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ABSTRACT

The Role of Profit Sharing in a Dual Labour Market with Flexible Outsourcing*

We analyze the following questions associated with flexible outsourcing under partly imperfect dual domestic labour markets, where high skilled workers participate in firm's profit via profit sharing: How does the implementation of profit sharing influence flexible outsourcing? What is the relationship between outsourcing cost, profit sharing and wages? We show that profit sharing has a positive effect on low skilled wage and thus an outsourcing enhancing character. The wages of both types of labour are negatively correlated and lower outsourcing cost can increase the wage dispersion by decreasing the low skilled wage and raising the high skilled wage. The overall effect of profit sharing on high skilled wage is ambiguous due to a positive direct effect and a negative indirect effect via the low skilled wage.

JEL Classification: E23, E24, H22, J23, J51, J82

Keywords: flexible outsourcing, dual labour market, profit sharing, labour market imperfection, employee effort

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I. Introduction

In an integrated world, marginal cost differences are the driving force for the reallocation of production parts (offshoring) and for the make-or-buy-decision (outsourcing). Especially for western European countries, the wage and labour cost differences constitute the central explanation for the increasing business practice of offshoring and international outsourcing to eastern European or Asian countries.[1] Reasons for the wage gaps are, among others, differences in labour market institutions and in the process of wage determination. In most western European countries, wages are determined by bilateral bargaining between firms or employer federations and trade unions. In eastern European or Asian countries, however, unions are much weaker so that wages are determined by market forces. Typically low-skilled workers in western Europe are unionized so that labour unions are able to push for their relatively high wages at the cost of a higher unemployment in continental Europe than in the United States (see e.g. Freeman and Schettkat (2001)). In opposite to the low skilled, the wages of skilled workers are mostly determined competitively.[2]

Since western European firms have the opportunity to buy foreign intermediate goods after knowing the domestic wage levels and so the marginal production cost, this will affect the domestic wage formation process for both types of workers. The threat of flexible outsourcing as a reaction to high domestic marginal production cost will dampen the opportunity of the trade union to realize a high wage level for the low skilled. To induce them to abstain from external procurement of intermediate goods, western European firms need lower marginal cost. Since both, wages for skilled and unskilled, affect the marginal production cost, there are two components to reduce marginal cost. If lower wages are not possible, firms have to increase their productivity. One channel to increase productivity is to stimulate workers' effort. The firm may

[1] See Amiti and Wei (2005) and Rishi and Saxena (2004), which 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 concentrate on labour market frictions that arise with search, while we focus on the role of labour unions in the case of unskilled wage formation.

introduce a profit sharing scheme that lets workers participate in the firm's success. The implementation of profit sharing will induce incentives to increase effort and thus productivity for given wage levels. Empirical studies show that profit sharing is an important phenomenon in many OECD countries. Pendleton et al. (2001) have presented detailed data on profit sharing schemes in 14 OECD countries.[3] However, only high skilled workers, such as managers, often realize profit sharing as a part of their income. So they participate in the firm's success, which is positively influenced by their effort. But profit sharing will also affect wage formation for low and high skilled workers. Since a part of the wage income can be substituted by profit income, profit sharing can probably affect the base wage for the high skilled worker. Although higher effort of skilled workers provides higher productivity and thus raises the firm's profit, which opens the opportunity for the trade union to pick up a higher share of this profit by demanding a higher wage for low skilled workers. However, this dampens the advantage of domestic production and increases outsourcing activities. As profit sharing is now commonly incorporated in the compensation schemes and international outsourcing has recently increased, e.g. in western EU-countries and in the United States, it is important to study the implications of profit sharing and wage bargaining on flexible outsourcing in a partly dual labour market.

