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Flexible Outsourcing and the Impacts of Labour Taxation in European Welfare States

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ABSTRACT

Flexible Outsourcing and the Impacts of Labour Taxation in European Welfare States

In European Welfare States, unskilled workers are typically unionized, while the wage formation of skilled workers is more competitive. To focus on this aspect, we analyze how flexible international outsourcing and labour taxation affect wage formation, employment and welfare in dual domestic labour markets. Higher productivity of outsourcing, lower cost of outsourcing and lower factor price of outsourcing increase wage dispersion between the skilled and unskilled workers. Increasing wage tax progression of unskilled workers decreases the wage rate and increases the labour demand of unskilled workers. It decreases the welfare of unskilled workers and increases both the welfare of skilled workers and the profit of firms.

JEL Classification: E24, H22, J21, J31, J51

Keywords: flexible outsourcing, dual labour market, impacts of labour taxation, welfare state

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I. Introduction

European Welfare States are characterized by dual labour markets. Unskilled workers are typically unionized, while skilled workers often negotiate on their wages individually, and, thus, face more competitive wage formation. Historically, labour unions have been able to push for relatively high wages of unskilled workers, at the cost of a higher unemployment in Continental Europe than in the United States (see e.g. Freeman and Schettkat (2001)). During the late 20th century and this decade, globalization has put the European welfare model under increasing pressure. Wage differences across countries constitute a central explanation for the increasing dominant business practice of international outsourcing across a wide range of industries (see e.g. Sinn (2007) for an overview and Stefanova (2006)) concerning the East-West dichotomy of outsourcing).[1]

When outsourcing and domestic labour are substitutes, the demand for domestic homogenous labour is decreasing and its wage elasticity is increasing in the share of outsourcing (see e.g. Senses (2006) for empirical evidence). This limits the mark-up trade unions can set above the opportunity cost of labour. Outsourcing can take two alternative forms. Firms may write long-term contracts that fix the amount of outsourcing before the trade union sets the wage, i.e. strategic outsourcing, or alternatively firms may be flexible enough to decide upon the amount of outsourcing activity simultaneously with domestic labour demand after the domestic wage is set by the trade union. In the case of homogenous domestic labour the impacts of labour tax policy reforms have been analyzed in Koskela and Schöb (2008) both in the case of strategic and flexible outsourcing.

We analyze the effects of international outsourcing and wage taxation on dual domestic labour markets by assuming that the unskilled workers are unionized, while the wages of skilled workers are determined competitively.[2] In Koskela and Poutvaara

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1 Moreover, Amiti and Wei (2005) as well as Rishi and Saxena (2004) emphasize the big difference in labour costs as the main explanation for the strong increase in outsourcing of both manufacturing and services to countries with low labour costs.

2 There are some papers that analyze the effects of outsourcing when labour is heterogeneous, like Davidson et al. (2007) and Davidson et al. (2008). However, these papers analyze labour market frictions that arise with search, while we focus on the role of labour unions. Importantly, the

(2008) we have assumed that outsourcing in this kind of dual domestic labour markets is strategic, but now we study how flexible outsourcing and labour taxation affect wage formation, employment and welfare in dual domestic labour markets. We use a production function where outsourcing is complementary for domestic skilled labour and substitutable to domestic unskilled labour.

We show that in the presence of flexible outsourcing the own wage elasticity and the cross wage elasticity for the unskilled labour demand depend negatively on the cost of outsourcing, and on the factor price of outsourcing and positively on the payroll tax, and the own wage elasticity and the cross wage elasticity for the skilled labour demand are independent of the cost of outsourcing and the payroll tax. We also find that the outsourcing elasticities are constant with respect to the unskilled wage, the payroll tax, the productivity of outsourcing and the cost of outsourcing. When the high-skilled wage adjusts to equalize labour demand and labour supply, the skilled wage depends negatively on the unskilled wage and the payroll tax. The skilled wage is independent of the skilled wage tax parameters in the case of skilled workers' Cobb-Douglas utility function. Moreover, the skilled wage depends on the cost of outsourcing and of the productivity of outsourced production indirectly, through its effect on unskilled wage. The reason for this is that skilled and unskilled labour are complements, so that unskilled wage affects how much unskilled labour input firms want to employ. However, there is no direct link from outsourcing cost and outsourcing productivity parameters to skilled wage.

In the presence of flexible outsourcing the lower cost of outsourcing, the lower factor price of outsourcing and the higher productivity of outsourced production will decrease the wage for the unskilled labour and increase the wage for the skilled labour, thereby inducing higher wage dispersion. The higher unskilled wage tax rate will increase the wage for the unskilled labour and decrease the wage for skilled labour and the higher unskilled wage tax exemption will decrease the wage for the unskilled labour and will increase the wage for the skilled labour. Similar qualitative effects arise in the

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effects of labour taxation may differ even qualitatively between models with labour unions and with search related employment (see e.g. Pissarides (1998) concerning the analysis of this issue in the absence of outsourcing).

absence of outsourcing. With flexible outsourcing, the higher payroll tax for the firms will decrease the wage for the unskilled and skilled labour. In the absence of outsourcing, the higher payroll tax for the firms will decrease the wage for the skilled labour, but has no effect on the wage of unskilled labour.

Increasing the wage tax and the tax exemption for the unskilled workers to keep the relative burden per worker constant implies a higher degree of tax progression. This will decrease the wage rate and increase labour demand of unskilled workers, while it will have no effect on the labour demand of skilled workers. Corresponding effects arise in the absence of outsourcing. We show that a higher degree of tax progression for low-skilled workers will decrease the welfare of unskilled workers and increase the welfare of skilled workers. Also the profits of firms increase.

We proceed as follows: Section II presents the time sequence of the decisions regarding some policy issues associated with labour taxes, wage setting for domestic low-skilled workers, labour demand for domestic skilled and unskilled workers, outsourcing and wage setting for skilled workers. We study the segmented domestic labour demand for heterogenous work force and outsourcing decision and wage formation of skilled workers due to market equilibrium under labour taxation in section III. Wage formation by the monopoly labour union for unskilled workers under a linearly progressive wage tax levied on workers and a proportional payroll tax levied on firms is analyzed in section IV. In section V we study the impacts of unskilled wage progression on employment, welfare and profits. Finally, we summarize conclusions in section VI.

II. Basic Framework

We analyze a model with heterogeneous domestic workers and international outsourcing. The production combines labour services by skilled workers and unskilled workers. Unskilled labour services can be provided either by the firm's own workers, or obtained from abroad through international outsourcing. We assume that the firms may be flexible enough to decide upon the amount of outsourcing activity only after the wage is set by the trade union. The time sequence for this case is described by Figure 1.

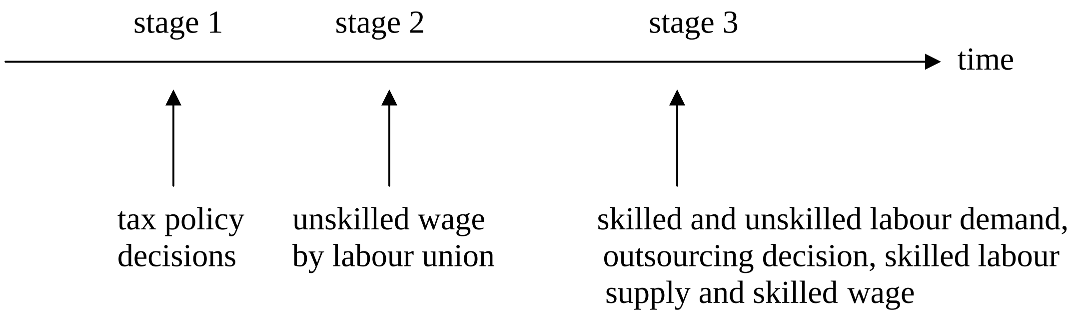

Figure 1: Time sequence of decisions

The government sets its policy at stage 1. At stage 2 conditional on policy choices by the government, the labour union determines the wage for the unskilled workers by taking into account how this affects the demand for labour and outsourcing by the firms. We assume that there are many industries, so that each labour union represents only a small fraction of the total labor force. At stage 3, firms decide on domestic employment and international outsourcing. The wages of the skilled labour adjust to equalize labour demand and labour supply. The decisions at each stage are analyzed by using backward induction.

III. Labour Demand, Outsourcing Decisions and Skilled Wage Formation

III.1. Labour Demand and Outsourcing

At the last stage, the firm decides on the skilled labour demand H, the unskilled labour demand L and outsourcing M in order to maximize the profit function

$$\underbrace{Max}_{(H,L,M)} \pi = F(H,L,M) - \tilde{w}_H H - \tilde{w}_L L - w_M M - g(M) \quad (1)$$

When deciding on its labour demand and outsourcing, each firm takes as given the gross wage for skilled labour, $\tilde{w}_H = w_H(1+s)$, and the gross wage for unskilled labour, $\tilde{w}_L = w_L(1+s)$, where s is the proportional payroll tax levied on the firm. In order to obtain M units of outsourced unskilled labour input, we assume that firms acquire the unskilled labour input at the factor price w_M and also firms have to spend $g(M) = 0{,}5cM^2$ with $g'(M) = cM > 0$ and $g''(M) = c > 0$ to establish the capacity for foreign outsourcing concerning the network of suppliers in the relevant low-wage countries.

