Note however that the argument has third-best character. The optimal tax on capital is zero if profits are directly taxable.

4. Monopoly union

In the previous section we derived the optimal tax on capital when labor demand is a monopoly. Next, we allow for monopoly power of labor supply. Labor supply is monopolized if a union chooses the amount of labor and the wage rate maximizing a representative member's utility, taking the aggregate labor demand schedule as given. For simplicity let every worker in the economy be a member of the union. In the following firms are not organized but behave perfectly competitive, and the union does not negotiate with every firm. Moreover, it is assumed that the union is not fully rational in the sense that it does not internalize adjustments in profit income resulting from its wage policy. Formally, the monopoly union maximizes

$$(1-\tau)wl - V(l) \quad \text{in } l, k, w \text{ subject to} \quad w = F_l \quad \text{and} \quad (1+\theta)q = F_k .$$

Maximization implies

$$\omega\left(1-\eta^d\right) = V', \qquad (\lambda) \quad (3')$$

where $\eta^d = \frac{l}{F_l F_{kk}}\left[F_{lk}^2 - F_{ll}F_{kk}\right] \in (0,1)$ denotes the inverse of the wage elasticity of labor demand. Compared with a competitive outcome the union chooses a wage that is too high. Following the terminology of Section 3, call the difference between the net wage and the marginal disutility of labor the monopoly wedge.[5] Since the wedge, $\eta^d\omega$,

[5] It is well known that the resulting equilibrium is not an efficient contract. There are employment/wage combinations where at least one party can be made better off without making the other party worse off. Efficient contracts can be reached when both parties bargain about wages and employment. It might be argued that collective bargaining yields efficient contracts, but it is nevertheless useful to study the optimal tax schemes with a monopoly union. See McDonald and Solow (1981) and Oswald (1985).

is positive, there is equilibrium unemployment in the sense, that at the given wage each worker is willing to supply more labor.

The following results show that the sign of $\eta_k^d \equiv \partial\eta^d / \partial k$ determines the sign of the optimal θ. More precisely, it turns out that whenever $\eta_k^d < 0$ we get an argument for subsidizing capital. In other words, when the market power of the union diminishes with more employment of capital, capital should – other things equal – be subsidized. If the market power of the union, however, increases in the employment of capital, a tax on capital is optimal.

Assuming the tax planner acts as a Stackelberg leader[6], she solves (2) - (6), where (3') is substituted for (3). Note that the maximization of (2)-(6) is a special case with $\eta^d \equiv 0$. As a result, the proofs of Propositions 1 to 3 follow by simply setting $\eta_k^d = 0$ in the proofs of Propositions 8 to 10 below. Turning to first-order conditions of the planner's optimization we obtain (8) just as before. Using (4), (9) reduces to

$$\alpha = (\gamma - 1)\left[\rho\frac{l}{1-\tau} - \rho'(\pi + I)/F_l\right]. \qquad (9')$$

Differentiating the Lagrangean with respect to capital *k* yields

$$\gamma\theta q = -(\gamma - 1)\left[\rho(lF_{lk} + kF_{kk}) - \rho'(1-\tau)(\pi + I)F_{lk}/F_l\right] \quad + \quad \lambda\omega\eta_k^d. \qquad (11)$$

Note that λ is positive if $\rho' \leq 0$. This follows from inspecting

$$\frac{\partial}{\partial\omega}: \quad \lambda(1-\eta^d) = (\gamma - 1)\left[l - \rho'(\pi + I)/F_l\right].$$

To determine the sign of the optimal tax on capital in the presence of a monopoly union, have a closer look at (11). The effect of union power is captured by the last term. It vanishes in two important cases. The obvious one is when labor supply is perfectly competitive, so that $\eta^d \equiv 0 = \eta_k^d$. However, η_k^d vanishes as well if the elasticity of substitution is constant in production, i.e., $F = \left[al^{-s} + bk^{-s} + f\right]^{-1/s}$. This follows

[6] In Palokangas (1987) it is argued that it is appropriate to model the interaction between the government and the union such that the government acts as a Stackelberg leader. Cournot conjectures are assumed in Fuest and Huber (1997).

because the CES specification implies $\eta^d = \frac{(s+1)f}{al^{-s} + f}$, which is obviously independent of *k*.