Concerning the analysis of the effects of outsourcing on compensation schemes under wage bargaining, there are two focuses in the literature, the case of committed and flexible outsourcing. While in the committed case outsourcing takes place before wage bargaining[4], in the flexible case outsourcing is decided after wage bargaining. Our focus in this paper is to assume that outsourcing is flexible, i.e. determined simultaneously with domestic labour demand, but after wage formation for low skilled

[3] See also Conyon and Freeman (2001).

[4] See e.g. Perry (1997) for an overview about the relationship between outsourcing and wage bargaining. Also e.g. Danthine and Hunt (1994) and Zhao (1998, 2001) have studied the effects of international outsourcing and foreign direct investment on wage formation in the home country. They showed that higher product market integration implies intensified product market competition, which moderates wage increases in unionized labour markets. Skaksen and Sorensen (2001) have studied the effects of trade unions on firms' foreign direct investments, which are made prior to the stage of the wage bargaining. Lommerud et al. (2008, 2006) have presented a theoretical model with monopolistic and oligopolistic competition to determine how unionization affects the fraction of outsourced inputs.

workers. To our knowledge, the first one, who studied the effects of flexible outsourcing on wage setting, is Skaksen (2004).[5] Also, Braun and Scheffel (2007b) have developed a simple two-stage game between a monopoly union and a firm by assuming that the labour union sets wages before the firm decides on the degree of outsourcing. But in these papers they have abstracted from the analysis of profit sharing as a part of the compensation scheme or heterogeneity of labour force, which is our focus.[6] Concerning the wage effect of profit sharing, Koskela and Stenbacka (2006) have studied the differences between committed and flexible profit sharing, but both in the absence of outsourcing and heterogeneous labour market. An analysis on the interaction of different profit sharing schemes and outsourcing, in strategic (committed) and flexible case, is done by Koskela and König (2008a, 2008b). However they also focus on homogenous labour force.

We extend their work by allowing for two types of workers[7] in dual labour markets by providing answers to the following question: How does the implementation of profit sharing for high skilled workers influence outsourcing activities? Since the firm is flexible to decide about the amount of outsourcing after decisions are made concerning wage negotiation for the low skilled and profit sharing for the high skilled, these income parts are influenced by outsourcing costs. By analyzing our main question, we thus also find answers to: How do the opportunity of flexible outsourcing and its cost influence the wage for both types of workers and profit sharing? And, what is the relationship between profit sharing and wage levels? We analyze these questions

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5 He has analyzed the implications of outsourcing, in terms of both potential (non-realized) and realized international outsourcing, for wage setting and employment under imperfectly competitive labour markets.

6 There are also some new analyses, which incorporated flexible outsourcing and wage bargaining, e.g. Koskela and Poutvaara (2008a), Koskela and Schöb (2008) or Koskela (2008). But the main focuses in these papers are labour taxation issues in the absence of profit sharing and worker heterogeneity.

7 Koskela and Stenbacka (2007) analyze strategic outsourcing in a dual labour market in the presence of wage solidarity by the labour union. Analyzing flexible outsourcing in a dual labour market is also done by Koskela and Poutvaara (2008b), but they are interested in taxation effects in the absence of profit sharing. For an introduction into the debate on dual labour markets see Saint-Paul (1996). His focus is on dual labour market with identical workers by looking on the dynamic efficiency wage models, but there is also a part with heterogeneous workers. However, this research is also in the absence of both outsourcing and profit sharing.

in a partial equilibrium model in which we assume a time sequence of the profit sharing decision, where firms commit to profit sharing *before* the base wage formation.

We find that in this case, the wage of the high skilled will be negatively affected by the wage of the low skilled. For the effect of implementing committed profit sharing we show that it will have a direct effect on the skilled wage, which has a supplementary character, but a negative indirect effect via the effect on the wage for the low skilled worker. Thus the overall effect on high skilled wage is ambiguous. We also show that lower outsourcing cost leads to falling wages for the low skilled. Since the high skilled wage does not directly depend on outsourcing cost, thus the high skilled wage is only affected indirectly via low skilled wage. Here, lower outsourcing cost will increase the high skilled wage and will thus raise the wage dispersion. Since outsourcing demand is only affected by the relation of low skilled worker wage and outsourcing cost, profit sharing will have an enhancing indirect effect on outsourcing activities.