We follow Koskela and Stenbacka (2007) by assuming a general and reasonable Cobb-Douglas-type production function with decreasing returns to scale according to three labour inputs, i.e. $F(H,L,M) = \left[H^a (L+\gamma M)^{1-a}\right]^{\rho}$, where the parameters ρ and a are assumed to satisfy the following assumptions : $0<\rho<1$ and $0<a<1$. The parameter $\gamma > 0$ captures the productivity of the outsourced unskilled labour input relative to the domestic unskilled labour input. The marginal products of skilled labour, unskilled labour and outsourcing are: $F_H = \rho Y^{\rho-1} a H^{a-1}(L+\gamma M)^{1-a}$, $F_L = \rho Y^{\rho-1} H^a (1-a)(L+\gamma M)^{-a}$, and $F_M = \gamma \rho Y^{\rho-1} H^a (1-a)(L+\gamma M)^{-a} = \gamma F_L$, where $Y = H^a (L+\gamma M)^{1-a}$. The outsourced unskilled labour input affects the marginal products of the domestic skilled and unskilled labour inputs as follows:

$$F_{HM} = \rho^2 Y^{\rho-1} a H^{a-1}(1-a)\gamma(L+\gamma M)^{-a} > 0 \qquad \text{(2a)}$$

$$F_{LM} = -\rho Y^{\rho-1} H^a (1-a)\gamma(L+\gamma M)^{-a-1}\left[1-\rho(1-a)\right] < 0\,. \qquad \text{(2b)}$$

For this production function the domestic skilled labour input and the outsourced unskilled labour input are complements, whereas the unskilled domestic labour input and the outsourced unskilled labour input are substitutes in terms of the marginal product effects of outsourcing. Also one can calculate from the production function that the domestic skilled and unskilled labour are complements, i.e. $F_{HL} > 0$. Given the wages, the outsourcing cost function and the tax parameters the first-order conditions characterizing the domestic skilled and unskilled labour demands and outsourcing are

$$\pi_H = \rho\left[H^a(L+\gamma M)^{1-a}\right]^{\rho-1} aH^{a-1}(L+\gamma M)^{1-a} - \tilde{w}_H = 0 \tag{3a}$$

$$\pi_L = \rho\left[H^a(L+\lambda M)^{1-a}\right]^{\rho-1}(1-a)H^a(L+\gamma M)^{-a} - \tilde{w}_L = 0 \tag{3b}$$

$$\pi_M = \rho\left[H^a(L+\lambda M)^{1-a}\right]^{\rho-1}\gamma(1-a)H^a(L+\gamma M)^{-a} - w_M - cM = 0. \tag{3c}$$

These first-order conditions imply the following relationship between the skilled labour (H) and the unskilled labour inclusive of outsourcing ($L+\gamma M$)

$$H = \frac{w_L}{w_H}\frac{a}{1-a}(L+\gamma M). \tag{4}$$

Using (3b) and (3c) we have

$$M^* = \frac{(\gamma w_L(1+s) - w_M)}{c} \tag{5}$$

where $\frac{M^*_{w_L} w_L}{M^*} = \frac{M^*_s(1+s)}{M^*} = \frac{M^*_\gamma \gamma}{M^*} = \frac{\gamma w_L(1+s)}{\gamma w_L(1+s) - w_M} = 1 + \frac{w_M}{cM^*} > 1$, $-\frac{M^*_c c}{M^*} = 1$ and $-\frac{M^*_{w_M} w_M}{M^*} = \frac{w_M}{\gamma w_L(1+s) - w_M} = \frac{w_M}{cM^*} > 0$ so that $-(\frac{M^*_c c}{M^*} + \frac{M^*_{w_M} w_M}{M^*}) = 1 + \frac{w_M}{cM^*} > 1$.

According to (5) optimal flexible outsourcing requires that $\gamma w_L(1+s) > w_M$ so that factor price of outsourcing should be smaller than the gross factor price of domestic unskilled labour multiplied by the relative productivity of outsourcing. Higher unskilled domestic wage rate, higher payroll tax and higher productivity of outsourced labour input, lower outsourcing cost and lower factor price of outsourcing will increase outsourcing.

Substituting the RHS of (4) into (3b) gives (see Appendix A) the unskilled labour demand, which can be expressed as follows

$$L^{*} = mw_{L}^{-\varepsilon_{L}^{L}} w_{H}^{-\varepsilon_{H}^{L}} (1+s)^{-\varepsilon} - \gamma\ M^{*} = mw_{L}^{-\varepsilon_{L}^{L}} w_{H}^{-\varepsilon_{H}^{L}} (1+s)^{-\varepsilon} - \gamma\left(\frac{\gamma\ w_{L}(1+s) - w_{M}}{c}\right), \quad (6)$$

where $m = \left[\rho a^{a\rho}(1-a)^{1-a\rho}\right]^{\frac{1}{1-\rho}} > 0$, $\varepsilon_{L}^{L} = \frac{1-\rho a}{1-\rho} > 1$ and $\varepsilon_{H}^{L} = \frac{\rho a}{1-\rho} > 0$, which are the own wage elasticity and the cross wage elasticity of the unskilled labour in the absence of outsourcing. These are higher with weaker decreasing returns to scale. In the absence of outsourcing the payroll tax elasticity of the unskilled labour is $\varepsilon = -\frac{L_{s}(1+s)}{L} = \frac{1}{1-\rho} > 1$ because of the decreasing returns to scale. According to (6), a more extensive outsourcing activity will decrease the unskilled labour demand. This feature is consistent with empirical evidence.[3] In the presence of outsourcing the wage elasticities of the unskilled labour, $-\left.\frac{L_{w_{L}}^{*} w_{L}}{L^{*}}\right|_{M>0}$ and $-\left.\frac{L_{w_{H}}^{*} w_{H}}{L^{*}}\right|_{M>0}$, can be written as follows

$$\eta_{L}^{f} = \varepsilon_{L}^{L}\left(1+\gamma\frac{M^{*}}{L^{*}}\right) + \gamma\frac{M^{*}}{L^{*}} + \gamma\frac{w_{M}}{cL^{*}} = \varepsilon_{L}^{L} + \frac{\gamma}{L^{*}}\left((1+\varepsilon_{L}^{L})M^{*} + \frac{w_{M}}{c}\right) \quad (7a)$$

$$\eta_{H}^{f} = \varepsilon_{H}^{L}\left(1+\gamma\frac{M^{*}}{L^{*}}\right). \quad (7b)$$

Concerning these wage elasticities we find that $\frac{\partial\eta_{L}^{f}}{\partial M^{*}} = \frac{\gamma}{L^{*}}(1+\varepsilon_{L}^{L}) - \frac{\gamma L_{M}^{*}}{L^{*2}}((1+\varepsilon_{L}^{L})M^{*} + \frac{w_{M}}{c}) = \frac{\gamma}{L^{*}}\left((1+\varepsilon_{L}^{L}) + \frac{\gamma}{L^{*}}(1+\varepsilon_{L}^{L})M^{*} + \frac{\gamma}{L^{*}}\frac{w_{M}}{c}\right) > 0$ and $\frac{\partial\eta_{H}^{f}}{\partial M^{*}} = \varepsilon_{H}^{L}\gamma\left[\frac{L^{*} - M^{*}L_{M}^{*}}{L^{*2}}\right] = \varepsilon_{H}^{L}\frac{\gamma}{L^{*}}(1+\gamma\frac{M^{*}}{L^{*}}) > 0$ so that when outsourcing will change, the own wage and cross wage elasticities of the unskilled labour demand

3 For instance Diehl (1999) has presented empirical evidence from German manufacturing industries in support of this hypothesis. Moreover, Görg and Hanley (2005) have used plant-level data of the Irish electronic sector to empirically conclude that international outsourcing reduces plant-level labour demand.

increase. These are in conformity with empirical evidence.[4] Differentiating (7a) with respect to s gives

$$\frac{\partial \eta_L^f}{\partial s} = (1+\varepsilon_L^L)\gamma\left[\frac{(L^* M_s^* - M^* L_s^*)}{L^{*2}}\right] + \frac{\gamma w_M}{c}\left(-\frac{L_s^*}{L^{*2}}\right) > 0 \tag{8}$$

so that the payroll tax in the presence of outsourcing will have a positive effect on the wage elasticity of the unskilled labour demand. Comparative statics is qualitatively similar in terms of η_H^f, but there is no wage elasticity effect of payroll tax in the absence of outsourcing, i.e. $\left.\frac{\partial \eta_L^f}{\partial s}\right|_{M=0} = 0$. In the presence of flexible outsourcing the payroll tax elasticity of the unskilled labour, $\left.-\frac{L_s^*(1+s)}{L^*}\right|_{M>0}$, is

$$\eta_s^f = \varepsilon\left(1+\gamma\frac{M^*}{L^*}\right) + \gamma\frac{M^*}{L^*}\frac{M_s^*(1+s)}{M^*} = \varepsilon\left(1+\gamma\frac{M^*}{L^*}\right) + \gamma\frac{M^*}{L^*}\left(1+\frac{w_M}{cM^*}\right) > 0 \tag{9}$$

so that higher outsourcing raises this elasticity as well. The effect of outsourcing cost on the wage elasticity of unskilled labour is

$$\frac{\partial \eta_L^f}{\partial c} = (1+\varepsilon_L^L)\gamma\left[\frac{(L^* M_c^* - ML_c^*)}{L^{*2}}\right] - \frac{\gamma\, w_M}{(cL^*)^2}(L^* + cL_c^*)$$
$$= -\frac{(1+\varepsilon_L^L)\gamma\, M^*}{cL^*}\left(1+\gamma\frac{M^*}{L^*}\right) - \frac{\gamma\, w_M}{c^2 L^*}\left(1+\gamma\frac{M^*}{L^*}\right) = -\frac{\gamma}{cL^*}\left((1+\varepsilon_L^L)M^* + \frac{w_M}{c}\right)\left(1+\gamma\frac{M^*}{L^*}\right) < 0 \tag{10}$$

so that lower outsourcing cost will increase wage elasticity of domestic unskilled labour demand. Also one can show that higher outsourcing productivity will increase the wage

[4] Senses (2006) has provided empirical evidence according to which a production mode with more ttoutsourcing seems to increase the wage elasticity of labour demand. Also Slaughter (2001) and Hasan et al. (2007) have shown that international trade has increased the wage elasticity of labour demand.

elasticity, i.e. $\frac{\partial \eta_L^f}{\partial \gamma} > 0$. The effect of factor price of outsourcing on the wage elasticity of unskilled labour is

$$\frac{\partial \eta_L^f}{\partial w_M} = (1+\varepsilon_L^L)\gamma\left[\frac{(L^* M_{w_M}^* - M L_{w_M}^*)}{L^{*2}}\right] + \frac{\gamma}{c}\left[\frac{L^* - w_M L_{w_M}^*}{L^{*2}}\right]$$

$$= \frac{(1+\varepsilon_L^L)\gamma\, M^*}{w_M L^*} \underbrace{\frac{M_{w_M}^* w_M}{M^*}}_{-}(1+\gamma\frac{M^*}{L^*}) + \frac{\gamma}{cL^*}(1+\gamma\frac{M^*}{L^*}\underbrace{\frac{M_{w_M}^* w_M}{M^*}}_{-}) \tag{11}$$

$$= -\frac{\gamma}{cL^*}\left[\varepsilon_L^L + \gamma\frac{M^*}{L^*}((1+\varepsilon_L^L)\gamma + \frac{w_M}{cM^*})\right] < 0.$$

Of course, lower factor price of outsourcing will increase the wage elasticity of domestic unskilled labour demand.