Proposition 7:

(i) If production is CES, union power does not vary with the employment of capital. As a result, union power may be ignored when determining the optimal θ.

(ii) If union power decreases (increases) with the employment of capital, which obviously requires the elasticity of substitution to be non-constant in production, this constitutes a reason for subsidizing (taxing) capital.

Part (ii) follows immediately from (11). Let us next evaluate (11) for each of the considered tax regimes.

Proposition 8: If there are no restrictions in the taxation of positive lumpsum income, $\rho \equiv 0$, it is optimal to set $\theta \begin{matrix} > \\ = \\ < \end{matrix} 0$ if, and only if, $\eta_k^d \begin{matrix} > \\ = \\ < \end{matrix} 0$.

The proof is straightforward. For $\rho \equiv 0$ the last term, $\lambda\omega\eta_k^d$, is the only one which might not vanish in (11). Proposition 1 is an immediate corollary just as Propositions 2 and 3 are immediate corollaries to Propositions 9 and 10 below.

Consider next a pure wage tax. From (11) we get

$$\gamma\theta q = -(\gamma - 1)(lF_{lk} + kF_{kk}) + \lambda\omega\eta_k^d \quad . \qquad (11')$$

Using (1) and $\eta_k^d \geq 0$ gives

Proposition 9: Consider a pure wage tax, $\rho \equiv 1$. If the market power of the union is increasing in the employment of capital, it is optimal to tax capital. The sign of the optimal tax on capital is ambiguous if the market power of the union is strictly decreasing in the employment of capital.

Proposition 9 extends Proposition 2 to the case of imperfectly competitive labor supply. Clearly, the sign of the optimal θ is ambiguous if union power is strictly decreasing in the employment of capital. Whether this is the case or not is an empirical question. Note however, that any variation in union power requires the elasticity of substitution to be non-constant in production.

Proposition 9 helps to interpret the simulation results of Holmlund and Kolm (1997). These authors examine the effects of an environmental tax reform within a richly structured model of a small open economy. The model allows for decentralized wage bargaining between unions and monopolistically competitive firms. It includes a tradable and a non-tradable sector. The available tax instruments are an energy tax and a payroll tax. Finally, the unemployed receive unemployment compensation, which is tied to real net wages. The model is rather complex – it is even more complex than the one of Koskela, Schöb, and Sinn (1998) – and has to be solved by simulation. On balance, the results do not support the case for an environmental tax reform. However, there are parameter constellations for which a marginal tax on energy enhances efficiency. It is not easy to identify the driving forces. In light of the present analysis one may, however, suggest the following explanation. The desirability of energy taxation will not be driven by unemployment compensation, as this is tied to real net wages. See Proposition 11, below. Instead the focus should be on two other features of the model. The first one is the availability of tax instruments. Wages are taxable, profits not. The second one is the bargaining power of unions. Holmlund and Kolm are only able to demonstrate the desirability of a marginal tax on energy if a wage premium is paid in the tradable sector. In this case the energy tax has the effect of reducing the bargaining power of the unions by inducing a reallocation of employment from the tradable to the non-tradable sector. This is just the combination of assumptions underlying Proposition 9: Positive lumpsum income is not taxable and the bargaining power of labor supply increases with the employment of capital/energy.

As before let us conclude this section by studying the effect of a uniform income tax. Using $\rho \equiv 1-\tau$ and $\rho' = -1$ equation (11) becomes

$$\gamma\theta q = -(\gamma-1)(1-\tau)\left[G + I\, F_{lk}/F_l\right] \quad + \quad \lambda\omega\eta_k^d \ . \qquad (11'')$$

Proposition 10: Consider a uniform income tax with $\rho \equiv 1-\tau$. If the union power is decreasing in the employment of capital, it is optimal to subsidize capital. If the union power is strictly increasing in the employment of capital, the sign of the optimal tax on capital is ambiguous.

The proof follows from (11'') by inserting $\eta_k^d \leq 0$. G and I are non-negative by assumption.