We proceed as follows. Section II presents the basic structure of theoretical framework and two different time sequences in terms of profit sharing decision. Labour demand, outsourcing and employee effort and skilled wage formation are presented in Section III. Section IV investigates the low skilled wage formation by monopoly labour union with committed profit sharing. Finally, we present conclusions in section V.

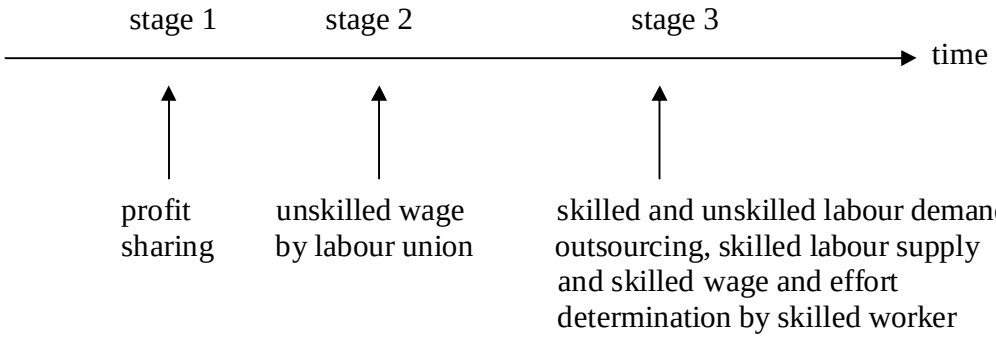
II. Basic Framework

We analyze a model with heterogeneous domestic workers, i.e. dual domestic labour market, flexible international outsourcing and committed profit sharing. The production combines labour services by effective skilled workers and unskilled workers. Effective skilled employment is a combination of absolute skilled employment and the effort by skilled workers, i.e. their productivity. Following empirical studies, we assume that low skilled workers and outsourcing activities are substitutes, so that unskilled labour services can be provided either by the firm's own workers, or obtained from abroad through international outsourcing. We assume that the firm may be flexible enough to decide upon the amount of outsourcing activity after the wage for

low skilled worker is set by the labour union. The analyzed timing decision is summarized in Figure 1. The timing structure captures the idea that the representative firm decides profit sharing before the monopoly trade union sets the unskilled wage.

Figure 1: time sequences of decision

Flexible outsourcing and committed profit sharing



In this timing structure profit sharing is assumed to be committed at stage 1 and at stage 2 conditional on profit sharing, 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 labour force. At stage 3, firms decide on domestic employment and international outsourcing. The wage of the skilled labour adjusts to equalize labour demand and labour supply and, moreover, the representative skilled worker decides on effort provision. The decisions at each stage are analyzed by using backward induction.

III. Labour Demand, Outsourcing Decision, Employee Effort and Skilled Wage Formation

III.1. Labour Demand and Outsourcing

At the last stage, the representative skilled worker decides on the effort e and the representative firm decides on the skilled labour demand H, the unskilled labour demand L, and outsourcing M. The firm decides domestic labour demand and outsourcing to maximize the profit function

$$\underbrace{Max}_{(H,L,M)} \pi = F(eH, L, M) - w_H H - w_L L - g(M) \tag{1}$$

by taking the skilled worker's effort, e, the negotiated unskilled and skilled wages, w_L and w_H, as well as profit sharing, τ, as given. In order to obtain M units of outsourced unskilled labour input, we assume that firms also have to spend $g(M) = 0{,}5cM^2$ with $g'(M) = cM > 0$ and $g''(M) = c > 0$. This increasing marginal cost of outsourcing captures the idea that there are some other costs associated with outsourcing as the price for the intermediate goods. Such cost could be communication cost or cost for quality proofing.

