Optimal factor taxation under wage bargaining – a dynamic perspective

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Abstract

We consider the issue of steady-state optimal factor taxation in a Ramsey-type dynamic general equilibrium setting with two distinct distortions: i) taxes on capital and labour are the only available tax instruments for raising revenues, and ii) labour markets are subject to a static inefficiency resulting from wage bargaining. If considered in isolation, under broad assumptions the two distortions create conflicting demands on the wage tax, while calling for a zero capital tax. By combining the two distortions, we arrive at the conclusion that both instruments should be used, implying that the zero-capital tax result in general is no longer valid under imperfectly competitive labour markets.

Zusammenfassung

Dieses Papier untersucht Aspekte einer Steady-State optimalen Faktorbesteuerung in einem dynamischen Gleichgewichtsmodell vom Ramsey-Typ mit zwei besonderen Verzerrungen: i) Steuern auf Kapital- und Arbeitseinkommen sind die einzig verfügbaren Instrumente für die Erhebung von Staatseinnahmen; ii) die Arbeitsmärkte weisen eine statische Ineffizienz aufgrund von Lohnverhandlungen auf. Jeweils für sich betrachtet, implizieren die beiden Verzerrungen in unserem Modellrahmen unter breiten Annahmen gegenläufige Anforderungen an die Steuer auf Arbeitseinkommen, während die Kapitalsteuer einen Wert von Null annehmen sollte. Werden jedoch beide Verzerrungen gleichzeitig in Betracht genommen, sollten beide Steuerinstrumente eingesetzt werden. Mit anderen Worten: es wird gezeigt, dass das Resultat einer Kapitalsteuer in Höhe von Null im allgemeinen nicht länger gültig ist, wenn die Arbeitsmärkte durch unvollständige Konkurrenz charakterisiert sind.

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1 Introduction

This paper studies the Ramsey problem of optimal factor taxation under commitment in an infinite horizon framework which deviates from a first-best representative agent economy in two important aspects. First, to raise revenues the government must use distortionary, second-best taxation. More specifically, following research along the lines of Chamley (1986) and Judd (1985), we assume that proportional taxes on wages and capital income are the only tax instruments for financing some exogenously specified sequence of government expenditures. Second, the economy is taken to be imperfectly competitive in the sense that the labour market is subject to a static wage bargain. Owing to this feature, wages are set with a mark-up compared with a fully competitive outcome, leading to a socially sub-optimal employment level. We assume that the institutional set-up which generates this labour market inefficiency is taken as given by the fiscal agent when designing the mix of factor taxes, implying that corrective taxes or subsidies are the only channel to address the labour market distortion.

As shown in seminal studies by Chamley (1986) and Judd (1985), the first distortion resulting from restrictions on the set of available taxes, if taken in isolation, requires under broad assumptions that the long-run second-best tax rate of capital income should be zero, while the labour tax rate should be positive. Essentially, this result can be seen as an implication of the uniform taxation principle which states that consumption at different dates should not be subject to differential taxation, as would be the case with a positive capital tax rate.[1] The purpose of this paper is to show that this reasoning may well require some modification if labour markets are assumed to be imperfectly competitive. To this end, we present a simple collective wage bargaining structure in which the representative firm is 'small' and its investment decision is made in a non-strategic manner, while the aggregate capital stock nevertheless acts period by period as a crucial input for the wage-setting process. As a result of this feature, the return rates to capital as perceived by the private sector and by the Ramsey planner are likely to be different. This, in turn, as we discuss from two perspectives, tends to invalidate the result of a steady-state zero-capital tax, making it instead advisable to use both tax instruments.

First, we consider a constellation in which, in a first-best sense, wage subsidies should be used to counteract the effects of wage mark-ups. Accordingly, from a second-best perspective the two distortions impose conflicting demands on the wage tax, i.e. a positive wage tax in line with the objective of generating revenues under distortionary taxation and a wage subsidy in order to correct for the labour market inefficiency. Addressing this 'conflict', our results indicate an interesting hierarchy of the use of the two tax instruments. Quite in line with the Chamley-Judd result, the labour tax is shown to bear the brunt of the revenue motive while a non-zero capital tax rate should be used, whenever possible, as a second-best tool to address the dis-

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[1]Alternatively, with capital acting as an input in an intertemporal framework, the result may also be inferred from the production efficiency principle, following Diamond and Mirrlees (1971).

tortion in the labour market. More specifically, we establish that whenever the wage mark-up depends on the size of the capital stock a non-zero capital tax rate should assist the corrective taxation motive by mitigating the mark-up pricing of wage setters. In our set-up, this will be the case for standard aggregate production functions of the CES type under conventional assumptions regarding the timing of actions and the stock/flow distinction between physical capital and labour. As is discussed in more detail below, these findings are broadly in line with Judd (1997, 2002) and Guo and Lansing (1999) who stress the importance of potential discrepancies between private and social returns to capital and establish a role for second-best corrective capital taxation under imperfectly competitive product markets. However, there is an interesting twist to this since the focus of these papers is not on labour market imperfections. Moreover, Judd (2002) offers the conjecture that "while labour markets may also be imperfectly competitive due to unionization, union mark-ups are similar to labour-income taxation and do not create exploding distortions between social and private costs." (p. 419). Our analysis offers a counter-example to this conjecture in the sense that in our set-up discrepancies between private and social costs of capital are triggered by a distortion which is directly linked to the introduction of union mark-ups in an otherwise standard setting.

Second, by slightly modifying some details of the labour market specification, we derive a constellation in which the employment level resulting from the bargain does not depend on the wage tax, i.e. labour earns a rent. Upon this change, assuming that these rents cannot be fully taxed, the capital tax should now take on the role of counteracting the creation of rents. Qualitatively, this finding is in line with Correia (1996) and Jones, Manuelli, and Rossi (1997) who also allow for the possibility of rents in dynamic Ramsey settings, although not in the context of imperfectly competitive labour markets.