To be a more realistic description of unionized labor markets, the analysis could and should be extended to wage bargaining models, but the important result of the present section is that market power of a union can only justify a tax on capital if union power is sufficiently increasing with the employment of capital.[7]

5. Unemployment benefits

The previous sections have shown how taxes on capital are set optimally if labor market competition is imperfect. However, we did not explicitly account for the cost of unemployment. This is of course not appropriate, since unemployed workers receive unemployment compensation in industrialized countries. Moreover, the utility of the unemployed cannot be simply ignored by a government, when economic policy is designed. To make the analysis as straightforward as possible, let labor markets be perfectly competitive but assume that, in addition to paying for public goods, the government also pays unemployment benefits to those who are not employed. This is an admittedly artificial separation. The benefit system obviously also affects the wage-setting behavior of a union. Similarly, the existence of benefits can be viewed as a reaction of the government to labor-market imperfections.

Following Pissarides (1998), let l be the time a representative worker is employed. Given a total endowment of time $\bar{l}$, $\bar{l}-l$ denotes the time out of work. As in the previous sections, being employed yields an income ωl and causes disutility $V(l)$. When

[7] Fuest and Huber (1997) model the interaction between the government and the union as a Cournot game. If the government takes the gross wage as given, it is optimal to subsidize capital. Fuest and Huber also explore the scenario where the government takes a Stackelberg leadership. For this case they fail, however, to derive clear-cut results for the sign of the optimal capital tax/subsidy. Boeters and Schneider (1999) distinguish between Cournot and Stackelberg conjectures on the one hand, and rational and not fully rational unions on the other hand. They show that assuming a *constant* elasticity of labor demand results in zero taxes on capital in either case.

unemployed the worker enjoys leisure time but receives unemployment benefits that are lower than the income while employed.[8] Let $B(\bar{l}-l,w,\tau)$ denote the benefit function. At this point the benefit function *B* is kept in a rather general form. It depends on the extent of unemployment, the gross-wage rate *w*, and the wage tax, τ. Later on we put more structure on the benefit function to show how the design of a transfer system affects the optimal tax on capital.

The social welfare function needs to be modified to account for the utility of employment and unemployment. Hence (2) is replaced by

$$\omega l+\rho(\pi+I)-V(l) \quad + \quad B(\bar{l}-l,\frac{\omega}{1-\tau},\tau)\,. \qquad (2')$$

Unemployment benefits are assumed to be part of government expenditure, and the government's budget constraint reads

$$\frac{\tau}{1-\tau}\,\omega l+\theta qk+(1-\rho)(\pi+I) \;=\; g+B(\bar{l}-l,\frac{\omega}{1-\tau},\tau)\;. \qquad (\gamma) \quad (6')$$

In (6'), the level of *g* is exogenously given, but *B* is endogenous and therefore total government spending. Consider what happens to expenditure *B* when time of employment, *l*, is kept fixed but capital, *k*, is marginally increased. We obtain

$$\left.\frac{dB}{dk}\right|_{l=const} \;=\; B_w F_{lk}+B_\tau\frac{d\tau}{dk}\;.$$

The tax rate τ has to adapt in order to keep $(1-\tau)F_l$ constant, as is required by (3) and (4). Hence $d\tau/dk=(1-\tau)F_{lk}/F_l$, and

$$\left.\frac{dB}{dk}\right|_{l=const} \;=\; \left[B_w+\frac{(1-\tau)}{w}B_\tau\right]F_{lk}$$

can be interpreted as an external effect from the use of capital on unemployment benefit. Optimal taxation of capital has to internalize this effect. This follows from maximizing (2') subject to the constraints (3) to (5) and (6'). The first-order necessary conditions with respect to $\theta,\tau,$ and *k* are (8),

[8] An alternative model that might be intuitively more appealing could include heterogeneous labor.

$$\alpha = (\gamma - 1)\left[\rho \frac{l}{1-\tau} - \rho'(\pi + I)\frac{1}{F_l} \quad - \quad \frac{1}{(1-\tau)F_{lk}} \frac{dB}{dk}\Big|_{l=const} \right], \text{ and} \qquad (12)$$

$$\theta q = -\frac{\gamma - 1}{\gamma}\left[\rho(lF_{lk} + kF_{kk}) - \rho'(1-\tau)(\pi + I)\frac{F_{lk}}{F_l} \quad - \quad \frac{dB}{dk}\Big|_{l=const} \right]. \qquad (13)$$

Except for the last term, (13) equals (11). Looking at (13), it turns out that the impact of unemployment compensation and income taxation, as captured by the last and the first two bracketed expressions, are perfectly separable. Hence we focus on the effect of unemployment compensation. The first thing to note is that the fiscal externality $dB / dk|_{l=const}$ vanishes under well-specified conditions.