Finally, substituting the RHS of equation (6) into the relationship in equation (4) gives the following demand for the skilled labour

$$H^* = \frac{ma}{1-a} w_H^{-\varepsilon_H^H} w_L^{-\varepsilon_L^H} (1+s)^{-\varepsilon}, \tag{12}$$

where $\varepsilon_H^H = -\frac{H_{w_H}^* w_H}{H^*} = \frac{1-\rho(1-a)}{1-\rho} > 1$, $\varepsilon_L^H = -\frac{H_{w_L}^* w_L}{H^*} = \frac{\rho(1-a)}{1-\rho} > 0$ and

$\varepsilon = -\frac{H_s^*(1+s)}{H^*} = \frac{1}{1-\rho} > 1$. These elasticities are also higher with weaker decreasing returns to scale, but unlike in the case with the unskilled labour, both the own wage and cross wage labor demand elasticities, and the payroll tax elasticity for the skilled labour are independent of outsourcing. The higher own wage, cross wage and payroll tax will of course affect negatively the skilled labour demand.

We can now summarize our findings regarding the properties of the domestic labour demand as follows.

Proposition 1 *In the presence of flexible outsourcing*

(a) both the own wage and the cross wage elasticities for the unskilled labour demand depend negatively on the cost of outsourcing and factor price of outsourcing, and positively on the payroll tax, and

(b) both the own wage and the cross wage elasticities for the skilled labour demand are independent of the cost of outsourcing and the payroll tax.

Proposition 1 reveals an asymmetry in how the demand for skilled and unskilled labor react to the cost of outsourcing and the level of payroll taxes. An increase in outsourcing cost or payroll tax would increase the own wage elasticity, and the cross wage elasticity for the unskilled labour demand, while having no effect on the elasticities for the skilled labour demand.

III.2. Wage Formation for Skilled Workers

III.2.1 Optimal Labour Supply of Skilled Workers

We assume that the market equilibrium for the skilled wage w_H follows from the equality of labour demand and the labour supply by using the case of Cobb-Douglas (C-D) utility function, so that the elasticity of substitution between consumption and leisure is one. First we derive labour supply and after that the wage formation from market equilibrium by taking the low-skilled wage w_L as given.

We assume that the government can employ the proportional wage tax t_H for skilled worker, which is levied on the wage rate w_H minus tax exemption e_H. Thus the total tax base in this case is $(w_H - e_H)H$, where H is labour supply. In the presence of positive tax exemption the marginal wage tax exceeds the average wage tax rate $t_H(1-e_H/w_H)$ so that the system is linearly progressive.[5] The net-of-tax wage, the skilled worker receives, is $\hat{w}_H = (1-t_H)w_H + t_H e_H$.

[5] For a seminal paper about tax progression, see Musgrave and Thin (1948), and for another elaboration, see e.g. Lambert (2001, chapters 7-8).

Labour supply of the skilled worker is determined by utility maximization. In the case of the C-D utility function maximizing $U(C,H) = C^{\mu}(1-H)^{1-\mu}$, $0<\mu<1$, s.t. $\hat{w}_H H = C$ with respect to labour supply H gives $U_H = \mu(\hat{w}_H H)^{\mu-1}(1-H)^{1-\mu}\hat{w}_H - (1-\mu)(\hat{w}_H H)^{\mu}(1-H)^{-\mu} = 0$ so that

$$H^s = \mu \tag{13}$$

Therefore under this assumption the net-of-tax wage $\hat{w}_H = (1-t_H)w_H + t_H e_H$ will have no effect on labour supply when the substitution and income effects of wage rate cancel each other. It is important to emphasize that a central finding in the empirical labour market literature is that labour supply tends to be quite unresponsive along the intensive margin (see for empirical evidence, e.g. Immervoll et al (2007) and Blundell and MaCurdy (1999)). Therefore, we focus on this finding concerning the market equilibrium of skilled workers.

III.2.2 Market Equilibrium for Skilled Wage Formation

Unlike in the case of low-skilled workers we assume that the skilled wage w_H is determined by the market equilibrium concerning the equality of the labour demand function and the labour supply function. In the case of C-D utility function the equality $H^* = H^s$ gives $\frac{ma}{1-a} w_H^{-\varepsilon_H^H} w_L^{-\varepsilon_L^H} (1+s)^{-\varepsilon} = \mu$, which allows to solve

$$w_H = \left[\frac{\mu(1-a)}{ma}\right]^{-\frac{1}{\varepsilon_H^H}} w_L^{-\frac{\varepsilon_L^H}{\varepsilon_H^H}} (1+s)^{-\frac{\varepsilon}{\varepsilon_H^H}} \tag{14}$$

where $\varepsilon_L^H / \varepsilon_H^H = \frac{\rho(1-a)}{1-\rho(1-a)} > 0$ and $\varepsilon / \varepsilon_H^H = \frac{1}{1-\rho(1-a)} > 1$. The comparative statics in terms of w_L is

$$\frac{\partial w_H}{\partial w_L} = -\frac{\varepsilon_L^H}{\varepsilon_H^H}\left[\frac{\mu(1-a)}{ma}\right]^{-\frac{1}{\varepsilon_H^H}} w_L^{-\frac{\varepsilon_L^H}{\varepsilon_H^H}-1} (1+s)^{-\frac{\varepsilon}{\varepsilon_H^H}} = -\frac{\varepsilon_L^H}{\varepsilon_H^H}\frac{w_H}{w_L} < 0 . \tag{15}$$

Equation (15) lies in conformity with empirics concerning the negative relationship between skilled and unskilled wages.[6] The effect of payroll tax on the wage rate of skilled workers is

$$\frac{\partial w_H}{\partial s} = -\frac{\varepsilon}{\varepsilon_H^H}\left[\frac{\mu(1-a)}{ma}\right]^{-\frac{1}{\varepsilon_H^H}} w_L^{-\frac{\varepsilon_L^H}{\varepsilon_H^H}}(1+s)^{-\frac{\varepsilon}{\varepsilon_H^H}-1} = -\frac{\varepsilon}{\varepsilon_H^H}\frac{w_H}{1+s} < 0 \qquad (16)$$

so that higher payroll tax will decrease the wage rate of skilled workers because it decreases labour demand given the labour supply (concerning empirical evidence, see. e.g. Daveri and Tabellini (2000), and Bingley and Lanot (2002)). According to (13) the skilled wage rate does not depend on the outsourcing cost and the productivity of outsourcing.

We can now summarize our findings regarding the properties of the skilled wage determination in the presence of outsourcing as follows.

Proposition 2 *In the presence of flexible outsourcing*

(a) the high-skilled wage depends negatively on the unskilled wage and the payroll tax, but is independent of the skilled wage tax parameters in the case of skilled workers' Cobb-Douglas utility function, and

(b) the skilled wage is also directly independent of the cost of outsourcing and the productivity of outsourcing, but depends indirectly on the unskilled wage change and the productivity of the unskilled wage change so that higher outsourcing cost will decrease, while higher productivity of outsourcing unskilled labour input relative to the domestic unskilled labour input will increase the skilled wage.

In the first sight, it may appear surprising that the skilled wage reacts negatively to the unskilled wage tax, but is independent of their own wage tax. The intuition for this relies on our assumption that the skilled workers have a Cobb-Douglas utility function.

6 See evidence from various countries which lies in conformity with this, e.g. Braun and Scheffel (2007), Feenstra and Hanson (1999, 2001), Hijzen et al (2005), Hijzen (2007), Egger and Egger (2006), Munch and Skaksen (2005), Riley and Young (2007) and Geishecker and Görg (2008).

With it, income and substitution effects of a tax increase on the labor supply cancel each other out.

IV. Wage Formation by Monopoly Labour Union

Now we analyze the wage formation of unskilled workers so that it takes place in anticipation of optimal labour and outsourcing decisions by the firm. We analyze the wage formation by the monopoly union (see also Cahuc and Zylberberg (2004), p. 401-403 concerning the monopoly union specification), which determines the wage for unskilled workers in anticipation of optimal in-house unskilled labour demand in the presence of flexible outsourcing determined simultaneously and of market equilibrium for the high-skilled wage w_H.[7]

IV.1. Wage Formation by the Monopoly Labour Union

We investigate the wage formation by monopoly labour union when there is proportional payroll tax, and the linearly progressive wage tax for unskilled workers. The market equilibrium for the skilled wage w_H follows from the equality of labour demand and the labour supply by focusing the case of C-D utility function. The monopoly labour union determines the wage for unskilled workers in anticipation of optimal domestic labour demand and outsourcing decisions by the firm. We assume that government can employ a proportional tax rate t_L, which is levied on the wage rate w_L minus a tax exemption e, i.e. the total tax base is $(w_L - e)L^*$. In the presence of a positive tax exemption the marginal wage tax exceeds the average wage tax rate $t_L(1-e/w_L)$ so that the system is linearly progressive and the net-of-tax wage is $\hat{w}_L = (1-t_L)w_L + t_L e$.