Our analysis proceeds in two stages. First, as a simple and transparent benchmark,

we consider an economy with monopolistic wage setting along the lines of Gali (1995, 1996) and zero rents, reflecting price taking behaviour by firms and constant returns to scale in the two inputs labour and physical capital. The labour supply of the representative household is assumed to be elastic, and wages are set with a mark-up over the marginal rate of substitution between consumption and leisure, leading to underemployment compared with a fully competitive economy. Using this wage-setting condition in the implementability constraint of the Ramsey problem, we conclude that a non-zero capital tax should be used whenever the wage elasticity of labour demand and, thus, the mark-up is not constant, but rather varies with the capital intensity of production. Moreover, stressing the corrective taxation aspect of this finding, the optimal labour tax schedule is shown to have a component which has the opposite sign of the capital tax. Second, extending this benchmark economy, we allow for a right-to-manage bargaining framework along the lines of Layard, Nickell, and Jackman (1991) in which both firms and workers have some bargaining power and in which the outcome of the bargain depends on the level of unemployment benefits and the aggregate unemployment rate. Using the first-order condition of this bargaining structure in the implementability constraint, we show that the optimal tax schedule depends in particular on how unemployment benefits are specified. As long as benefits are not proportional to the net wage, the qualitative findings of our benchmark economy carry over to the bargaining framework. Intuitively, this is the case because under this specification the labour market allocation resulting from the bargain depends on both the labour tax and the wage elasticity of labour demand, as in the benchmark economy. Hence, there is scope for a capital tax (or subsidy) to assist the corrective taxation motive. By contrast, if benefits are proportional to the net wage, the labour market allocation no longer responds to changes in the wage tax, which is consistent with findings established in Pissarides (1998). Consequently, there emerges a rent in the labour

market, and our results generalize findings by Jones, Manuelli, and Rossi (1997) by allowing for wage bargaining. More specifically, if it is assumed that the rent cannot be fully taxed away (because there exists an exogenous, upper bound on the labour tax), the capital tax rate should be used as a tool for preventing the creation of rents. Then, whenever the rent correlates positively with the long-run capital stock, the capital tax should be positive to counteract the rent-creation process.

In the remainder of the paper we proceed as follows. Section 2 establishes the notation and presents our main findings within a simple benchmark economy with monopolistic wage setting. Section 3 allows for a richer right-to-manage wage bargain and highlights the importance of the specification of unemployment benefits for the optimal design of steady-state factor taxes. Section 4 discusses our main findings in the context of related literature. Section 5 offers some conclusions.

2 Optimal factor taxes under monopolistic wage setting

We consider a dynamic general equilibrium framework in which infinitely lived households have preferences over consumption and leisure. There is one good which can be equally consumed or invested, and the aggregate production technology is characterized by constant returns to the two inputs labour and capital. The economy is in many ways standard, with the exception that labour markets are not fully competitive insofar as households have some market power when setting their wages, similar to Gali (1995, 1996).[2]

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[2] Apart from this special feature, the set-up in this section follows closely the textbook version of optimal factor taxation under commitment by Sargent and Ljungqvist (2000, chapter 12).

2.1 Description of the economy

There is a continuum of households and firms, each being of measure 1. The representative household has in every period t a constant time endowment $L^e = 1$ which the household divides between leisure L_t and working hours N_t. Let the per household levels of output and physical capital be denoted by Y_t and K_t. Production of output occurs according to the constant returns to scale technology $Y_t = F(K_t, N_t)$, with F being increasing, continuously differentiable, and strictly concave. Capital depreciates at the constant rate $\delta \in (0,1)$. Since firms are 'small', they take the (correctly foreseen) sequence of factor prices as given and choose employment and capital according to the first-order conditions

$$w_t = F_N(K_t, N_t) \tag{1}$$

$$r_t = F_K(K_t, N_t), \tag{2}$$

where w_t and r_t denote the gross wage rate and the gross return rate on capital, respectively. Hence, firms make zero profits, and the return on capital is distributed to households which own the economy's capital stock. In every period, the government finances a constant stream of government expenditures $G > 0$, providing no utility to the representative household. The set of available tax instruments is restricted to proportional taxes on labour income (τ_t^N) and capital income (τ_t^K). Moreover, the government issues one-period bonds, yielding the flow budget constraint of the government

$$G + B_t = \tau_t^K r_t K_t + \tau_t^N w_t N_t + \frac{B_{t+1}}{R_t}, \tag{3}$$

where R_t denotes the gross return on a bond issued in period t and redeemed in period $t+1$. Let C_t denote the consumption level of the household in period t. Then, the resource constraint of the economy is given by

$$G + C_t + K_{t+1} = F(K_t, N_t) + (1 - \delta)K_t. \tag{4}$$

Preferences of households are time-separable, and the flow utility $u(C, L)$ is increasing, differentiable, strictly concave and, for further simplification, separable in leisure and consumption, i.e. $u_{CL} = 0$. The objective of the household is to maximize

$$\max \sum_{t=0}^{\infty} \beta^t u(C_t,\ 1 - N_t), \tag{5}$$

where $\beta \in (0, 1)$ denotes the discount factor. To rationalize some wage-setting power on the part of households without introducing further heterogeneity into the set-up, let households be collectively organized in a trade union which acts as a monopolistic wage setter. Wages are set for one period, and, with the aggregate capital stock being predetermined by the investment and savings decisions of the previous period, the wage-setting behaviour takes into account the static constraint imposed by the labour demand schedule:

$$N_t = N(w_t, K_t). \tag{6}$$

The wage-setting specification rests on three key assumptions. i) Firms are too small to behave in a strategic manner vis-à-vis the outcome of the bargain, i.e. we abstract from the hold-up problem which typically arises under firm-specific bargaining. ii) The union disregards the effects of its wage-setting behaviour on capital income. iii) The behaviour of the union is myopic in the sense that intertemporal feedback-effects of wage decisions are not taken into account.[3] We want to point out, however, that, despite these seemingly strong assumptions, the specification is naturally linked to a fully competitive set-up. In particular, with $\eta(N, K) = \frac{-N_w w}{N}$ denoting the wage elasticity of labour demand, the specification turns into the standard competitive case as η tends to infinity.

Households consider tax-exempt government bonds and claims on physical capital

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[3] When extending this set-up in Section 3, we rationalize this type of myopic wage-setting in a framework with sector-specific wage bargaining and turnover between sectors.

as perfect substitutes, implying the no-arbitrage condition

$$(1 - \tau_{t+1}^K)r_{t+1} + 1 - \delta = R_t.$$

If one defines and normalizes the discount factors as

$$q_t^o = \prod_{i=0}^{t-1} R_i^{-1}, \quad q_0^o = 1,$$

the present value budget constraint of the household can be written as

$$\sum_{t=0}^{\infty} q_t^o C_t = \sum_{t=0}^{\infty} q_t^o (1 - \tau_t^N)w_t N_t + [(1 - \tau_0^K)r_0 + 1 - \delta]K_0 + B_0, \qquad (7)$$

where K_0 and B_0 are initial holdings of capital and bonds and τ_0^K is the initial capital tax rate. Acting on behalf of its members, the trade union maximizes (5) over C and w subject to (6) and (7). Using $q_t^o/q_{t+1}^o = R_t$, this gives rise to the first-order conditions

$$q_t^o = \beta^t \frac{u_C(t)}{u_C(0)} \qquad (8)$$

$$u_C(t) = \beta u_C(t+1)[(1 - \tau_{t+1}^K)r_{t+1} + 1 - \delta] \qquad (9)$$

$$(1 - \tau_t^N)w_t = \frac{u_L(t)}{u_C(t)}M_t, \qquad (10)$$

where $M_t(N_t, K_t) = \frac{\eta(N_t, K_t)}{\eta(N_t, K_t) - 1}$ in (10) denotes the mark-up of net wages over the marginal rate of substitution between leisure and consumption.[4] For future reference, it is helpful to shed some light on the determinants of the wage mark-up. Let $k = K/N$ denote the capital intensity of production and, for illustration, consider a CES production function with constant returns to scale

$$F(K, N) = \left[(1 - \alpha)N^{\frac{\sigma-1}{\sigma}} + \alpha K^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \qquad (11)$$