Proposition 11: Given that unemployment compensation does

(i) not depend on wages, $B \equiv b(\bar{l} - l)$;

(ii) or, if it does, only on net wages, $B \equiv b(1-\tau)w(\bar{l} - l)$, then capital has no external effect on government spending.

The proof follows from noting that $B_w + \frac{1-\tau}{w} B_\tau = 0$ when B is specified according to (i) or (ii). The fiscal externality does not vanish when unemployment compensation is tied to gross wages. If $B = bw(\bar{l} - l)$, we get $B_w + \frac{1-\tau}{w} B_\tau = b(\bar{l} - l)$, which is positive for all $b>0$.

Proposition 12: If unemployment benefits are tied to gross wages, with $B = bw(\bar{l} - l)$, and if either lump-sum income can be fully taxed or if a wage-tax regime applies, then it is optimal to tax capital. With a uniform income tax the sign of the optimal tax on capital is ambiguous.

Propositions 11 and 12 show that as long as unemployment benefits or other transfer payments depend on net wages or are not wage-indexed at all, second-best solutions result, and Propositions 1-3 apply. If, however, transfer payments are indexed to gross wages, only third-best solutions are attainable, and it may be optimal to tax capital, even if the taxation of lump-sum income is not constrained.

This result has strong policy implications. First, there are countries, in which transfer payments are pegged to gross wages. Those countries can reap efficiency gains from reforming the welfare system and let all transfer payments depend on *net* wages. However, that implies secondly that in an efficiently designed welfare system internationally mobile factors are untaxed.

The labor market studied in this section does not – except for the public transfer payments – suffer from imperfections. Nevertheless it is possible and useful to extend the discussion to models that allow for imperfect labor markets. The relevance of the benefit system on the working of the labor market has already been addressed in the literature. In various models of unemployment it can be shown that whenever unemployment compensation is indexed to net wages, a change in labor taxes has no effect on equilibrium unemployment. With benefits that are fixed to labor costs, however, the conclusion changes.

Results that are close in spirit to Propositions 11 and 12 have been obtained by Koskela and Schöb (1996) in a wage bargaining model and by Bovenberg and van der Ploeg (1995) in a job-search model. A tax on capital has the effect of shifting part of the tax burden from the employed to the unemployed. It does so by reducing labor productivity and gross wages. The reduction in gross wages is partly offset by lower wage taxes for the employed. If unemployment payments are indexed to gross wages, they decrease as well. However, unemployment pay does not benefit from lower labor taxes. Thus the tax on capital helps to increase the difference between labor income and unemployment compensation, thereby enhancing the efficiency of the system. Related to this literature is Pissarides (1998), who concludes that in a competitive labor market cutting employment taxes has a bigger impact on employment when the ratio of unemployment benefits to gross wages is fixed than when the net replacement ratio is fixed.

6. Application: Ecological tax reform

An application of the analysis is the discussion about an ecological tax reform and possible double dividends from revenue recycling. It has been argued by politicians but also by economists that environmental taxes might yield efficiency gains over and above gains from reducing an externality. The basic idea is that tax revenue from environmental taxes can be used to reduce the distortions created by other taxes. In particular, positive employment effects of a tax reform would be welcomed. The theoretical results of this debate are mixed. Bovenberg and de Mooij (1994a) show that in an economy with full employment and a consumption externality the second-best tax on the polluting good is less than the Pigouvian tax, thereby refuting the double-dividend hypothesis. This result has been criticized because the model did not explicitly account for unemployment. In fact, it has been shown in various papers, that an existing inefficient tax system can be (marginally) reformed such that unemployment is reduced (e.g., Bovenberg and van der Ploeg, 1995; Koskela and Schöb, 1996; Koskela, Schöb, and Sinn, 1998).