In case of our production function, we partly 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. $F(eH, L, M) = \left[(eH)^a (L+M)^{1-a}\right]^\rho$, where the parameters ρ and a are assumed to satisfy the assumption: $0 < \rho; a < 1$. From (1) we can derive the marginal products of skilled labour, unskilled labour and outsourcing: $F_H = \rho Y^{\rho-1} a e^a H^{a-1} (L+M)^{1-a}$ and $F_L = \rho Y^{\rho-1} e^a H^a (1-a)(L+M)^{-a} = F_M$, with $Y = (eH)^a (L+M)^{1-a}$. The outsourced unskilled labour input affects the marginal products of the domestic skilled and unskilled labour inputs as follows:

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

and

$$F_{LM} = -\rho Y^{\rho-1}(eH)^{a}(1-a)(L+M)^{-a-1}\underbrace{[1-\rho(1-a)]}_{+} < 0.$$

Taking these, we can conclude that for our type of 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.[8] Also, one can calculate from the production function that the domestic skilled and unskilled labour are complements, i.e. $F_{HL} = \rho^2 Y^{\rho-1} a e^{a} H^{a-1}(1-a)(L+M)^{-a} > 0$. Using the marginal products we can calculate the first-order conditions characterizing the domestic skilled and unskilled labour demand and outsourcing activities

$$\pi_H = \rho\left[(eH)^{a}(L+M)^{1-a}\right]^{\rho-1} a e^{a} H^{a-1}(L+M)^{1-a} - w_H = 0 \qquad (2a)$$

$$\pi_L = \rho\left[(eH)^{a}(L+M)^{1-a}\right]^{\rho-1}(1-a)(eH)^{a}(L+M)^{-a} - w_L = 0 \qquad (2b)$$

$$\pi_M = \rho\left[(eH)^{a}(L+M)^{1-a}\right]^{\rho-1}(1-a)(eH)^{a}(L+M)^{-a} - cM = 0. \qquad (2c)$$

These first-order conditions (2a) and (2b) imply the relationship between the skilled (H) and the unskilled labour inclusive of outsourcing $(L+M)$ as follows

$$H = \frac{w_L}{w_H}\frac{a}{1-a}(L+M). \qquad (3)$$

Using (2b) and (2c) we get the demand for outsourcing as

$$M = \frac{w_L}{c}, \qquad (4)$$

[8] Ethier (2005) has introduced a partly related production function to analyze the decision between international outsourcing and in-house production this analysis of the effect of globalization on the skill premium.

where $\frac{M_{w_L} w_L}{M} = 1$, and $-\frac{M_c c}{M} = 1$. According to equation (4) higher unskilled domestic wage rate, and lower outsourcing cost will increase outsourcing.

Substituting the RHS of (3) into (2b) gives the unskilled labour demand, which can be expressed as follows (see Appendix A)

$$L = m w_L^{-\delta} w_H^{-\varepsilon} e^{\varepsilon} - M = m w_L^{-\delta} w_H^{-\varepsilon} e^{\varepsilon} - \left(\frac{w_L}{c} \right), \tag{5}$$

where $m = \left[\rho a^{a\rho} (1-a)^{1-a\rho} \right]^{\frac{1}{1-\rho}} > 0$, $\delta = \frac{1-\rho a}{1-\rho} > 1$ and $\varepsilon = \frac{\rho a}{1-\rho} > 0$, with δ as the own wage elasticity and ε as the cross wage elasticity in the absence of outsourcing. According to (5), a more extensive outsourcing activity will decrease the unskilled labour demand, which shows again the substitutability of low skilled labour and international outsourcing, which is consistent with empirical evidence. As we can see, higher own wage and cross wage and lower high skilled effort will affect negatively the unskilled labour demand. In the presence of outsourcing the wage elasticities of the unskilled labour, $-\frac{L_{w_L} w_L}{L}\Big|_{M>0} = \eta_L$ and $-\frac{L_{w_H} w_H}{L}\Big|_{M>0} = \eta_H$, and the effort elasticity of the unskilled labour $\frac{L_e e}{L}\Big|_{M>0} = \eta_e$ can be written as follows