7 In Western European countries, which we like to focus, labour market institutions are close to this (see e.g. Freeman (2008)).

The objective function of the labour union is assumed to be $V=((1-t_L)w_L+t_Le-b_L)L^*+b_LN=(\hat{w}_L-b_L)L^*+b_LN$, where b_L is the (exogenous) outside option available to the unskilled workers and N is the number of labour union members. The monopoly labour union sets wage for the unskilled workers so as to maximize the surplus according to

$$\underbrace{\max}_{(w_L)} \; V=(\hat{w}_L-b_L)L^*+b_LN \tag{17}$$

s.t. $L^*=mw_L^{-\varepsilon_L^L}w_H^{-\varepsilon_H^L}(1+s)^{-\varepsilon}-\gamma\, M^*=mw_L^{-\varepsilon_L^L}w_H^{-\varepsilon_H^L}(1+s)^{-\varepsilon}-\gamma\left(\frac{\gamma w_L(1+s)-w_M}{c}\right)$ and $H^*=H^s$

where in the presence of payroll tax $H^*=\frac{ma}{1-a}w_H^{-\varepsilon_H^H}w_L^{-\varepsilon_L^H}(1+s)^{-\varepsilon}$ and $H^s=\mu$, which implies $w_H=\left[\frac{\mu(1-a)}{ma}\right]^{-\frac{1}{\varepsilon_H^H}}w_L^{-\frac{\varepsilon_L^H}{\varepsilon_H^H}}(1+s)^{-\frac{\varepsilon}{\varepsilon_H^H}}$ (see equations (12), (13) and (14)).

The first-order condition associated with (17) is

$$V_{w_L}=\frac{L^*}{w_L}\left[(1-t_L)w_L+((1-t_L)w_L+t_Le-b_L)\left(\frac{L^*_{w_L}w_L}{L^*}+\frac{L^*_{w_H}w_H}{L^*}\frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H}\right)\right]=0. \tag{18}$$

and this can be written as follows

$$V_{w_L}=(1-t_L)w_L(1-(\eta_L^f+\eta_H^f\frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H}))+(b_L-t_Le)(\eta_L^f+\eta_H^f\frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H}))=0 \tag{19}$$

where $\frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H}=-\frac{\varepsilon_L^H}{\varepsilon_H^H}$, the own wage elasticity of unskilled labour demand is $\eta_L^f=\varepsilon_L^L\left(1+\gamma\frac{M^*}{L^*}\right)+\gamma\frac{M^*}{L^*}+\gamma\frac{w_M}{cL^*}=\varepsilon_L^L+\frac{\gamma}{L^*}\left((1+\varepsilon_L^L)M^*+\frac{w_M}{c}\right)$ and the cross wage elasticity of unskilled labour demand $\eta_H^f = \varepsilon_H^L\left(1+\gamma\frac{M^*}{L^*}\right)$. These unskilled labour demand elasticities are not constant because the unskilled labour demand, $L^* = mw_L^{-\varepsilon_L^L} w_H^{-\varepsilon_H^L}(1+s)^{-\varepsilon} - \gamma\left(\frac{\gamma\ w_L(1+s)-w_M}{c}\right)$ $L^* = mw_L^{-\varepsilon_L^L} w_H^{-\varepsilon_H^L}(1+s)^{-\varepsilon} - \gamma^2\frac{w_L(1+s)}{c}$ depends negatively on the following variables: the skilled wage, the unskilled wage, the productivity of the outsourced unskilled labour input relative to the domestic unskilled labour input, and the payroll tax and positively on the cost of outsourcing and the factor price of outsourcing.

Equation (19) can be expressed as follows

$$w_L^* = \left(\frac{\eta_L^f - \eta_H^f\frac{\varepsilon_L^H}{\varepsilon_H^H}}{\eta_L^f - \eta_H^f\frac{\varepsilon_L^H}{\varepsilon_H^H}-1}\right)\hat{b}_L = \left(\frac{\gamma(\frac{M^*}{L^*}+\frac{w_M}{cL^*})+(\varepsilon_L^L-\varepsilon_H^L\frac{\varepsilon_L^H}{\varepsilon_H^H})(1+\gamma\frac{M^*}{L^*})}{\gamma(\frac{M^*}{L^*}+\frac{w_M}{cL^*})+(\varepsilon_L^L-\varepsilon_H^L\frac{\varepsilon_L^H}{\varepsilon_H^H})(1+\gamma\frac{M^*}{L^*})-1}\right)\hat{b}_L \tag{20}$$

$$= \left(\frac{(\varepsilon_L^L-\varepsilon_H^L\frac{\varepsilon_L^H}{\varepsilon_H^H})+(1+\varepsilon_L^L-\varepsilon_H^L\frac{\varepsilon_L^H}{\varepsilon_H^H})\gamma\frac{M^*}{L^*}+\gamma\frac{w_M}{cL^*}}{(\varepsilon_L^L-\varepsilon_H^L\frac{\varepsilon_L^H}{\varepsilon_H^H})+(1+\varepsilon_L^L-\varepsilon_H^L\frac{\varepsilon_L^H}{\varepsilon_H^H})\gamma\frac{M^*}{L^*}+\gamma\frac{w_M}{cL^*}-1}\right)\hat{b}_L$$

where $\hat{b}_L = \frac{b_L - t_L e}{1-t_L}$. Therefore we have (see Appendix B)

$$w_L^*(c, w_H, \gamma, t_L, e, b_L, s) = \left(\frac{\overline{\eta}_L^f}{\overline{\eta}_L^f - 1}\right)\hat{b}_L = \frac{\beta L^* + (1+\beta)\gamma\ M^*) + \gamma\frac{w_M}{c}}{(\beta-1)L^* + (1+\beta)\gamma\ M^*) + \gamma\frac{w_M}{c}}\hat{b}_L \tag{21}$$

so that the total wage elasticity also allowing for the relationship between skilled and unskilled wages is $\overline{\eta}_L^f = \beta(1+\gamma\frac{M^*}{L^*})+\gamma\frac{M^*}{L^*}+\gamma\frac{w_M}{cL^*} > 1$, where $\beta = \frac{1}{1-\rho(1-a)} > 1$

and $M^* = \left(\dfrac{\gamma\ w_L(1+s) - w_M}{c} \right)$. It is important to emphasize that the optimal unskilled wage (21) even in the case of the monopoly labour union is an implicit form in the presence of outsourcing, because the mark-up $A^f = \dfrac{\beta\ L^* + (1+\beta)\gamma\ M^* + \gamma \dfrac{w_M}{c}}{(\beta - 1)L^* + (1+\beta)\gamma\ M^* + \gamma \dfrac{w_M}{c}}$ depends on the unskilled wage rate in a non-linear way so that it cannot be solved explicitly for the optimal domestic unskilled wage.

IV.2. Comparative Statics of Wage Formation

In order to characterize the effect of outsourcing cost on the unskilled wage formation we therefore apply the implicit differentiation. Differentiating the wage formation (21) with respect to the unskilled wage and the outsourcing cost gives

$$\left(1 - \frac{\left[(\overline{\eta}_L^f - 1)\dfrac{\partial \overline{\eta}_L^f}{\partial w_L} - \overline{\eta}_L^f \dfrac{\partial \overline{\eta}_L^f}{\partial w_L} \right]}{(\overline{\eta}_L^f - 1)^2} \hat{b}_L \right) dw_L^* = \frac{\left[(\overline{\eta}_L^f - 1)\dfrac{\partial \overline{\eta}_L^f}{\partial c} - \overline{\eta}_L^f \dfrac{\partial \overline{\eta}_L^f}{\partial c} \right]}{(\overline{\eta}_L^f - 1)^2} \hat{b}_L dc \qquad (22)$$

which can be expressed as $\dfrac{dw_L^*}{dc} = -\dfrac{\dfrac{\partial \overline{\eta}_L^f}{\partial c}}{(\overline{\eta}_L^f - 1)^2} \hat{b}_L \Bigg/ \left(1 + \dfrac{\dfrac{\partial \overline{\eta}_L^f}{\partial w_L}}{(\overline{\eta}_L^f - 1)^2} \hat{b}_L \right) < 0$. Using equation (21) $\hat{b}_L = \dfrac{w_L(\overline{\eta}_L^f - 1)}{\overline{\eta}_L^f}$, and calculating $\dfrac{\partial \overline{\eta}_L^f}{\partial c} = -\dfrac{\gamma}{cL^*}((1+\beta)M^* + \dfrac{w_M}{c})(1 + \gamma \dfrac{M^*}{L^*}) < 0$ (see equation (10)), and

$$\frac{\partial \overline{\eta}_L^f}{\partial w_L} = \frac{(1+\beta)\gamma\ M^*}{w_L L^*} \left[\frac{M_{w_L}^* w_L}{M^*} - \frac{L_{w_L}^* w_L}{L^*} \right] + \frac{\gamma w_M}{c w_L L^*} \left(-\frac{L_{w_L}^* w_L}{L^*} \right) =$$

$$\frac{(1+\beta)\gamma\ M^*}{w_L L^*} \left[1 + \frac{w_M}{cM^*} + \eta_L^f \right] + \frac{\gamma w_M}{c w_L L^*} \eta_L^f > 0$$

the relationship between the unskilled wage formation and outsourcing cost can be written as follows

$$\frac{dw_L^*}{dc} = -\frac{\frac{\partial \overline{\eta}_L^f}{\partial c} \frac{w_L}{\overline{\eta}_L^f}}{\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L} \frac{w_L}{\overline{\eta}_L^f}} > 0 \qquad (23)$$

so that higher (lower) outsourcing cost will increase (decrease) the wage of unskilled domestic workers.