In the public discussion of green tax reforms it is typically argued that taxes on energy should be substituted for taxes on labor. The idea is enjoying increasing popularity, as the proposal of the European Commission (1997) suggests. Energy, however, is an internationally traded input like mobile capital. Hence the non-ecological effects of taxing energy as a production input are qualitatively the same as the effects of taxing internationally mobile capital. This implies that the double-dividend hypothesis is validated if, and only if, reasons can be found for taxing capital at source.

The present paper raises the question of whether it is efficient to tax capital at source when labor markets suffer from various imperfections and the taxation of lumpsum income is constrained. While the analysis gives no final answer, it sheds light on potential reasons favoring the taxation of capital - hence supporting the double-dividend hypothesis. The following reasons have been identified: (i) institutional constraints rendering any taxation of profit income infeasible; (ii) market power in the demand for labor in combination with (i); (iii) market power in the supply of labor which increases with the employment of capital and thus requires a non-constant elasticity of

substitution in production; finally (iv) unemployment benefits which are tied to gross wages. We would argue that none of these reasons make a particularly strong case for taxing internationally mobile factors. In fact, arguments against (i)-(iv) are readily at hand. The existence of a uniform income tax for once violates (i). Similarly, reason (ii) is considerably weakened, once the existence of positive capital income in combination with a uniform income tax is accounted for. Reason (iii) may raise questions that have to be settled empirically. Note however that a non-constant of elasticity of substitution in production might not be the kind of assumption to rely on, when defending an environmental tax reform. Moreover, as argued in Richter and Schneider (1999), there is empirical evidence that with varying elasticities of substitution the conditions derived in the paper support subsidies on energy rather than taxes. Finally (iv) requires more than anything else, to reform unemployment compensation. Hence it all comes down to the question whether various sources of income can be taxed at differentiated rates. If differentiated taxation is feasible, efficiency requires to skim off pure profits directly rather than to tax mobile factors at source. If, however, all income has to be taxed at a uniform rate, then it is highly questionable whether a double dividend can be reaped from taxing the employment of mobile factors. As mentioned before, the role of unemployment compensation for the effectiveness of green tax reforms has well been examined in the literature. The effects of existing constraints in the taxation of positive lumpsum income, however, seem to be less recognized.

Clearly, applying the present model to the double-dividend debate does not acknowledge that capital and energy are both internationally mobile factors of production. However, introducing internationally mobile capital with no constraints on the taxation of capital is not going to affect the results of the paper regarding the tax treatment of private energy consumption and the use of energy in production. The results of the analysis presented here might no longer hold when mobile capital is taxed and the tax on capital is treated to be exogenous.

7. Conclusions

The paper addresses the question of whether it is efficient to tax capital at source when labor markets and the tax system suffers from imperfections. The answers given in

this paper are rather mixed. In Section 2 we have shown that the optimal treatment of capital critically depends on the availability of instruments that allow the government to tax lumpsum income earned by households. In Sections 3 and 4 rudimentary forms of imperfections in labor market competition have been studied. Section 5 has focused on distortions caused by unemployment compensation. Clearly, the selection of labor market imperfections is far from being complete, and we do not claim that any of the chosen models reflects reality. They just serve as benchmark cases and may help to get a better understanding of the driving forces in more structured models of unemployment. There is a number of useful extensions of the model. For example, the presented model is a static model, hence the effect of capital taxation on incentives to accumulate capital are not accounted for. Furthermore, labor market imperfections are accounted for, capital market imperfections are ignored. Moreover, it could be interesting to look at a model with structural unemployment resulting from search frictions. Work by Bovenberg and van der Ploeg (1995) could be a good starting point.

Figure 1 illustrates the various sources of labor market imperfections analyzed in this paper. First-best efficiency requires equality between the marginal product and the marginal disutility of labor. It is second-best to accept a tax wedge between the two when labor markets are perfectly competitive and when lumpsum taxes are not available to finance a fixed government budget. Taxes on capital, however, are not second-best. They are optimal in some third-best sense only if the government is restricted to tax wage income and to leave all positive lumpsum income untaxed. Imperfections in labor market competition provide further reasons for taxing capital as part of a third-best policy. We have studied two extreme cases of market power, a monopsony and a monopoly. A monopsonist drives a wedge between the marginal product of labor and the labor cost, generating profit income. If there is no direct way of taxing profits, we should consider to tax capital. However, if a uniform income tax is available, the policy implication is ambiguous.