$$\eta_L = \delta\left(1 + \frac{M}{L}\right) + \frac{M}{L} = \delta + (1+\delta)\frac{M}{L} = \delta + (1+\delta)\frac{w_L}{cL} \tag{6a}$$

$$\eta_H = \varepsilon\left(1 + \frac{M}{L}\right) = \varepsilon\left(1 + \frac{w_L}{cL}\right) = \eta_e . \tag{6b}$$

Of course, in the absence of outsourcing both the wage and effort elasticities are constant and smaller, i.e. $\eta_L\big|_{M=0} = \delta$ and $\eta_H\big|_{M=0} = \eta_e\big|_{M=0} = \varepsilon$.

Using the wage elasticities (6a) and (6b) we find that $\frac{\partial \eta_L}{\partial M} = \frac{(1+\delta)}{L}\left(1+\frac{M}{L}\right) > 0$ and $\frac{\partial \eta_H}{\partial M} = \frac{\varepsilon}{L}\left(1+\frac{M}{L}\right) = \frac{\partial \eta_e}{\partial M} > 0$ so that when outsourcing will increase, the own wage and cross wage elasticities of the unskilled labour demand increase. These are also in conformity with empirical evidence. The effects of outsourcing cost on the own wage and the cross wage elasticity of unskilled labour are

$$\frac{\partial \eta_L}{\partial c} = (1+\delta)\cdot\left[\frac{(LM_c - ML_c)}{L^2}\right] = -(1+\delta)\frac{M}{cL}\left(1+\frac{M}{L}\right) < 0 \tag{7a}$$

$$\frac{\partial \eta_H}{\partial c} = \varepsilon\cdot\left[\frac{(LM_c - ML_c)}{L^2}\right] = -\varepsilon\frac{M}{cL}\left(1+\frac{M}{L}\right) = \frac{\partial \eta_e}{\delta c} < 0 \tag{7b}$$

so that lower outsourcing cost will increase the wage elasticities of domestic unskilled labour demand.[9]

Finally, substituting the RHS of equation (5) into the relationship in equation (3) gives the following labour demand for the representative skilled worker

$$H = \frac{ma}{1-a} w_H^{-(1+\varepsilon)} w_L^{-(\delta-1)} e^{\varepsilon}, \tag{8}$$

where $(1+\varepsilon) = -\frac{H_{w_H} w_H}{H} = \frac{1-\rho(1-a)}{1-\rho} > 1$, $(\delta-1) = -\frac{H_{w_L} w_L}{H} = \frac{\rho(1-a)}{1-\rho} > 0$ and $\varepsilon = \frac{\rho a}{1-\rho} > 0$. These elasticities are also higher with weaker decreasing returns to scale, but unlike in the case with unskilled labour, both the own wage and cross wage labor demand elasticities and the effort elasticity for the skilled labour are independent of outsourcing. As for unskilled demand, higher own wage, cross wage and the lower effort will of course affect negatively the skilled labour demand.

[9] See e.g. Hasan et al. (2007), Slaughter (2001) and Senses (2006), who have provided empirical evidence according to which international trade has increased the wage elasticity of low-skilled labour demand.

We can now summarize our findings of an asymmetry in how the demands for skilled and unskilled labour react to the cost of outsourcing as follows.

Proposition 1: *In the presence of flexible outsourcing*

(a) the own wage, the cross wage and the effort elasticity for the unskilled labour demand depend negatively on the cost of outsourcing, and positively on the amount of outsourcing, whereas

(b) the own wage, the cross wage and the effort elasticity for the skilled labour demand are independent of the cost of outsourcing.