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[4]Of course, for a well-defined optimization problem, the usual transversality conditions for the stocks of capital and government bonds need to be satisfied as well.

where $0 < \alpha < 1$ is the distribution parameter and σ is the elasticity of substitution between capital and labour. Exploiting well-known properties of the CES production function, we provide the following summary for future reference:

Lemma *Under the constant returns to scale CES production function the mark-up of the net wage over the marginal rate of substitution between leisure and consumption is a function of the capital intensity, with $M(K, N) = M(k) = \frac{\eta(k)}{\eta(k)-1}$ and*

$$\frac{\partial M}{\partial k} \begin{cases} < 0 \text{ if } \sigma < 1 \\ = 0 \text{ if } \sigma = 1 \\ > 0 \text{ if } \sigma > 1 \end{cases}.$$

Remark: For a derivation, see Appendix, part 1.

According to the lemma, the wage mark-up M will be constant if the wage elasticity of labour demand η is independent of the capital intensity. As is well known, this will be satisfied for the special case of a Cobb-Douglas function ($\sigma = 1$). However, under gross complementarity ($\sigma < 1$), a higher capital intensity, quite intuitively, increases the wage elasticity of labour demand (since the factor complementary to labour is now relatively more abundant) and, thus, reduces the wage mark-up. Conversely, under gross substitutability ($\sigma > 1$), the effect is of an opposite nature, i.e. a higher capital intensity reduces the wage elasticity of labour demand and, thus, increases the wage mark-up.

2.2 Optimal taxation

Given the revenue requirements implied by the sequence of government expenditures, the government is assumed to set its instruments in a manner which maximizes the utility of the representative household. Following Lucas and Stokey (1983), it has become common practice to solve this type of dynamic Ramsey problem by means of

the primal approach which expresses the choice problem of the government in terms of quantities. Using the first-order conditions (8)-(10) to substitute out for prices and taxes in the intertemporal budget constraint of the representative household, one obtains the 'implementability' constraint:

$$\sum_{t=0}^{\infty} \beta^t [u_C(t)C_t - u_L(t)N_t M_t] - A = 0, \tag{12}$$

where A is given by $A = u_C(0)\{[(1-\tau_0^K)F_K(0)+1-\delta]K_0+B_0\}$. When maximizing (5) subject to (4) and (12), let ϕ denote the value of the Lagrange multiplier associated with the implementability constraint. Moreover, let

$$V(C_t, N_t, K_t, \phi) = u(C_t, 1 - N_t) + \phi[u_C(t)C_t - u_L(t)N_t M_t] \tag{13}$$

and rewrite the objective of the primal approach compactly as

$$J = \sum_{t=0}^{\infty} \beta^t \{V(C_t, N_t, K_t, \phi) + \theta_t[F(K_t, N_t) + (1-\delta)K_t - G - C_t - K_{t+1}]\} - \phi A. \tag{14}$$

With K_0, B_0 and some fixed initial capital tax rate τ_0^K being given, the first-order conditions of this 'pseudo-planning problem' can be calculated as follows[5]:

$$K_{t+1} \quad : \quad \theta_t = \beta\{\theta_{t+1}[F_K(t+1) + 1 - \delta] + V_K(t+1)\} \tag{15}$$

$$C_t \quad : \quad V_C(t) = \theta_t \tag{16}$$

$$N_t \quad : \quad V_N(t) = -\theta_t F_N(t) \tag{17}$$

$$C_0 \quad : \quad V_C(0) = \theta_0 + \phi u_{CC}(0)\{[(1 - \tau_0^K)F_K(0) + 1 - \delta]K_0 + B_0\} \tag{18}$$

$$N_0 \quad : \quad V_N(0) = -\theta_0 F_N(0), \tag{19}$$

where

$$V_C(t) \quad = \quad u_C(t) + \phi(u_{CC}(t)C(t) + u_C(t))$$

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[5] As discussed further below, since the time-zero capital stock can be taxed without deadweight loss some restriction with respect to τ_0^K typically needs to be imposed in order to ensure that the implementability constraint is binding.

$$V_N(t) \;=\; -u_L(t) + \phi(u_{LL}(t)N(t)M(t) - u_L(t)M(t) + u_L(t)K(t)M_K(t))$$

$$V_K(t+1) \;=\; -\phi u_L(t+1)N(t+1)M_K(t+1).$$

Note that equation (15) captures the standard intertemporal trade-off described by the Euler-equation from the household's optimization problem as long as $V_K(t+1) = 0$. By contrast, $V_K(t+1) \neq 0$ indicates that the returns to investments in physical capital as perceived by the private sector and the Ramsey planner no longer coincide. For the remainder of this analysis, we follow the literature in assuming that there exists a solution to the Ramsey problem which converges to a time-invariant allocation, giving rise to a unique combination of steady-state factor taxes. Schedules for optimal taxes can be recovered by combining the first-order conditions of the pseudo-planning problem and the household. More specifically, by using the steady-state versions of (9) and (15) one obtains for the optimal capital income tax rate

$$\tau^K = -\frac{V_K}{V_C F_K} = \frac{\phi u_L N}{V_C F_K} M_K. \tag{20}$$

Analogously, combining the steady-state versions of (10), (16) and (17) yields for the optimal labour tax rate

$$\tau^N \;=\; 1 - z(M) \tag{21}$$

$$\text{where } z(M) \;=\; \frac{1 + \phi(1 + u_{CC}\frac{C}{u_C})}{\frac{1}{M} + \phi(1 - u_{LL}\frac{L}{u_L}\frac{N}{1-N} - \frac{K}{M}M_K)}. \tag{22}$$

To gain an intuitive understanding of the forces which shape the second-best optimal mix of factor taxes under monopolistic wage-setting, it seems helpful, initially, to look at two clear-cut steady-state benchmark results which are summarized by the following two propositions:

Proposition 1 *(First-best factor taxes and imperfectly competitive labour markets) If the implementability constraint is not binding ($\phi = 0$) and labour markets are imperfectly competitive ($M > 1$), the unconstrained socially optimal allocation can*

be implemented by subsidizing labour at the rate $\tau^N = 1 - M < 0$ and leaving capital untaxed ($\tau^K = 0$).