Differentiating the implicit wage formation (21) with respect to the productivity of the outsourced unskilled labour input relative to the domestic unskilled labour input and unskilled wage formation gives

$$\left(1 - \frac{\left[(\overline{\eta}_L^f - 1) \frac{\partial \overline{\eta}_L^f}{\partial w_L} - \overline{\eta}_L^f \frac{\partial \overline{\eta}_L^f}{\partial w_L} \right]}{(\overline{\eta}_L^f - 1)^2} \hat{b}_L \right) dw_L^* = \frac{\left[(\overline{\eta}_L^f - 1) \frac{\partial \overline{\eta}_L^f}{\partial \gamma} - \overline{\eta}_L^f \frac{\partial \overline{\eta}_L^f}{\partial \gamma} \right]}{(\overline{\eta}_L^f - 1)^2} \hat{b}_L d\gamma \qquad (24)$$

which can be expressed by using $\frac{\partial \overline{\eta}_L^f}{\partial \gamma} = (1+\beta)\gamma \left[\frac{L^* M_\gamma^* - M^* L_\gamma^*}{L^{*2}} \right] + \frac{w_M}{cL^*} - \frac{\gamma w_M}{c} \frac{L_\gamma^*}{L^{*2}} = (1+\beta) \frac{M^*}{L^*} \frac{M_\gamma^* \gamma}{M^*} + (1 + \frac{M_\gamma^* \gamma}{M^*})(\gamma \frac{M^*}{L^*} + \frac{w_M}{cL^*}(1 + \gamma \frac{M^*}{L^*}) > 0$ as follows

$$\frac{dw_L^*}{d\gamma} = -\frac{\frac{\partial \overline{\eta}_L^f}{\partial \gamma} \frac{w_L}{\overline{\eta}_L^f}}{\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L} \frac{w_L}{\overline{\eta}_L^f}} < 0 \qquad (25)$$

Differentiating the implicit wage formation (21) with respect to the factor price of outsourcing and unskilled wage formation gives

$$\left(1-\frac{\left[(\overline{\eta}_L^f-1)\frac{\partial\overline{\eta}_L^f}{\partial w_L}-\overline{\eta}_L^f\frac{\partial\overline{\eta}_L^f}{\partial w_L}\right]}{(\overline{\eta}_L^f-1)^2}\hat{b}_L\right)dw_L^*=\frac{\left[(\overline{\eta}_L^f-1)\frac{\partial\overline{\eta}_L^f}{\partial w_M}-\overline{\eta}_L^f\frac{\partial\overline{\eta}_L^f}{\partial w_M}\right]}{(\overline{\eta}_L^f-1)^2}\hat{b}_L dw_M \qquad (26)$$

which can be expressed as $\frac{dw_L^*}{dw_M}=-\frac{\frac{\partial\overline{\eta}_L^f}{\partial w_M}}{(\overline{\eta}_L^f-1)^2}\hat{b}_L\Bigg/\left(1+\frac{\frac{\partial\overline{\eta}_L^f}{\partial w_L}}{(\overline{\eta}_L^f-1)^2}\hat{b}_L\right)<0$ so that

$$\frac{dw_L^*}{dw_M}=-\frac{\frac{\partial\overline{\eta}_L^f}{\partial w_H}\frac{w_L}{\overline{\eta}_L^f}}{\overline{\eta}_L^f-1+\frac{\partial\overline{\eta}_L^f}{\partial w_L}\frac{w_L}{\overline{\eta}_L^f}}>0 \qquad (27)$$

where like in equation (11) we have

$$\frac{\partial\overline{\eta}_L^f}{\partial w_M}=\frac{(1+\beta)\gamma\, M^*}{w_M L^*}\left(\frac{M_{w_M}^* w_M}{M^*}-\frac{L_{w_M}^* w_M}{L^*}\right)+\frac{\gamma}{cL^*}(1-\frac{L_{w_M}^* w_M}{L^*})=-\frac{\gamma}{cL^*}\left[\beta+\gamma\frac{M^*}{L^*}((1+\beta)\gamma+\frac{w_M}{cM^*})\right]<0.$$

Therefore, lower factor price of outsourcing will have a wage moderating effect on the domestic unskilled wage due to the higher wage elasticity of the unskilled labour demand.

Moreover, and importantly, equations (23), (25) and (27) jointly with equation (15) imply $\frac{dw_H}{dc}<0$ and $\frac{dw_H}{d\gamma}>0$ and $\frac{dw_H}{dw_M}<0$ so that both the lower cost of outsourcing, the higher productivity of the outsourced low-skilled labour input and the lower factor price of outsourcing will have positive effects on the domestic skilled wage.

In terms of comparative statics of the unskilled the wage tax, the tax exemption and the outside option for unemployment benefit we have the following results (see Appendix B)

$$\frac{dw_L^*}{dt_L} = \left(\frac{\overline{\eta}_L^f}{\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L} \frac{w_L}{\overline{\eta}_L^f}} \right) \frac{b_L - e}{(1-t_L)^2} > 0 \text{ as } b_L - e > 0 \qquad (28a)$$

$$\frac{dw_L^*}{de} = -\left(\frac{\overline{\eta}_L^f}{\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L} \frac{w_L}{\overline{\eta}_L^f}} \right) \frac{t_L}{(1-t_L)} < 0 \qquad (28b)$$

$$\frac{dw_L^*}{db_L} = \left(\frac{\overline{\eta}_L^f}{\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L} \frac{w_L}{\overline{\eta}_L^f}} \right) \frac{1}{(1-t_L)} > 0 \qquad (28c)$$

According to (28a-28c) the effects of wage tax, tax exemption and outside option on low-skilled wage formation are qualitatively the same with and without outsourcing because $\left.\frac{dw_L^*}{dt_L}\right|_{M=0} = \frac{\beta}{(\beta-1)} \frac{b_L - e}{(1-t_L)^2} > 0$, $\left.\frac{dw_L^*}{de}\right|_{M=0} = -\frac{\beta}{(\beta-1)} \frac{t_L}{(1-t_L)} < 0$ and $\left.\frac{dw_L^*}{db_L}\right|_{M=0} = \frac{\beta}{(\beta-1)} \frac{1}{(1-t_L)} > 0$. Of course, in the absence of outsourcing the mark-up between outside option and wage formation $A|_{M=0} = \frac{\beta}{\beta-1} = \frac{1}{\rho(1-a)} > 1$ is higher than in the presence of outsourcing. Moreover, the equations (28a-c) imply jointly with equation (15) that $\frac{dw_H}{dt_L} < 0$, $\frac{dw_H}{de} > 0$ and $\frac{dw_H}{db_L} < 0$ so that the higher wage tax and the higher outside option of unskilled workers will decrease the wage for the skilled labour, while the higher tax exemption of low-skilled workers will increase the wage for the skilled labour.

Finally, differentiating the implicit wage formation (21) with respect to the wage of unskilled workers and the payroll tax gives

$$\left(1-\frac{\left[(\bar{\eta}_L^f-1)\frac{\partial\bar{\eta}_L^f}{\partial w_L}-\bar{\eta}_L^f\frac{\partial\bar{\eta}_L^f}{\partial w_L}\right]}{(\bar{\eta}_L^f-1)^2}\hat{b}_L\right)dw_L^*=\frac{\left[(\bar{\eta}_L^f-1)\frac{\partial\bar{\eta}_L^f}{\partial s}-\bar{\eta}_L^f\frac{\partial\bar{\eta}_L^f}{\partial s}\right]}{(\bar{\eta}_L^f-1)^2}\hat{b}_L ds\,, \qquad (29)$$

which can be expressed as follows

$$\frac{dw_L^*}{ds}=-\frac{\frac{\partial\bar{\eta}_L^f}{\partial s}\frac{w_L^*}{\bar{\eta}_L^f}}{\left[\bar{\eta}_L^f-1+\frac{\partial\bar{\eta}_L^f}{\partial w_L}\frac{w_L^*}{\bar{\eta}_L^f}\right]}<0 \qquad (30)$$

because the higher payroll tax will increase the wage elasticity of the unskilled labour, i.e. for the reason that we have

$$\frac{\partial\bar{\eta}_L^f}{\partial s}=(1+\beta)\gamma\left[\frac{L^*M_s^*-M^*L_s^*}{L^{*2}}\right]+\frac{\gamma w_M}{c}\left(-\frac{L_s^*}{L^{*2}}\right)=\frac{(1+\beta)\gamma M^*}{(1+s)L^*}\left(1+\frac{w_M}{cM^*}+\eta_s^f\right)+\frac{\gamma w_M}{(1+s)L^*c}\eta_s^f>0. \qquad (31)$$

Therefore, the payroll tax will have a wage moderating effect concerning the low-skilled workers' wage, because the payroll tax will have a positive effect on the wage elasticity. But in the absence of outsourcing it will have no effect on wage formation, i.e. $\left.\frac{\partial\bar{\eta}_L^f}{\partial s}\right|_{M=0}=0$ because $M=0$.

The total effect of the payroll tax on the skilled workers' wage is the following

$$\frac{dw_H}{ds}=\underbrace{\frac{\partial w_H}{\partial s}}_{-}+\underbrace{\frac{\partial w_H}{\partial w_L^*}}_{-}\underbrace{\frac{dw_L^*}{ds}}_{-}<0 \qquad (32)$$

(see Appendix C) where there is the negative direct effect and the positive indirect effect of the payroll tax, and the total effect is negative. In the absence of outsourcing this is also negative, because $\left.\frac{dw_L^*}{ds}\right|_{M=0} = 0.$

We can now summarize our findings in terms of the unskilled wage formation in the presence of outsourcing as follows.