III.2. Wage Formation for Skilled Workers

III.2.1 Optimal Labour Supply and Effort Determination 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. The high skilled labour supply is assumed to be constant, i.e. $H^s = \mu$.[10] Taking this assumption into account, we derive the high skilled wage from market equilibrium by taking the low-skilled wage w_L as given.

The effort determination of the skilled worker is assumed to be determined as follows: The effort provision of the skilled worker is associated with a disutility, which is assumed to satisfy the function $h(e) = \gamma e^{1/\gamma}$ with $0 < \gamma < 1$ so that it is convex, $h'(e) = e^{(1/\gamma)-1} > 0$ $h''(e) = [(1/\gamma)-1]e^{(1/\gamma)-2} > 0$. Under constant labour supply the overall utility only depends on the profit income and the disutility of effort as the difference between profit income and the sum of disutility of effort $S = \tau\pi - H \cdot h(e)$. We assume identical high skilled worker, so that the individual utility function for the employed

[10] A central finding in the empirical labour market literature is that low skilled 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). To provide a relative simple model, we adopt this strong assumption for high skilled labour supply.

high skilled worker in terms of profit sharing, firm's profit and disutility of effort can be written as

$$U = \frac{S}{H} = \tau \frac{\pi}{H} - h(e), \tag{9}$$

where τ is profit sharing and π the representative firm's profit. Equation (9) shows that every skilled worker gets the same per capita profit income, but he/she realizes the individual disutility for providing a certain effort level. The optimal individual provided effort level results from individual utility maximization of (9) with respect to effort, which yields the first-order condition

$$U_e = \frac{\tau}{H} \pi_e - h'(e) = 0 . \tag{10}$$

Using $h'(e) = e^{1/\gamma - 1} > 0$ calculating π_e / H, equation (10) implies (see Appendix B)

$$e = K(\tau \; w_H)^{\gamma}, \tag{11}$$

where $K = \left[\rho m^{-(1-\rho)} a^{a\rho} (1-a)^{1-a\rho}\right]^{\gamma}$ and $\gamma = \frac{e_\tau \tau}{e} = \frac{e_{w_H} w_H}{e}$ is the elasticity of the representative skilled worker's effort with respect to profit sharing and the skilled wage.[11] Therefore, the optimal effort by the representative skilled worker is influenced positively by the income parts, $e_{w_H} = \frac{\gamma \, e}{w_H} > 0$ and $e_\tau = \frac{\gamma \, e}{\tau} > 0$, so that both the base wage and profit sharing enhance the productivity by increasing effort provision and

[11] The case of zero effort elasticity describes a firm, where individual worker has no influence on the firm's profit. Thus she/he has no incentive to increase effort and will provide only a minimum effort level of one. By implementing profit sharing the firm distributes only a part of its profit to the worker without effects on effort or profit. So it is beneficial for the firm to avoid profit sharing. In this scenario the optimal profit share will be zero (see Koskela and König (2008a, b)). Since we are analyzing the effect of implementing profit sharing we assume positive effort elasticity.

positively affect labour demand indirectly.[12] But outsourcing will have no direct effect in case of perfect substitutability between outsourcing and domestic unskilled labour.

III.2.2 Market Equilibrium for Skilled Wage Formation

Unlike in the case of unskilled 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 our constant labour supply, $H^s = \mu$, the equality $H = H^s$ gives $\frac{ma}{1-a} w_H^{-(1+\varepsilon)} w_L^{-(\delta-1)} e^{\varepsilon} = \mu$, which allows to solve $w_H = \left[\frac{\mu(1-a)}{ma}\right]^{-\frac{1}{1+\varepsilon}} w_L^{-\left(\frac{\delta-1}{1+\varepsilon}\right)} e^{\frac{\varepsilon}{1+\varepsilon}}$, and by using $X = \left[\frac{\mu(1-a)}{ma}\right]^{-\frac{1}{1+\varepsilon}}$ and $e = K(\tau\, w_H)^{\gamma}$, we can rewrite it explicitly as follows