Remark: The unconstrained socially optimal allocation is given by the solution of the problem (P) of the social planner:

$$\max \ u(C_t, 1 - N_t)$$

$$s.t. \ K_{t+1} = F(K_t, N_t) + (1 - \delta)K_t - G - C_t, \ \ K_0 \text{ given.}$$

Denote this solution by $\{\widehat{K_t}, \widehat{N_t}, \widehat{C_t}\}$ and *assume $\phi = 0$* in the Ramsey problem of maximizing (14). Then, $\{\widehat{K_t}, \widehat{N_t}, \widehat{C_t}\}$ solves (14) as well, and $\tau^K = 0, \tau^N = 1 - M < 0$ follows from (20)-(22). For the conjecture $\phi = 0$ to be valid, however, at the prices associated with the allocation $\{\widehat{K_t}, \widehat{N_t}, \widehat{C_t}\}$ the inequality

$$\widehat{u_C}(0)[\tau_0^K \cdot \widehat{r}_0 \cdot K_0 - B_0] \geq \sum_{t=0}^{\infty} \beta^t \{\widehat{u_C}(t)[G - (1 - M)\widehat{w}_t \widehat{N}_t]\} \tag{23}$$

needs to be satisfied. $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ □

Proposition 1 summarizes basic insights from the static literature on labour market imperfections. From the first-order conditions of the unconstrained problem (P) it is evident that a welfare-maximizing social planner would seek to implement a steady-state allocation which is characterized by the optimality conditions $F_N(K, N) = u_L/u_C$ and $1 = \beta(F_K(K, N) + 1 - \delta)$. To replicate these conditions in an (imperfectly) competitive equilibrium, as is inferred from the first-order conditions (9) and (10) of the representative household, taxes have to be set according to $\tau^N = 1 - M$ and $\tau^K = 0$. This means that the inefficiency associated with monopolistic wage setting should be cured by subsidizing wages at a flat rate, while leaving capital untaxed. According to (20)-(22) this will indeed be optimal from the Ramsey perspective if the implementability constraint is non-binding ($\phi = 0$). This in turn requires, as summarized by (23), that the government's initial net lending position vis-à-vis the

private sector is sufficiently strong (i.e. B_0 sufficiently negative) or that the initial tax on capital τ_0^K is sufficiently large to ensure that the entire sequence of future government expenditures (inclusive the corrective wage subsidies) can be financed without resorting to distortionary taxes.[6]

We turn now to constellations in which the unconstrained social optimum cannot be implemented and present the second benchmark result.

Proposition 2 *(Second-best factor taxes and competitive labour markets)*
If the implementability constraint is binding ($\phi > 0$) and wages are set in a competitive manner ($M \equiv 1$), then: (i) $\tau^K = 0$ and (ii) $\tau^N > 0$.

Part (i) of Proposition 2 restates the result by Chamley (1986) and Judd (1985) that in a fully competitive setting under second-best taxation it is too costly to distort the intertemporal margin of optimality, making the labour tax the preferred instrument. Note, however, the well-known tension between the time-zero capital tax rate (to be set as high as possible in order to reduce the shadow value ϕ of the implementability constraint) and the steady-state result of a zero-capital tax rate.[7] Moreover, equations (21)-(22) show that the steady-state level of the labour tax which corresponds to the Chamley-Judd capital taxation result typically cannot be inferred from steady-state quantities alone. Instead, it depends through the value of the implementability constraint ϕ on the entire sequence of equilibrium conditions and the initial wealth positions, as discussed in further detail by Chamley (1985,

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[6]If (23) holds as a strict inequality, the difference between the initial wealth position of the government and the present value of its expenditures needs to be rebated to households in a lump-sum manner.

[7]Related to this tension, Lansing (1999) shows that under the specific assumption of logarithmic utility (which removes anticipation effects of changes in future return rates) and a balanced budget requirement (which removes the possibility to 'store' distortionary taxation revenues) the front loading of distortionary taxation ceases to be optimal, implying $\tau^K > 0$ in the long run. For a discussion of associated time-consistency issues, see also Section 4.

1986) and Lucas (1990). Our simplifying separability assumption regarding $u(C,L)$, however, is a particularly simple sufficient condition for the steady-state value of τ^N to be always positive, ensuring that the entire steady-state tax burden falls on labour.[8]

Building on these two benchmark results, we now discuss a constellation with imperfectly competitive labour markets ($M > 1$) under distortionary, second-best taxation requirements ($\phi > 0$). In the light of the lemma established above we distinguish between wage mark-ups which are constant or, alternatively, depend on the capital intensity of production.

Proposition 3 *(Second-best factor taxes and imperfectly competitive labour markets)*

Assume the implementability constraint is binding ($\phi > 0$) and wages are set with a mark-up $M > 1$.

i) If $M > 1$ is constant (as implied by the Cobb-Douglas case with $\sigma = 1$), then $\tau^K = 0$, $\tau^N > 0$.

ii) If $M > 1$ is non-constant, then $\tau^K \begin{cases} < 0 \ \text{if} \ \sigma < 1 \\ > 0 \ \text{if} \ \sigma > 1 \end{cases}$ and, ceteris paribus, τ^N will be larger (smaller) than in the case of Cobb-Douglas production if $\sigma < 1 \ (> 1)$.

Regarding part (i) of Proposition 3, the term $1/M$ in equation (22) indicates, ceteris paribus, the desirability of correcting for the labour market distortion. However, as long as the mark-up M is constant, the labour market distortion cannot be

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[8]If one allows for $u_{CL} \neq 0$ (and assumes $M \equiv 1$), (22) turns into

$$z(M) = \frac{1 + \phi(1 + u_{CC}\frac{C}{u_C} - \frac{u_{LC}}{u_C}N)}{1 + \phi(1 - u_{LL}\frac{L}{u_L}\frac{N}{1-N} + \frac{u_{LC}}{u_C}C)}.$$

Hence, concavity of $u(C,L)$ is no longer sufficient to ensure $\tau^N > 0$ if $\phi > 0$. Note, however, that assuming a constant stream of government expenditures $G > 0$, the outcome $\tau^N > 0$ is consistent with the consumption smoothing results of Lucas and Stokey (1983).

indirectly alleviated by taxing or subsidizing capital. Clearly, as assumed in part (ii) of Proposition 3, this is different if $M(k)$ depends on the mix of factor inputs. Then, since $M_K = M_k/N \neq 0$, taxing or subsidizing capital income can be used as an indirect tool for mitigating the wage-setting power of households in the labour market. More precisely, capital should be taxed (subsidized) whenever the mark-up rises (falls) in the capital stock, or, equivalently, whenever $\sigma > 1$ ($\sigma < 1$). Corresponding to this finding, since M_K enters the expressions for τ^K and τ^N with opposite sign, the labour tax should be used in an offsetting manner, which is to say that, ceteris paribus, labour should be less (more) strongly taxed than in the case of a constant mark-up whenever $\sigma > 1$ ($\sigma < 1$).[9]