The labor supply monopoly drives a wedge between the net wage rate and the marginal disutility of labor. As it turns out, it is optimal to tax capital only if monopoly power increases with the employment of capital. Variation with the employment of

capital requires the elasticity of substitution to be non-constant in production. Hence, a monopoly is more apt to support the subsidization of capital than the taxation of capital.

In Section 5 of the paper the focus is on the transfer system with a competitive labor market. As long as transfer payments are tied to gross wages a tax on capital is third-best. However, it is efficiency improving to tie transfer payments to net wages and not to tax capital.

The results of the paper are surprisingly clear cut. The assumptions made allow to identify the major factors determining optimal tax treatment of capital. At this point we conclude that the case for taxing capital is anything but compelling. As indicated above, much of the discussion surrounding the double-dividend hypothesis might be interpreted along these lines.

References

Atkinson, A.B. and J.E. Stiglitz, 1980, Lectures on Public Economics, McGraw-Hill.

Boal, W.M. and M.R. Ransom, 1997, Monopsony in the labor market, Journal of Economic Literature 35, 86-112.

Boeters, S. and K. Schneider, 1999, Government versus union: The structure of optimal taxation in a unionized labor market, forthcoming in: Finanzarchiv

Bovenberg, A.L. and R.A. de Mooij, 1994a, Environmental levies and distortionary taxation, The American Economic Review 84, 1085-1089.

Bovenberg, A.L. and R.A. de Mooij , 1994b, Environmental taxes and labor-market distortions, European Journal of Political Economy 10, 655-683.

Bovenberg, L. and F. van der Ploeg, 1995, Tax reform, structural unemployment and the environment, Fondazione Eni Enrico Mattei Discussion Paper 6/95.

Bucovetsky, S. and J.D. Wilson, 1991, Tax competition with two tax instruments, Regional Science and Urban Economics 21, 333-350.

Dasgupta, P. and J. Stiglitz, 1972, On optimal taxation and public production, Review of Economic Studies 39, 87-103

De Mooij, R. and L. Bovenberg, 1998, Environmental taxes, international capital mobility and inefficient tax systems: Tax burden vs. tax shifting, International Tax and Public Finance 5, 7-39.

Diamond, P. A. and J.A. Mirrlees, 1971, Optimal taxation and public production, I: Production efficiency, and II: Tax rules, The American Economic Review 61, 8-27, 261-278.

European Commission, 1997, Proposal for Council directors for restructuring the Community framework for the taxation of energy products, COM (97) 30.

Fuest, C. and B. Huber, 1997, Tax coordination and unemployment, Working Paper, University of Munich.

Gordon, R.H., 1986, Taxation of investment and savings in a world economy, The American Economic Review 76, 1086-1102.

Gordon, R.H., 1992, Can capital taxes survive in open economies?, The Journal of Finance 47, 1159-1180.

Holmlund B. and A-S. Kolm, 1997, Environmental tax reform in a small open economy with structural unemployment, Working Paper 1997:2, Uppsala University.

Huizinga, H.P. and S.B. Nielsen, 1997, Capital income and profit taxation with foreign ownership of firms, Journal of International Economics 42, 149-165.

Koskela, E. and R. Schöb, 1996, Alleviating unemployment: The case for green tax reforms, CES Working Paper No 106, University of Munich, forthcoming in: European Economic Review.

Koskela, E., R. Schöb and H.-W. Sinn, 1998, Pollution, factor taxation and unemployment, International Tax and Public Finance 5, 379-396.

McDonald, I. and R.M. Solow, 1981, Wage bargaining and employment, American Economic Review 71, 896-908.

Mintz, J. and H. Tulkens, 1996, Optimality properties of alternative systems of taxation of foreign capital income, Journal of Public Economics 60, 373-399.

Mirrlees, J.A., 1972, On producer taxation, Review of Economic Studies 39, 105-111.

Oswald, A.J., 1985, The economic theory of trade unions: An introductory survey, Scandinavian Journal of Economics 87, 160-193.