$$w_H = N w_L^{-\left(\frac{\delta-1}{1+\varepsilon(1-\gamma)}\right)} \tau^{\frac{\varepsilon\gamma}{1+\varepsilon(1-\gamma)}} \tag{12}$$

where $N = X^{\frac{1+\varepsilon}{1+\varepsilon(1-\gamma)}} K^{\frac{\varepsilon}{1+\varepsilon(1-\gamma)}} > 0$. Knowing this, we can look on comparative statics of w_H in terms of w_L:

$$\frac{\partial w_H}{\partial w_L} = -\left(\frac{\delta-1}{1+\varepsilon(1-\gamma)}\right) N w_L^{-\left(\frac{\delta-1}{1+\varepsilon}\right)-1} \tau^{\frac{\varepsilon\gamma}{1+\varepsilon(1-\gamma)}},$$

so that

$$\frac{\partial w_H}{\partial w_L} = -\frac{(\delta-1)}{1+\varepsilon(1-\gamma)} \frac{w_H}{w_L} < 0. \tag{13}$$

[12] This finding lies in conformity with empirics (see e.g. Booth and Frank (1999), Cable and Wilson (1990), Cahuc and Dormont (1997), Kruse (1992) and Wadhwani and Wall (1990)). Also in the theoretical focus of the literature we find evidence of increasing effort by higher wages, see e.g. Lin et al. (2002).

Equation (13) lies in conformity with empirics concerning the negative relationship between skilled and unskilled wages in the presence of outsourcing.[13]

Differentiating (12) with respect to profit sharing τ gives the direct effect on the high skilled wage

$$\frac{\partial w_H}{\partial \tau} = \frac{\varepsilon\gamma}{1+\varepsilon(1-\gamma)}\frac{w_H}{\tau} > 0\,. \tag{14}$$

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 skilled wage depends negatively on the unskilled wage and positively in a direct way on profit sharing, and

(b) the skilled wage is also directly independent of the cost of outsourcing, but depends on the unskilled wage, so that higher outsourcing cost affects indirectly, whereas

(c) the skilled effort depends positively both on the skilled wage and profit sharing.

These results are intuitively in our setting. Since high and low skilled labour are complements a higher low skilled wage will reduce both labour demands. Thus in the competitive wage formation for high skilled labour the lower labour demand for given labour supply will induce a smaller high skilled wage, ceteris paribus. The positive direct effect of profit sharing can be explained as follows. Higher profit sharing will increase the effort, which leads for given wage level to a higher productivity. This increases labour demand and results in a higher wage for given labor supply**.**

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

IV. Unskilled Wage Formation by Monopoly Labour Union under Committed Profit Sharing

Now we analyze the wage formation of unskilled workers, which takes place in anticipation of optimal labour and outsourcing decisions by the firm. We analyze the wage formation by the monopoly labour 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 and of market equilibrium for the high-skilled wage w_H.[14]

IV.1. Wage Formation by the Monopoly Labour Union under Committed Profit Sharing

The objective function of the labour union of unskilled workers is assumed to be $V = (w_L - b_L)L + b_L N$, where b_L is the (exogenous) outside option available for 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

$$\underbrace{\max}_{w_L} \; V = (w_L - b_L)L + b_L N \tag{15}$$

s.t. $$L = m w_L^{-\delta} w_H^{-\varepsilon} e^{\varepsilon} - M = m w_L^{-\delta} w_H^{-\varepsilon} e^{\varepsilon} - \left(\frac{w_L}{c}\right)$$ and

$H = \frac{ma}{1-a} w_H^{-(1+\varepsilon)} w_L^{1-\delta} e^{\varepsilon} = H^s = \mu$, which implies $w_H = N w_L^{-\left(\frac{\delta - 1}{1+\varepsilon(1-\gamma)}\right)} \tau^{\frac{\varepsilon\gamma}{1+\varepsilon(1-\gamma)}}$ (see equation (12)).