In sum, the main finding of this section is that in a dynamic Ramsey setting with imperfectly competitive labour markets the role of capital taxation tends to be aligned with the corrective taxation rather than the revenue motive, as long as there are no rents accruing to labour. Qualitatively, this confirms the findings of Guo and Lansing (1999) who, building on Judd (1997), study optimal tax policies in a setting with imperfectly competitive intermediate product markets. However, there are two key differences from our paper: i) the considered deviation from perfect competition affects the two inputs labour and capital in a perfectly symmetric manner; ii) because of their monopoly power, intermediaries earn pure economic profits which are treated for tax purposes, in the absence of a genuine profit tax, as capital income. The first-best policy ('corresponding to $\phi = 0$') is shown to consist of a uniform subsidy to both labour and capital, reflecting the first difference. More specifically, the subsidies are required in order to correct for differences between the private and the social

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[9]This statement is subject to the qualification that competitive equilibria with different values of M will also be characterized by different steady state values of the other endogenous varaiables, including ϕ. Thus, quantifying the labour-market related subsidy-component of the τ^N-schedule in a comparative manner would require simulations in order to capture all general equilibrium feedback effects.

returns to the inputs. From a second-best taxation perspective, the tax on labour is positive, while the sign of the steady-state capital tax rate is ambiguous owing to the 'underinvestment' and the 'profit' effect, reflecting the second difference.[10] However, Guo and Lansing (1999) show that if profits can be fully taxed by means of a genuine profit tax, the entire tax burden falls on labour, while capital should be subsidized in order to correct for the suboptimal level of investment. This latter finding is conceptually in line with our Proposition 3. The fact that in our analysis the sign of the second-best capital tax rate is a priori ambiguous simply reflects the fact that capital may need to be taxed or subsidized in order to mitigate the wage setting power of households, depending on whether in the aggregate production function the elasticity σ is assumed to be larger or less than unity.

3 Optimal taxation under right-to-manage wage bargaining: the role of unemployment benefits

This section extends the previously studied economy and allows for a richer, less centralized wage-setting process in which both firms and households decide on the wage and in which the outcome of the bargain depends on the level of unemployment benefits and the aggregate unemployment rate, much as in Layard, Nickell, and Jackman (1991). Since versions of this set-up have been widely used in the past to study labour market issues in economies in which a large part of the workforce earns wages that result from collective wage bargaining agreements, we find it natural to proceed along these lines. Given our discussion in section 2, however, it should be clear that qualitatively the results derived below are not restricted to this particular set-up. More specifically, we now assume that the economy is characterized by a

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[10]As shown by the authors, this result needs some further modification if the tax treatment of capital depreciation introduces additional distortions.

large number of symmetric sectors. Each sector consists of infinitely many small firms and households of measure 1. Within each sector, firms and households are organized in an employer's federation and a union, respectively, and we consider a representative, sector-specific bargain of the right-to-manage type which determines w, while the employment level is decided by firms. Conceptually, this modification implies that the simple wage mark-up in the first-order condition (10) from the household's problem derived under monopolistic wage-setting will now be replaced by a richer expression, describing the outcome of the right-to-manage bargain in a symmetric equilibrium.

The representative household has in each period a time endowment of $L^e = 1$, which is inelastically supplied. Wage contracts last for one period and, depending on the outcome of the bargain, a fraction N of households will be employed at the net wage rate $w(1 - \tau^N)$, while a fraction $1 - N$ remains unemployed and receives benefits b. Investment and savings decisions are made before the bargain takes place. As above, there is no strategic interaction between the wage-setting decision and the process of capital formation, since firms within each sector are 'small', i.e. the period-t wage bargain takes the sector-wide capital stock K_t as given. Moreover, savings of households are diversified over all sectors, representing claims against the aggregate capital stock. Since the representative sector is assumed to be small compared with the rest of the economy, future factor returns are taken as exogenous in the wage bargain. We introduce some turnover between the sectors to ensure that the wage-setting behaviour in the representative sector takes the aggregate employment situation into account as well. In particular, using the specification of Layard, Nickell, and Jackman (1991, chapter 2), the outside option ($\underline{w}$) maintained in the representative bargain in period t is specified as

$$\underline{w}_t = (1 - \chi u_t) w_t^e (1 - \tau_t^N) + \chi u_t b_t, \tag{24}$$

where u denotes the (expected) economy-wide unemployment rate, w^e is the ex-

pected average wage rate across sectors and χ with $(1 < \chi < 1/u)$ is a measure of turnover between sectors after the wage has been set.[11] Let the relative bargaining power of the union be denoted by γ and consider the Nash bargain in period t, with τ^N, K and $\underline{w}$ taken as given:

$$\max_{w_t} \{(w_t(1 - \tau_t^N) - \underline{w}_t)N(K_t, w_t)\}^\gamma \cdot \{F(K_t, N(K_t, w_t)) - w_t N(K_t, w_t)\}^{1-\gamma} \quad (25)$$

The first-order condition regarding the wage rate is given by

$$\gamma \frac{(1 - \tau_t^N)N_t + (w_t(1 - \tau_t^N) - \underline{w}_t)N_w(t)}{(w_t(1 - \tau_t^N) - \underline{w}_t)N_t} = (1 - \gamma)\frac{N_t}{F_t - w_t N_t}. \quad (26)$$

Since all sectors are identical, a symmetric equilibrium requires $w^e = w$, $u = 1 - N$, yielding the following expression for the surplus of the net wage over the outside option

$$w_t(1 - \tau_t^N) - \underline{w}_t = \chi(1 - N_t)(w_t(1 - \tau_t^N) - b_t). \quad (27)$$

As we show in the following two subsections, the factor taxation results depend sensitively on how the level of unemployment benefits b is specified in the outside option $\underline{w}$. To simplify the exposition, we restrict the analysis to the case of a CES production function with properties as established in Section 2.1.

3.1 Non-indexed unemployment benefits

We assume first that unemployment benefits b_t are set at some exogenously specified level $b > 0$. Then, as derived in part 2 of the appendix, the net wage resulting from the bargain can be expressed as, upon using (27) in (26):

$$w_t(1 - \tau_t^N) = b\frac{1}{1 - \frac{1}{\chi(1 - N_t)\xi(k_t)}} \quad (28)$$

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[11]If there is zero turnover across sectors ($\chi \to 1/u$), the outside option is determined solely by unemployment benefits. The relative importance of benefits decreases in job turnovers, i.e. it is smallest if there is complete turnover ($\chi \to 1$). For a discussion of the reduced-form equation (24) in a related model, see also Kaas and von Thadden (2002).

$$\xi(k_t) = \eta(k_t) + \frac{1-\gamma}{\gamma} \cdot \frac{\eta(k_t) - \sigma}{\sigma}. \tag{29}$$