Pissarides, C.A., 1998, The impact of employment tax cuts on unemployment and wages; The role of unemployment benefits and tax structure, European Economic Review 42, 155-183.

Richter, W. and K. Schneider, 1999, Energy taxation: Reasons for discriminating in favor of the production sector, Working Paper, University of Dortmund.

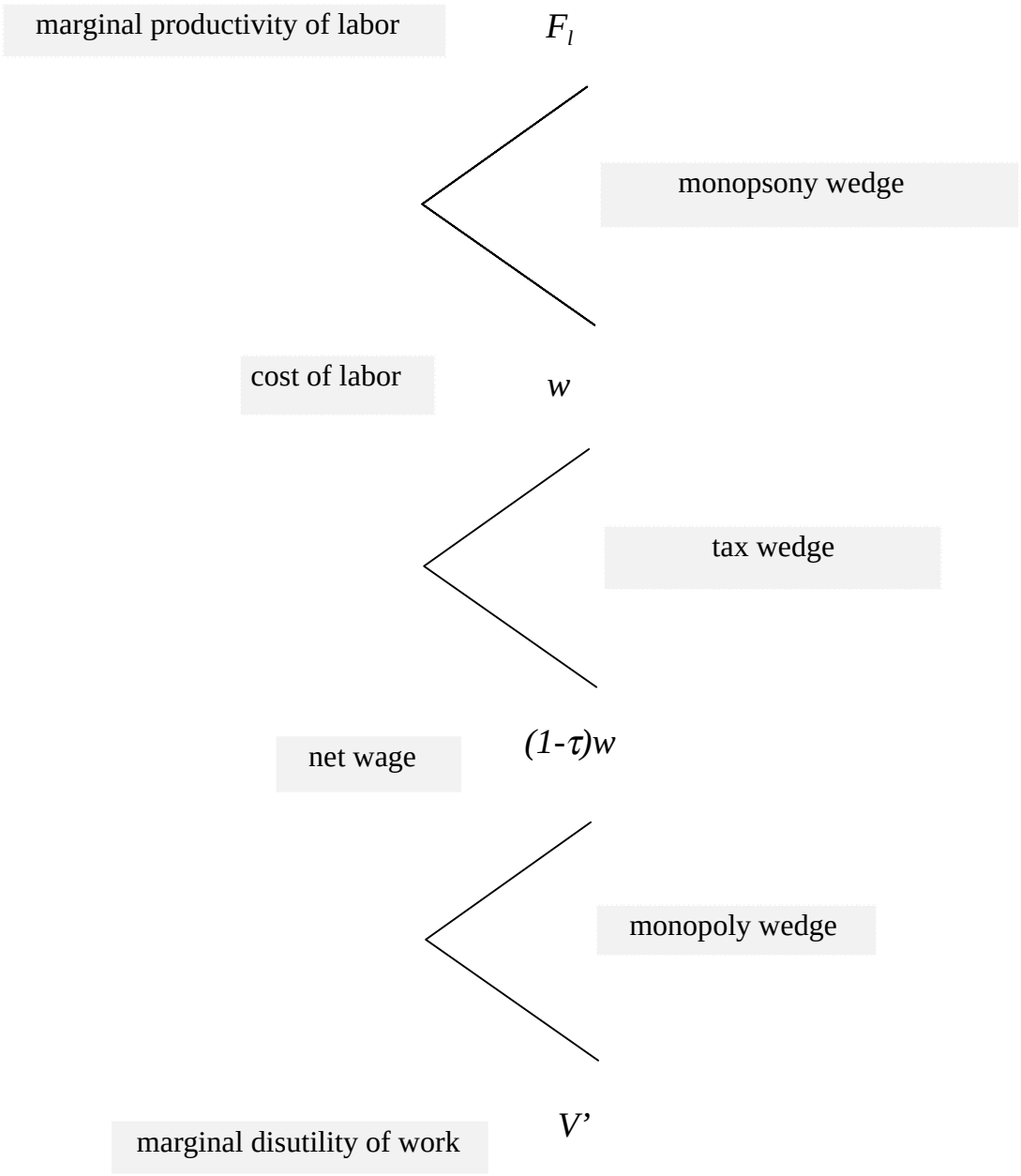

Figure 1: Distortions of the labor market