Proposition 3 *In the presence of flexible outsourcing*

(a) the lower cost of outsourcing, the lower factor price of outsourcing and the higher productivity of outsourced production will decrease the wage for the unskilled labour and increase the wage for the skilled labour, thereby inducing higher wage dispersion, and

(b) the higher unskilled wage tax will increase the wage for the unskilled labour and decrease the wage for skilled labour and the higher unskilled wage tax exemption will decrease the wage for the unskilled labour and will increase the wage for the skilled labour, and these qualitative results are also similar but higher in the absence of outsourcing, whereas

(c) the higher payroll tax for the firms will decrease the wage for the unskilled and for the skilled labour. In the absence of outsourcing, the higher payroll tax for the firms will decrease the wage for the skilled labour, but has no effect on the wage of unskilled labour.

According to the first part of this proposition higher outsourcing due to lower outsourcing cost, higher productivity of outsourcing input and lower factor price of outsourcing is perfectly in line with the fact that the outsourced input is a substitute for the unskilled domestic labour and a complement for the skilled domestic labour. According to the second part of this proposition the qualitative effects of wage tax and tax exemption for the unskilled workers are not changed by flexible outsourcing. The third part of proposition reveals that in the absence of outsourcing the higher payroll tax will have no effect on the wage of the unskilled labour set by the monopoly union, but in the presence of flexible outsourcing the monopoly union will cut the wage it sets because the own wage elasticity of the unskilled labour will increase. Finally, the higher payroll tax will have a negative effect the wage for the skilled in the presence of outsourcing, and also in the absence of outsourcing.

V. The Impacts of Unskilled Wage Tax Progression

V.1. Employment Effects

Next we analyze the effect of wage tax progression on wage formation by the unskilled workers and labour demand. We assume that the tax reform will keep the relative tax burden per unskilled worker constant, which means

$$t_L - \frac{t_L e}{w_L} = R \tag{33}$$

The government can raise the degree of wage tax progression by increasing t_L and e and allowing change in w_L under the condition $dR = 0$. Formally we have

$$\left.\frac{de}{dt_L}\right|_{dR=0,} = \frac{\left(w_L^* - e + \frac{t_L e}{w_L^*}\frac{\partial w_L^*}{\partial t_L}\right)}{\left(t_L - \frac{t_L e}{w_L^*}\frac{\partial w_L^*}{\partial e}\right)} > 0 \tag{34}$$

Concerning the unskilled wage effect of this reform we have $dw_L^* = \frac{\partial w_L^*}{\partial t_L} dt_L + \frac{\partial w_L^*}{\partial e} de$ and dividing by dt_L and substituting the RHS of (34) for de/dt_L gives (see Appendix D)

$$\left.\frac{dw_L^*}{dt_L}\right|_{dR=0} = \frac{\left[\frac{\partial w_L^*}{\partial t_L} + \frac{(w_L^* - e)}{t_L}\frac{\partial w_L^*}{\partial e}\right]}{\left[1 - \frac{e}{w_L^*}\frac{\partial w_L^*}{\partial e}\right]} < 0 \tag{35}$$

so that a higher degree of wage tax progression, keeping the relative tax burden per unskilled worker constant, will decrease the unskilled wage rate. In the absence of outsourcing the qualitative effect is similar, i.e. $\left.\frac{dw_L^*}{dt_L}\right|_{dR=0,dM=0} < 0$ (see Appendix D).

Finally, we characterize the unskilled employment effect by raising tax progression keeping the relative tax burden per unskilled worker constant to increase t_L and e according to (34), so that we have the following employment effect $dL^* = \left[L^*_{w_L^*} + L^*_{w_H}\frac{\partial w_H}{\partial w_L^*}\right]\left[\frac{\partial w_L^*}{\partial t_L}dt_L + \frac{\partial w_L^*}{\partial e}de\right]$. Dividing this by dt_L and substituting the RHS of (34) for de/dt_L gives

$$\left.\frac{dL^*}{dt_L}\right|_{dR=0} = \left(L^*_{w_L^*} + L^*_{w_H}\frac{\partial w_H}{\partial w_L^*}\right)\left.\frac{dw_L^*}{dt_L}\right|_{dR=0.} = -\frac{L^*}{w_L^*}\left(\beta(1+\gamma\frac{M^*}{L^*}) + \gamma\frac{\gamma w_L(1+s)}{cL^*}\right)\underbrace{\left.\frac{dw_L^*}{dt_L}\right|_{dR=0}}_{-} > 0 \tag{36}$$

so that higher degree of wage tax progression keeping the relative tax burden per low-skilled worker constant, will increase the unskilled labour demand. These results (34) and (35) also happen in the case of domestic dual labour markets in the presence of strategic outsourcing (see Koskela and Poutvaara (2008)) and in the case of homogenous domestic labour markets (see Koskela and Schöb (2008)). The qualitative effect is similar in the absence of outsourcing.[8]

The total effect concerning direct and indirect effects of changes in unskilled wage on the skilled labour demand is zero, i.e. $dH^* = H^*_{w_L^*}dw_L^* + H^*_{w_H}\frac{\partial w_H}{\partial w_L^*}dw_L^*$ can be expressed using equation (12) as

$$\frac{dH^*}{dw_L^*} = H^*_{w_L^*} + H^*_{w_H}\frac{\partial w_H}{\partial w_L^*} = \frac{H^*}{w_L^*}\left[\frac{H^*_{w_L^*}w_L^*}{H^*} + \frac{H^*_{w_H}w_H}{H^*}\frac{\partial w_H}{\partial w_L^*}\frac{w_L^*}{w_H}\right] = \frac{H^*}{w_L^*}\left[-\varepsilon_L^H - \varepsilon_H^H\frac{\partial w_H}{\partial w_L^*}\frac{w_L^*}{w_H}\right] = 0 \tag{37}$$

8 This has been analyzed in the absence of outsourcing e.g. in Koskela and Vilmunen (1996) and in Koskela and Schöb (2002).

We can now summarize our findings in terms of the unskilled wage formation and labour demand in the presence of flexible outsourcing as follows.

Proposition 4 *In the presence of flexible outsourcing*

(a) *a higher degree of tax progression by raising the wage tax and the tax exemption for the unskilled workers to keep the relative burden per worker constant will decrease the wage rate and increase labour demand of unskilled workers,*

(b) *while it will have no effect on the labour demand of skilled workers and*

(c) *qualitatively similar effects arise in the absence of outsourcing.*

From the perspective of the labour union, an increase in tax progression changes the tradeoff between net wage rate and employment. An increasing progression encourages the labour union to moderate its wage demand, as the opportunity cost of a given new wage increases in terms of additional unemployment increases.

V.2. Welfare Effects

Now we analyze the welfare effects of unskilled wage tax progression on the unskilled trade union objective, the skilled Cobb-Douglas utility and the firm's profits by still assuming that the tax reform will keep the relative tax burden per unskilled worker constant.

The total effect of changes in tax parameters t_L and e on the objective function of unskilled workers $V^* = ((1-t_L)w_L^* + t_L e - b_L)L^* + b_L N = (\hat{w}_L - b_L)L^* + b_L N$ is $dV^* = V_{t_L}^* dt_L + V_e^* de + V_{w_L^*}^* dw_L^*$, where $V_{w_L^*}^* = 0$ according to the envelope theorem. To keep the relative tax burden per unskilled worker $t_L - \frac{t_L e}{w_L} = R$ constant means that $de\big|_{dR=0} = \frac{(w_L^* - e)}{t_L} dt_L + \frac{e}{w_L^*} dw_L^*$ and substituting the RHS of this for de in $dV^* = V_{t_L}^* dt_L + V_e^* de + V_{w_L^*}^* dw_L^*$ gives

$$\left.\frac{dV^*}{dt_L}\right|_{dR=0} = \underbrace{V_{t_L}^* + \frac{(w_L^* - e)}{t_L}V_e^*}_{=0} + \frac{e}{w_L^*}V_e^* \underbrace{\left.\frac{dw_L^*}{dt_L}\right|_{dR=0}}_{-} < 0 \qquad (38)$$

where $V_{t_L}^* = -(w_L^* - e)L^*$ and $V_e^* = t_L L^*$ so that $V_{t_L}^* + \frac{(w_L^* - e)}{t_L}V_e^* = 0$. Higher unskilled wage tax progression will decrease the welfare of unskilled workers by decreasing the wage rate. This also happens in the absence of outsourcing.

The total effect of changes in tax parameters t_L and e on the objective function of skilled workers $U^* = C^{*\mu}H^{*1-\mu} = ((1-t_H)w_H + t_H e_H)^{\mu} H^*$ is $dU^* = U_{t_L}^* dt_L + U_e^* de + U_{w_H}^* \frac{\partial w_H}{\partial w_L^*} dw_L^*$, where $U_{t_L}^* = U_e^* = 0$ so that we have

$$\left.\frac{dU^*}{dt_L}\right|_{dR=0} = U_{w_H}^* \underbrace{\frac{\partial w_H}{\partial w_L^*} \left.\frac{dw_L^*}{dt_L}\right|_{dR=0}}_{+} > 0 \qquad (39)$$

where

$$U_{w_H}^* = \mu(1-t_H)((1-t_H)w_H + t_H e_H)^{\mu-1} H^* + ((1-t_H)w_H + t_H e_H)^{\mu} \left[H_{w_L^*}^* + H_{w_H}^* \frac{\partial w_H}{\partial w_L^*} \right] > 0$$

because $\left[H_{w_L^*}^* + H_{w_H}^* \frac{\partial w_H}{\partial w_L^*} \right] = 0$ according to (37). Therefore, higher unskilled wage tax progression will increase the welfare of skilled workers as a result of higher skilled wage. This also happens in the absence of outsourcing.