Equation (28) generalizes the set-up of the previous section as now the net wage depends on the wage elasticity of labour demand (η), the unemployment benefit level (b), the relative bargaining power of the two sides $((1-\gamma)/\gamma)$, the turnover between sectors (χ) and the steady-state unemployment rate $(u = 1 - N)$. For further reference, we emphasize that the mark-up of the net wage over unemployment benefits declines, ceteris paribus, in the wage elasticity of labour demand. The total income of households obtained in the labour market (i.e. inclusive of unemployment benefits), denoted $\widetilde{w}$, is given by

$$\begin{aligned}
\widetilde{w}_t &= N_t w_t (1 - \tau_t^N) + (1 - N_t) b \\
&= (1 + \frac{N_t}{\chi(1 - N_t)\xi(k_t) - 1}) b.
\end{aligned}$$

Note that $\widetilde{w}$ is independent of prices and taxes, which means that we can use it as an alternative to equation (10) to replace the term $(1 - \tau^N)wN$ in the implementability constraint. Since labour is inelastically supplied at the individual level, we suppress it in the flow utility of the representative household.[12] Upon these changes, the flow objective of the pseudo-planning problem becomes

$$V(C_t, N_t, K_t, \phi) = u(C_t) + \phi[u_C(t)(C_t - \widetilde{w}_t(N_t, K_t))], \tag{30}$$

Using (30) in (14), the following is obtained from the first-order condition of the Ramsey problem with respect to K_{t+1}:

$$\theta_t = \beta\{\theta_{t+1}[F_K(t+1) + 1 - \delta] + V_K(t+1)\}$$

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[12] More specifically, households offer their labour supply inelastically to the union which represents them in the bargain. Hence, by making the simplifying assumption $u(C, 1 - N) = u(C)$ we assume that the disutility of labour does not depend on the employment status. This can be rationalized, for example, by assuming that benefits are handed out only in return for the participation in some training activity which keeps the human capital of unemployed people intact, but does not contribute to the per household output measure $F(K, N)$.

$$= \beta\{\theta_{t+1}[F_K(t+1) + 1 - \delta] - \phi u_C(t+1)\widetilde{w}_\xi(t+1)\xi_K(t+1)\}$$

Combining this with the no-arbitrage condition from the consumer's problem, as given by (9), yields for the steady-state tax rate on capital:

$$\tau^K = \frac{\phi}{V_C}\frac{u_C}{F_K}\widetilde{w}_\xi\xi_K \tag{31}$$

Examining (31) leads to:

Proposition 4 *If the implementability condition is binding ($\phi > 0$), the optimal steady-state tax rate on capital should be set according to*

$$\tau^K \begin{cases} < 0 \ if \ \sigma < 1 \\ = 0 \ if \ \sigma = 1 \\ > 0 \ if \ \sigma > 1 \end{cases}.$$

Remark: The result follows from $\xi_K = \xi_k/N$, $sign(\xi_k) = sign(\eta_k)$ and the properties of η established for the Lemma in Section 2.1. Since $\widetilde{w}_\xi < 0$, $sign(\tau^K) = -sign(\eta_k)$.

Despite the different labour market specification, Proposition 4 essentially replicates the main finding of Proposition 3, which states that the steady-state capital tax should be non-zero whenever the wage elasticity of labour demand depends on the capital intensity of production. The main reason for this is as follows: Although the labour supply is assumed to be inelastic at the individual level, employment is elastic at the sectoral level at which the representative wage bargain takes place. One of the key determinants of employment is the size of the mark-up of wages over unemployment benefits which depends, ceteris paribus, on the wage elasticity of labour demand. Hence, similar to Proposition 3, the long-run employment level may depend on the level of the capital stock, and, whenever this is the case, there is scope for a non-zero capital tax to be used according to the corrective taxation motive.

3.2   Unemployment benefits indexed to the net wage

Assume now that unemployment benefits are proportional to the net wage so that

$$b_t = \lambda w_t(1 - \tau_t^N), \quad \lambda > 0. \tag{32}$$

Using equation (32) we obtain for the difference between the net wage rate and the outside option

$$w_t(1 - \tau_t^N) - \underline{w}_t = \chi(1 - N_t)(1 - \lambda)w_t(1 - \tau_t^N). \tag{33}$$

Using (33) in (26), one can easily confirm that now the labour market allocation no longer depends on the labour tax rate τ^N, since changes in τ^N leave the relative importance of the inside and outside option unaffected, as discussed in more detail, for example, in Pissarides (1998). More precisely, substituting (33) into (26) gives

$$
\begin{aligned}
w_t &= F_N(K_t, N_t) = w(k_t) \tag{34}\\
N_t &= 1 - \frac{1}{(1 - \lambda)\chi\xi(k_t)} = N(k_t), \tag{35}
\end{aligned}
$$

where (35) defines implicitly some relationship between the levels of employment and capital. Hence, under the assumption of indexed unemployment benefits the total labour market income $\widetilde{w}$ can be expressed as

$$\widetilde{w}_t = N_t w_t(1 - \tau_t^N) + (1 - N_t)\lambda w_t(1 - \tau_t^N) = (1 - \tau_t^N)w_t[N_t(1 - \lambda) + \lambda].$$

Since the labour market allocation (34) and (35) is not affected by changes in τ^N, there is a rent accruing to labour which can be taxed away without deadweight loss, with the rent R being given by

$$R_t = w_t[N_t(1 - \lambda) + \lambda] = R(k_t). \tag{36}$$

Before we proceed, we point out that (36) is a generalization of the case of a rent considered in Jones, Manuelli, and Rossi (1997) who analyze an economy with a

fully competitive labour market in which labour is in fixed supply ($N = 1$) and $\lambda = 0$. Hence the rent in their model is simply the gross wage rate, i.e. $R = w$. Equation (36) generalizes this idea since the rate N at which labour is employed, although being independent of τ^N, is no longer fixed, but results instead from the bargain and depends on the capital intensity k_t. Thus, the size of the rent to labour depends now on the wage rate $w(k)$ *and* on the employment rate $N(k)$. To keep the following analysis meaningful, we follow Jones, Manuelli, and Rossi (1997) and assume that the rent cannot be fully taxed (because of some exogenous upper bound for the tax rate on labour $\tau^N = \overline{\tau^N} < 1$) and that in steady state the labour tax revenue $\overline{\tau^N} R$ is not sufficient to cover all government expenditures. Hence, the flow objective and the Lagrangian of the pseudo-planning problem become, respectively,

$$V(C_t, N_t, K_t, \phi) = u(C_t) + \phi\{u_C(t)(C_t - (1 - \overline{\tau^N})R_t)\} \tag{37}$$

$$J = \sum \beta^t \{V(C_t, N_t, K_t, \phi) + \theta_t[F(K_t, N_t) + (1-\delta)K_t - G - C_t - K_{t+1}]\} - \phi A. \tag{38}$$

The first-order condition of (38) with respect to K_{t+1} is given by

$$\theta_t = \beta\{\theta_{t+1}[F_K(t+1) + 1 - \delta] + V_K(t+1)\} \tag{39}$$

$$V_K(t+1) = -(1 - \overline{\tau^N})\phi u_C(t+1)R_K(t+1). \tag{40}$$

Accordingly, the steady-state capital tax rate can be expressed as

$$\tau_K = \frac{(1 - \overline{\tau^N})\phi u_C}{V_C F_K} R_K \tag{41}$$

$$R_K = F_{NK}(N(1-\lambda) + \lambda) + F_N N_K(1-\lambda), \tag{42}$$

where $w = F_N$ has been used in deriving (42). This leads us to

Proposition 5 *Under proportional unemployment benefits there exists a rent in the labour market. If this rent cannot be fully taxed ($\tau^N = \overline{\tau^N} < 1$) and the implementability constraint is binding ($\phi > 0$), the optimal steady-state capital tax rate τ^K is positive whenever the rent increases in the capital stock. This will always be the case for $\sigma \leq 1$, while the effect on τ^K is a priori ambiguous for $\sigma > 1$.*

Remark: According to (35), $sign(\xi_k) = sign(N_k)$. Thus, $N_K = N_k \frac{1}{N} = 0$ if $\sigma = 1$, and $N_K > 0(< 0)$ if $\sigma < 1$ $(\sigma > 1)$, while $F_{NK} > 0$ will be satisfied irrespective of how σ relates to unity.

Proposition 5 is a generalization of the rent result of Jones, Manuelli, and Rossi (1997) who show that the steady-state capital tax should be positive whenever the capital stock and the (non-fully taxable) rent are positively correlated, requiring in their set-up simply $w_K = F_{NK} > 0$.[13] However, as a key difference, the total effect of the capital stock on the size of the rent can now be decomposed into a 'wage' and an 'employment' effect. In the special case of a Cobb-Douglas function ($\sigma = 1$) the employment rate consistent with the bargaining outcome is in 'fixed' supply, i.e. the employment effect is zero and, according to (42), $\tau^K > 0$ obtains because of $w_K = F_{NK} > 0$, as in Jones, Manuelli, and Rossi (1997).[14] By contrast, if $\sigma \neq 1$, the employment rate depends on the level of the capital stock. Under gross complementarity ($\sigma < 1$), the steady-state employment rises in the capital stock, thereby increasing the rent, i.e. the two effects reinforce each other, calling unambiguously for a positive capital tax rate. Correspondingly, if $\sigma > 1$ the two effects operate in different directions, making the overall effect a priori ambiguous. This ambiguity, however, does not imply that under $\sigma > 1$ the capital tax rate τ_K must be lower than in the Cobb-Douglas case. The reason for this is that the weights of the two effects depend on the replacement ratio λ. Assume, for example,

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[13]In related work, Correia (1996) considers a competitive economy with constant returns to scale in labour, capital and a third input which cannot be taxed and earns a rent. She shows that the steady-state tax rate on capital should be positive (negative) whenever capital and the third factor enter the production function as complements (substitutes), a finding which is qualitatively in accordance with the intuition given above.

[14]The property $w_K = F_{NK} > 0$ follows from the assumptions regarding $F(K, N)$ made at the outset. In particular, this condition is certainly always satisfied by a CES function, irrespective of the size of the elasticity of substitution between labour and capital.

that λ is 'high' (i.e. close to 1), ensuring a comparatively low level of steady-state employment. Then, the employment effect carries a low weight, while the wage effect associated with $\sigma > 1$ may well outweigh the total effect under $\sigma = 1$.

In any case, the main message of this section is that the second-best role of capital taxation is significantly altered once imperfectly competitive labour markets are characterized by rents which cannot be directly taxed away. In particular, our results indicate that whenever the rent correlates positively with the long-run capital stock the capital tax should be positive to counteract the rent-creation process. We are aware that our particular set-up, with only two inputs, suffers from the limitation that the assumption of a non-fully taxable rent automatically imposes some exogenous upper bound for the labour tax rate. This is not an entirely satisfactory feature and we therefore leave to future work a reexamination of the results of this final section in a setting which allows, for example, for a third input which cannot be taxed along the lines of Correia (1996) and, at the same time, maintains the notion of imperfectly competitive labour markets.

4 Related literature

This section briefly discusses our main findings in the context of related literature. First, to our knowledge, the role of imperfectly competitive labour markets in the design of second-best optimal factor taxes has not yet been explored in dynamic settings which allow for aspects of capital accumulation. However, our steady-state results can, naturally, be linked to static, open-economy frameworks in which the return to capital is taken as given from the world market and the capital (labour) endowment is assumed to be perfectly mobile (immobile). Richter and Schneider (2001) derive for the monopoly union case, similar to the reasoning behind our Proposition 3, a role of a non-zero capital tax rate as an indirect tool for reducing

the wage-setting power of the union.[15] Similarly, Koskela and Schöb (2002) consider a labour market which is subject to right-to-manage wage bargaining and derive capital taxation results which have some resemblance to our Proposition 4. Moreover, in line with our discussion in Section 2 of the 'profit effect' established in Guo and Lansing (1999), the two papers report that the role of capital taxation will be strengthened if profits cannot be fully taxed. Finally, Bovenberg and van der Ploeg (1996), in a different set-up which abstracts from capital taxation issues, discuss the conflict which arises if a positive labour tax is needed for generating revenues under distortionary taxation, although a wage subsidy would be required to correct for some labour market inefficiency.

Second, returning to the literature on dynamic Ramsey problems, results on second-best optimal factor taxes are known to depend sensitively on the set of feasible tax instruments, as illustrated in Section 3.2. Along these lines, Coleman (2000) has recently re-emphasized that work in the Chamley-Judd-tradition, by excluding the possibility of consumption taxes, leads at best to restricted versions of the principle of uniform taxation. Upon including the additional instrument of a consumption tax, Coleman (2000) derives a uniform taxation result regarding consumption and leisure (implying that labour should be subsidized at the rate of the consumption tax) which restores the unconstrained social optimum without compromising on the zero-capital tax result. Coleman's analysis can easily be adapted to our set-up discussed in Section 2. In particular, allowing for a constant consumption tax (τ^C), equation (9) in the crucial first-order conditions of the household remains unaffected,

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[15]The taxation findings of Richter and Schneider (2001) for the CES case in Proposition 7 (p. 254) differ from ours, however, since in their set-up profit-maximizing firms simultaneously choose optimal levels of labour and capital. By contrast, in our set-up capital is a predetermined variable regarding the employment decision of firms.

while (10) turns into:
$$\frac{1 - \tau^N}{1 + \tau^C} \cdot w = \frac{u_L}{u_C} \cdot M.$$

Owing to the additional tax instrument, the unconstrained social optimum can now be restored if taxes are set according to $(1 - \tau^N)/(1 + \tau^C) = M$. Whenever $M > 1$, one obtains $-\tau^N > \tau^C$, i.e. the labour market distortion strengthens the need to subsidize labour and thereby overturns the uniform taxation result which holds in a fully competitive setting.