Finally, the total effect of changes in tax parameters t_L and e on the firm's profit is $d\pi^* = \pi_{t_L}^* dt_L + \pi_e^* de + \pi_{w_L^*}^* dw_L^*$ and to keep $t_L - \frac{t_L e}{w_L} = R$ constant means that $de|_{dR=0} = \frac{(w_L^* - e)}{t_L} dt_L + \frac{e}{w_L^*} dw_L^*$ and substituting its RHS for de in $d\pi^* = \pi_{t_L}^* dt_L + \pi_e^* de + \pi_{w_L^*}^* + \pi_{w_H}^* \frac{\partial w_H}{\partial w_L^*} dw_L^*$ gives using the envelope theorem

$$\left.\frac{d\pi^*}{dt_L}\right|_{dR=0} = \pi^*_{t_L} + \frac{(w_L^* - e)}{t_L}\pi^*_e + \left(\pi^*_{w_L^*} + \pi^*_{w_H}\frac{\partial w_H^*}{\partial w_L^*} + \frac{e}{w_L^*}\pi^*_e\right)\underbrace{\left.\frac{dw_L^*}{dt_L}\right|_{dR=0}}_{-} \tag{40}$$

where $\pi = \left[H^a(L+\gamma M)^{1-a}\right]^\rho - \tilde{w}_H H - \tilde{w}_L L - w_M M - \frac{1}{2}cM^2$ so that $\pi^*_{t_L} = \pi^*_e = 0$, $\pi^*_L = \pi^*_H = \pi^*_M = 0$ and $M^* = \frac{(\gamma w_L(1+s) - w_M)}{c}$. We can rewrite (40) as follows

$$\left.\frac{d\pi^*}{dt_L}\right|_{dR=0} = \left(\pi^*_{w_L^*} + \pi^*_{w_H}\frac{\partial w_H}{\partial w_L^*}\right)\underbrace{\left.\frac{dw_L^*}{dt_L}\right|_{dR=0}}_{-} > 0 \tag{41}$$

where $\pi^*_{w_L^*} = -(1+s)(L+\gamma M^*) < 0$ and $\pi^*_{w_H} = -(1+s)H^* < 0$ and $\pi^*_{w_L^*} + \pi^*_{w_H}\frac{\partial w_H}{\partial w_L^*} < 0$ (see Appendix E). Therefore, higher unskilled wage tax progression by decreasing the unskilled wage will increase the firm's profit and the qualitative result is similar in the absence of outsourcing.

We can now summarize our findings in terms of the welfare effects of low-skilled tax progression in dual labour markets as follows.

Proposition 5 *In the presence of flexible outsourcing*

(a) a higher degree of tax progression, resulting from raising the wage tax and the tax exemption for the unskilled workers to keep the relative burden per worker constant, will decrease the welfare of unskilled workers, and

(b) it will increase the welfare of skilled workers as a result of higher skilled wage, and

(c) it will increase the profit of firms, and

(d) the effects of tax progression are qualitatively similar as in (a)-(c) also in the absence of outsourcing.

The welfare effects are driven by the changed labour union incentives, reported in Proposition 4. Increased tax progression reduces the monopoly rent that the labour union is able to extract, thus resulting in a lower welfare for the unskilled union members. At the same time, reduced unskilled wage rate obviously increases the profits of firms already in case the firms would not change their employment, and further when employment changes are accounted for. The skilled workers gain due to complementariness in production because higher unskilled wage tax progression will reduce unskilled wage, and therefore increasing the total use of unskilled labour by the firms.

VI. Conclusions

Most western European countries are characterized by dual labour markets, in which wages of some workers are set by labour unions, while other wages are determined competitively. In this paper we have studied how the presence of flexible outsourcing affects such an economy when the unskilled workers are unionized and the skilled workers are employed in competitive labour markets.

We have shown that in the presence of flexible outsourcing the own wage elasticity and the cross wage elasticity for the unskilled labour demand depend negatively on the cost of outsourcing, and the factor price of outsourcing and positively on the payroll tax, and these elasticities are independent of the cost of outsourcing and the payroll tax for the skilled labour demand. By assuming that the market equilibrium for the skilled wage follows from the equality of labour demand and labour supply and that the skilled workers have a Cobb-Douglas utility function, we find that the skilled wage depends negatively on the unskilled wage and the payroll tax, and it is independent of the skilled wage tax parameters. The skilled wage depends indirectly on the unskilled wage change and the productivity of outsourced production so that higher outsourcing cost will decrease, while higher productivity of unskilled labour input relative to the domestic labour input will increase the skilled wage.

In the presence of flexible outsourcing the lower cost of outsourcing, the lower factor price of outsourcing and the higher productivity of outsourced production will decrease the wage for the unskilled labour and increase the wage for the skilled labour, thereby inducing higher wage dispersion. Moreover, the higher unskilled wage tax will increase the wage for the unskilled labour and decrease the wage for skilled labour and the higher unskilled wage tax exemption will decrease the wage for the unskilled labour and will increase the wage for the skilled labour. The higher payroll tax for the firms will decrease the wage for the unskilled and skilled labour, while in the absence of outsourcing, the higher payroll tax for the firms will decrease the wage for the skilled labour, but has no effect on the wage of unskilled labour.

In the presence of flexible outsourcing raising the wage tax and the tax exemption for the unskilled workers to keep the relative burden per worker constant, this higher degree of tax progression will decrease the wage rate and increase labour demand of unskilled workers, while it will have no effect on the labour demand of skilled workers, and this also works in the absence of outsourcing. Concerning the welfare effects of unskilled wage tax progression on the unskilled trade union objective, the skilled Cobb-Douglas utility and the firm's profits, we have shown that this higher degree of tax progression will decrease the welfare of unskilled workers and increase the welfare of skilled workers as a result of higher skilled wage, while it will increase the profit of firms by decreasing the unskilled wage.

Our framework suggests several avenues for future research. First of all, we restricted the analysis of tax reforms to the effects of increasing tax progression for unskilled workers, so that their average tax rate stays the same. An alternative reform scenario would be to assume that the government has a given revenue requirement, and wage tax parameters are changed so that it is still satisfied. In that case, wage taxation would react also to employment changes. One could then also study the effects of a reform that would change the wage tax rate and the payroll tax rate. For example, what would be effects of increasing the unskilled wage tax rate and lowering the payroll tax, if the change is implemented such that the total government revenue from wage taxes and payroll taxes does not change? Moreover, it is important to study what would be the optimal linear labour tax structure in the presence of outsourcing?

Another important research question would be to compare the effects of flexible outsourcing, analyzed in this paper, with strategic outsourcing in Koskela and Poutvaara (2008). Which regime results in a higher level of outsourcing? How the wage rates of the unskilled and skilled workers differ? Which type of outsourcing results in more low-skilled unemployment? What are the effects on the welfare of different skill types and on the profit rates? Due to complexities involved, it appears that such an analysis would call for a computational general equilibrium model, allowing calculating the economic equilibrium in the two scenarios. Doing this is left for future research.

Finally, our research calls for additional empirical work. Establishing how common strategic and flexible outsourcing are in various industries, combined with a theoretical analysis that would compare their economic effects, would allow to estimate economic effects that increasing globalization can be expected to have on European Welfare States.

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Appendix A: Optimal Unskilled Labour Demand

Substituting the RHS of (4) for H into (3b) gives

$$\rho\left\{(\frac{w_L}{w_H})^a(\frac{a}{1-a})^a(L+\gamma M)^a(L+\gamma M)^{1-a}\right\}^{\rho-1}(1-a)(\frac{w_L}{w_H})^a(\frac{a}{1-a})^a(L+\gamma M)^a(L+\gamma M)^{-a} = \tilde{w}_L \tag{A1}$$

so that $$\rho\left\{(\frac{w_L}{w_H})^a(\frac{a}{1-a})^a(L+\gamma M)\right\}^{\rho-1}(1-a)(\frac{w_L}{w_H})^a(\frac{a}{1-a})^a = \tilde{w}_L \tag{A2}$$

which is equivalent to

$$(L+\gamma M)^{\rho-1}(\frac{w_L}{w_H})^{a\rho}(1-a)(\frac{a}{1-a})^{a\rho} = \rho^{-1}\tilde{w}_L \ . \tag{A3}$$

(A3) and (5) in its turn give (6). QED.

Appendix B: Optimal Wage Setting under Progressive Wage Taxation and Proportional Payroll Taxation

The first-order condition associated with $\underbrace{\max}_{(w_L)} \ V = ((1-t_L)w_L + t_L e - b_L)L$ s.t. $\pi_L = 0$

and $H^* = H^s$ can be written as follows

$$V_{w_L} = (1-t_L)w_L(1-(\eta_L^f + \eta_H^f \frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H})) + (b_L - t_L e)(\eta_L^f + \eta_H^f \frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H})$$

$$= (1-t_L)w_L\left((1-\gamma\frac{M^*}{L^*} - \gamma\frac{w_M}{cL^*} - (\varepsilon_L^L + \varepsilon_H^L \frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H})(1+\gamma\frac{M^*}{L^*})\right) + \qquad \text{(B1)}$$

$$(b_L - t_L e)(\gamma\frac{M^*}{L^*} + \gamma\frac{w_M}{cL^*} + (\varepsilon_L^L + \varepsilon_H^L \frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H})(1+\gamma\frac{M^*}{L^*})) = 0$$

where the own wage elasticity of labour demand is $\eta_L^f = \varepsilon_L^L\left(1+\gamma\frac{M^*}{L^*}\right) + \gamma\frac{M^*}{L^*} + \gamma\frac{w_M}{cL^*} = \varepsilon_L^L + \frac{\gamma}{L^*}\left((1+\varepsilon_L^L)M^* + \frac{w_M}{c}\right)$ and the cross wage elasticity is $\eta_H^f = \varepsilon_H^L\left(1+\gamma\frac{M^*}{L^*}\right)$ and the labour demand under payroll tax is $L^* = mw_L^{-\varepsilon_L^L} w_H^{-\varepsilon_H^L}(1+s)^{-\varepsilon} - \gamma\, M^* = mw_L^{-\varepsilon_L^L} w_H^{-\varepsilon_H^L}(1+s)^{-\varepsilon} - \gamma\left(\frac{\gamma w_L(1+s) - w_M}{c}\right)$. In the case of the C-D utility function we have

$$w_H = \left[\frac{\mu(1-a)}{ma}\right]^{-\frac{1}{\varepsilon_H^H}} w_L^{-\frac{\varepsilon_L^H}{\varepsilon_H^H}} (1+s)^{-\frac{\varepsilon}{\varepsilon_H^H}} \qquad \text{(B2)}$$

so that

$$\frac{\partial w_H}{\partial w_L} = -\frac{\varepsilon_L^H}{\varepsilon_H^H}\left[\frac{\mu(1-a)}{ma}\right]^{-\frac{1}{\varepsilon_H^H}} w_L^{-\frac{\varepsilon_L^H}{\varepsilon_H^H}-1}(1+s)^{-\frac{\varepsilon}{\varepsilon_H^H}} = -\frac{\varepsilon_L^H}{\varepsilon_H^H}\frac{w_H}{w_L} < 0\ . \qquad \text{(B3)}$$

Using (B2) and (B3) gives $\frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H} = -\frac{\varepsilon_L^H}{\varepsilon_H^H} = -\frac{\rho(1-a)}{1-\rho(1-a)} < 0$, which implies the equation (21) because

$$\varepsilon_L^L - \varepsilon_H^L\frac{\varepsilon_L^H}{\varepsilon_H^H} = \frac{\varepsilon_L^L\varepsilon_H^H - \varepsilon_H^L\varepsilon_L^H}{\varepsilon_H^H} = \frac{(1-\rho a)(1-\rho(1-a)) - \rho a\rho(1-a)}{(1-\rho(1-a))(1-\rho)} = \frac{1}{1-\rho(1-a)} = \beta > 1\,.$$

Differentiating (21) in terms of unskilled wage and wage tax rate gives

$$\left(1 - \frac{\left[(\bar{\eta}_L^f - 1)\frac{\partial\bar{\eta}_L^f}{\partial w_L} - \bar{\eta}_L^f\frac{\partial\bar{\eta}_L^f}{\partial w_L}\right]}{(\bar{\eta}_L^f - 1)^2}\hat{b}_L\right)dw_L^* = \frac{\bar{\eta}_L^f}{(\bar{\eta}_L^f - 1)}\frac{b_L - e}{(1-t_L)^2}dt_L \qquad \text{(B4)}$$

and using $\hat{b}_L = \frac{w_L(\overline{\eta}_L^f - 1)}{\overline{\eta}_L^f}$, (B4) can be expressed as

$$\left(1 + \frac{\frac{\partial \overline{\eta}_L^f}{\partial w_L}\frac{w_L}{\overline{\eta}_L^f}}{(\overline{\eta}_L^f - 1)} \right) dw_L^* = \frac{\overline{\eta}_L^f}{(\overline{\eta}_L^f - 1)} \frac{b_L - e}{(1 - t_L)^2} dt_L \tag{B5}$$

which gives (28a). Equations (28b) and (28c) can be derived in the similar way. QED.

Appendix C: The total effect of the payroll tax on the skilled workers' wage

Using equations (15), (16), (30) and (31) the equation (32) can be expressed as

$$\frac{dw_H}{ds} = -\frac{\varepsilon}{\varepsilon_H^H}\frac{w_H}{(1+s)} + \frac{\varepsilon_L^H}{\varepsilon_H^H}\frac{\frac{\partial \overline{\eta}_L^f}{\partial s}\frac{w_H}{\overline{\eta}_L^f}}{\left[\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L}\frac{w_L^*}{\overline{\eta}_L^f}\right]} \tag{C1}$$

so that

$$\frac{dw_H}{ds} = -\frac{\varepsilon w_H}{\varepsilon_H^H (1+s)}\left[1 - \frac{\varepsilon_L^H\left[\frac{\partial \overline{\eta}_L^f}{\partial s}\right]\frac{1}{\overline{\eta}_L^f}(1+s)}{\varepsilon\left[\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L}\frac{w_L^*}{\overline{\eta}_L^f}\right]}\right] =$$

$$= -\frac{w_H}{\varepsilon_H^H (1+s)\left[\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L}\frac{w_L^*}{\overline{\eta}_L^f}\right]}\left(\begin{array}{l} \varepsilon\left[\beta - 1 + (1+\beta)\frac{\gamma M^*}{L^*} + \frac{\gamma w_M}{cL^*}\right] + \\ \frac{1}{\overline{\eta}_L^f}\left[\frac{\partial \overline{\eta}_L^f w_L^*}{\partial w_L^*}\varepsilon - \frac{\partial \overline{\eta}_L^f}{\partial s}\varepsilon_L^H (1+s)\right] \end{array} \right)$$

$$= -\frac{w_H}{\varepsilon_H^H (1+s)\left[\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L}\frac{w_L^*}{\overline{\eta}_L^f}\right]}\left(\begin{array}{l} \varepsilon\left[\beta - 1 + (1+\beta)\frac{\gamma M^*}{L^*} + \frac{\gamma w_M}{cL^*}\right] + \\ \frac{1}{\overline{\eta}_L^f}\left[\begin{array}{l} \varepsilon(1+\beta)\gamma\frac{M^*}{L^*}(1 + \frac{w_M}{cM^*} + \eta_L^f) + \varepsilon\gamma\frac{w_M}{cL^*}\eta_L^f - \\ \varepsilon_L^H(1+\beta)\gamma\frac{M^*}{L^*}(1 + \frac{w_M}{cM^*} + \eta_s^f) - \varepsilon_L^H\gamma\frac{w_M}{cL^*}\eta_s^f \end{array} \right] \end{array} \right) < 0$$

(C2)

QED.

Appendix D: Tax Progression and Unskilled Labour Demand

Substituting the RHS of (34) into $dw_L^* = \frac{\partial w_L^*}{\partial t_L} dt_L + \frac{\partial w_L^*}{\partial e} de$ implies

$$\left.\frac{dw_L^*}{dt_L}\right|_{dR=0} = \frac{\left(\frac{\partial w_L^*}{\partial t_L} t_L (1 - \frac{e}{w_L^*}\frac{\partial w_L^*}{\partial e}) + \frac{\partial w_L^*}{\partial e}(w_L^* - e) + \frac{\partial w_L^*}{\partial e}\frac{t_L e}{w_L^*}\frac{\partial w_L^*}{\partial t_L}\right)}{t_L\left[1 - \frac{e}{w_L^*}\frac{\partial w_L^*}{\partial e}\right]} \tag{D1}$$

which gives (35), where the denominator is positive. Concerning the numerator $\frac{\partial w_L^*}{\partial t_L} + \frac{(w_L^* - e)}{t_L}\frac{\partial w_L^*}{\partial e}$ in (35) we obtain that it is negative, i.e.

$$\frac{\partial w_L^*}{\partial t_L} + \frac{(w_L^* - e)}{t_L}\frac{\partial w_L^*}{\partial e} = \frac{D}{(1-t_L)^2}(b_L - \hat{w}_L) < 0 \tag{D2}$$

where $D = \frac{\overline{\eta}_L^f}{\overline{\eta}_L^f - 1 + \frac{\partial \overline{\eta}_L^f}{\partial w_L}\frac{w_L}{\overline{\eta}_L^f}} > 0$ and $b_L - \hat{w}_L = b_L - (w_L^*(1-t_L) + t_L e) < 0$. In the absence of outsourcing we have the same qualitative result $\left.\frac{dw_L^*}{dt_L}\right|_{dR=0,M=0} = \left[\frac{\partial w_L^*}{\partial t_L} + \frac{(w_L^* - e)}{t_L}\frac{\partial w_L^*}{\partial e}\right]_{M=0} = \frac{\beta}{(\beta-1)(1-t_L)^2}(b_L - \hat{w}_L) < 0$. QED.

Appendix E: Tax Progression and Welfare Effect of Firms

Concerning $\left(\pi_{w_L^*}^* + \pi_{w_H}^* \frac{\partial w_H}{\partial w_L^*}\right)$ in equation (41) we have $\pi_{w_L^*}^* = -(1+s)(L^* + \gamma M^*) < 0$ and $\pi_{w_H}^* = -(1+s)H^* < 0$ so that

$$\pi_{w_L^*}^* + \pi_{w_H}^* \frac{\partial w_H}{\partial w_L^*} = -(1+s)\left[L^* + \gamma M^* + H^* \frac{\partial w_H}{\partial w_L^*}\right] = -(1+s)\left[L^* + \gamma M^* - H^* \frac{\varepsilon_L^H}{\varepsilon_H^H}\frac{w_H}{w_L^*}\right] \tag{E1}$$

where $L^* + \gamma M^* = m w_L^{*-\varepsilon_L^L} w_H^{-\varepsilon_H^L}(1+s)^{-\varepsilon}$,

$-H^* \frac{\varepsilon_L^H}{\varepsilon_H^H}\frac{w_H}{w_L^*} = -\frac{m\rho a}{1-\rho(1-a)} w_H^{1-\varepsilon_H^H} w_L^{*-1-\varepsilon_L^H}(1+s)^{-\varepsilon}$. Using $\varepsilon_H^H - 1 = \varepsilon_H^L$ and $\varepsilon_L^H + 1 = \varepsilon_L^L$ equation (E1) can be expressed as

$$\pi_{w_L^*}^* + \pi_{w_H}^* \frac{\partial w_H}{\partial w_L^*} = -(L^* + \gamma M^*)\frac{1-\rho}{1-\rho(1-a)} < 0. \text{ QED} \tag{E2}$$