Third, given the deliberately narrow focus of our analysis, we conclude with a brief account of contributions to the literature that establish alternative mechanisms which invalidate the Chamley-Judd taxation result. The following list, however, is certainly not exhaustive, and we concentrate on some recent contributions which we find particularly important.[16] i) Erosa and Gervais (2002) show that in a life-cycle framework optimal tax plans are likely to require different steady-state tax rates over an individual's lifetime. Assuming an increasing leisure profile over the life-cycle of agents, the capital tax rate should be positive whenever age-specific tax schemes are not available. ii) Benhabib and Rustichini (1997), Phelan and Stacchetti (2001), and Klein and Ríos-Rull (2002) address the well-known time-inconsistency of the Chamley-Judd finding of a zero long-run capital tax, resulting from the fact that in any period the capital stock is in fixed supply. As succinctly summarized by Benhabib and Rustichini, "the time inconsistency of the solution is most extreme precisely at the steady state, when the tax on capital is smallest and the incentive to revise the plan in order to relieve the economy of distortionary labour taxes, the largest" (p. 233). Imposing the time-consistency of tax announcements as an additional constraint, simulation results reported in the three studies, however, disagree on whether sustainable, time-consistent plans call for capital taxes

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[16] For more comprehensive overviews of the literature, see, for example, Atkeson, Chari, and Kehoe (1999) and Ljungqvist and Sargent (2000, Chapter 12).

or subsidies. iii) Stressing distributional aspects, Garcia-Milà, Marcet, and Ventura (2001) evaluate the welfare consequences of lowering capital taxes in a model with heterogenous agents. The main finding of the paper is that such a policy may well face a trade-off between the higher aggregate efficiency in production and the redistribution of wealth against agents with a low ratio of capital income over labour income. With a similar intention, Lansing (1999) and Krusell (2002) establish a redistributive role of steady-state capital taxation in a set-up with heterogenous agents which is similar to Judd (1985), but imposes time-consistent policies. iv) Introducing the notion of incomplete markets, Aiyagari (1995) considers a set-up in which agents face uninsurable idiosyncratic shocks and borrowing constraints. This motivates at the individual level precautionary savings, and the paper shows that a positive capital tax rate is required to prevent excessive capital formation. For a related analysis, see also Chamley (2001). v) Jones, Manuelli, and Rossi (1997) show, within a human capital set-up in which (effective) labour has a stock component similar to physical capital, that it may well be optimal to set both capital and labour taxes equal to zero in the long run. By implication, under such a scheme the government must acquire in the transition towards the steady state claims against the private sector which, in steady state, yield sufficient interest earnings to cover all government expenditures.

5   Conclusion

This paper studies features of optimal factor taxes under commitment in a representative agent, infinite horizon economy in which factor taxes are the only available tax instruments for financing some exogenously given stream of government expenditures. Distinguishing our work from the Chamley-Judd tradition, however, the labour market is assumed to be imperfectly competitive in the sense that wage mark-

ups resulting from a bargaining structure lead to a socially suboptimal employment level. To characterize second-best optimal taxes in line with these assumptions, we apply the logic of Ramsey-taxation exercises, i.e. we recognize that different tax schedules trigger different equilibrium reactions of agents which in turn will be associated with different (imperfectly) competitive equilibrium allocations. According to this logic, a benign social planner should choose that particular tax schedule which yields, in terms of the associated intertemporal allocation, the highest utility of the representative agent, taking as given the labour market constraint that it must be possible to decentralize the allocation through a wage bargain.

The main purpose of this paper is to show that the Chamley-Judd result which calls in steady state for a zero capital tax rate may well be invalidated under conditions of imperfectly competitive labour markets. At first sight this result may seem surprising since the assumed deviations from perfect competition are seemingly unrelated to capital and restricted to the labour market. However, the features of the labour market which we identify as potential sources of a non-zero capital tax rate have a clear appeal. First, we show that under a collective wage bargaining structure in which the representative firm is 'small' and its investment decision is made in a non-strategic manner, but the aggregate capital stock nevertheless acts as an important input for the wage-setting process, the return rates to capital as perceived by the private sector and by the Ramsey planner are likely to be different. More specifically, we show how in such a constellation a non-zero capital tax can have a role in correcting for the labour market distortion by mitigating the mark-up pricing of wage setters. Second, we show that the Chamley-Judd result vanishes when the wage bargaining specification gives rise to rents accruing to labour which cannot be directly taxed. In our set-up, this is the case if unemployment benefits are proportional to the net wage.

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Appendix

Part 1

The CES production function (11) implies, using $X = \alpha K^{\frac{\sigma}{\sigma-1}} + (1-\alpha)N^{\frac{\sigma-1}{\sigma}}$, $F_N = (1-\alpha)X^{\frac{1}{\sigma-1}}N^{-\frac{1}{\sigma}}$, $F_{NN} = -\frac{\alpha(1-\alpha)}{\sigma}X^{\frac{2-\sigma}{\sigma-1}}N^{-\frac{(1+\sigma)}{\sigma}}K^{\frac{\sigma-1}{\sigma}}$. Implicitly differentiating the first-order condition $F_N(K,N) = w$, the wage elasticity of labour demand η can be expressed as $\eta = -\frac{N_w w}{N} = -\frac{F_N}{N F_{NN}}$. Substituting out for F_N and F_{NN} and using $k = K/N$, η turns out to be a function of the capital-labour ratio

$$\eta = \sigma \frac{X}{\alpha \left[K^{\frac{\sigma-1}{\sigma}}\right]} = \sigma \left[\frac{1-\alpha}{\alpha}k^{\frac{1-\sigma}{\sigma}} + 1\right] \tag{43}$$

Since $M = \frac{\eta(k)}{\eta(k)-1}$ falls in η, for $\eta > 1$, the sign of $\frac{\partial M}{\partial k}$ as established in the lemma follows immediately from (43).

Part 2

Suppressing time indices, the first-order condition regarding the wage rate as given by (26) can be rearranged to express the net wage rate in terms of the outside option $\underline{w}$:

$$w(1 - \tau^N) = \frac{\gamma\eta + (1-\gamma)\frac{s}{1-s}}{\gamma(\eta-1) + (1-\gamma)\frac{s}{1-s}}\underline{w}, \tag{44}$$

where $s = \frac{wN}{F(K,N)}$ describes the labour share. In the special case of a CES production function the labour share is given by the expression $s = \frac{1}{1+\frac{\alpha}{1-\alpha}k^{\frac{\sigma-1}{\sigma}}}$, implying $\frac{s}{1-s} = \frac{1-\alpha}{\alpha}k^{\frac{1-\sigma}{\sigma}}$. Combining this with the expression for the wage elasticity of labour demand derived in (43) gives $\frac{s}{1-s} = \frac{\eta(k)-\sigma}{\sigma}$. Upon isolating $\underline{w}$ in (27) and substituting into (44), one obtains equation (28) stated in the main text.

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