The first-order condition associated with (15) is

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

$$V_{w_L} = \frac{L}{w_L}\left[w_L + (w_L - b_L)\frac{w_L}{L}\frac{dL}{dw_L} \right] = 0, \tag{16}$$

with $\frac{dL}{dw_L} = \frac{\partial L}{\partial w_L} + \frac{\partial L}{\partial w_H} \cdot \frac{\partial w_H}{\partial w_L}$. Plug in the labour demand reaction in equation (16), we have $V_{w_L} = \frac{L}{w_L}\left[w_L + (w_L - b_L)\left(\frac{\partial L}{\partial w_L} \cdot \frac{w_L}{L} + \frac{\partial L}{\partial w_H} \cdot \frac{w_H}{L} \cdot \frac{w_L}{w_H} \cdot \frac{\partial w_H}{\partial w_L} \right) \right] = 0$. Simplifying this expression leads to

$$V_{w_L} = w_L\left[1 - \left(\eta_L + \eta_H \frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H} \right) \right] + b_L\left(\eta_L + \eta_H \frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H} \right) = 0, \tag{17}$$

where $\frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H} = -\frac{(\delta - 1)}{1 + \varepsilon(1-\gamma)}$, the own wage elasticity of unskilled labour demand is $\eta_L = \delta + (1+\delta)\frac{w_L}{cL}$ and the cross wage elasticity of unskilled labour demand $\eta_H = \varepsilon\left(1 + \frac{w_L}{cL} \right) = \eta_e$. These unskilled labour demand elasticities are not constant because the unskilled labour demand, $L = m w_L^{-\delta} w_H^{-\varepsilon} e^{\varepsilon} - \left(\frac{w_L}{c} \right)$, depends negatively on the skilled wage and the unskilled wage but positively on the skilled worker's effort and the cost of outsourcing.

Simplifying the first order condition, we get (see Appendix C)

$$w_L(c, w_H, b_L, e, \tau) = \left(\frac{\overline{\eta}_L}{\overline{\eta}_L - 1} \right) b_L = \frac{\beta L + (1+\beta)M}{(\beta - 1)L + (1+\beta)M} b_L, \tag{18}$$

so that the total wage elasticity, also allowing for the relationship between skilled and unskilled wages, is $\overline{\eta}_L = \beta\left(1 + \frac{M}{L} \right) + \frac{M}{L} > 1$, where

$\delta - \frac{\varepsilon(\delta-1)}{1+\varepsilon(1-\gamma)} = \frac{1}{1-\rho}\left[\frac{1-\rho-(1-\rho a)\rho a\gamma}{1-\rho+\rho a(1-\gamma)}\right] = \beta$, outsourcing $M = \frac{w_L}{c}$ and domestic unskilled labour demand $L = m w_L^{-\delta} w_H^{-\varepsilon} e^{\varepsilon} - \left(\frac{w_L}{c}\right)$. It is important to emphasize that the optimal unskilled wage (18), even in the case of the monopoly labour union, is an implicit form in the presence of outsourcing, because the mark-up $A = \frac{\beta\, L + (1+\beta)M}{(\beta-1)L + (1+\beta)\, M} > 1$ depends on the unskilled wage rate in a non-linear way so that it cannot be solved explicitly for the optimal domestic unskilled wage. In the absence of outsourcing the mark-up is constant, i.e. $A\big|_{M=0} = \frac{\beta}{(\beta-1)}$.

In order to answer our research question and characterize the effect of outsourcing cost on the unskilled wage formation, we therefore apply the implicit differentiation. Differentiating the wage formation (18) with respect to the unskilled wage and the outsourcing cost gives

$$\left(1 - \frac{\left[(\overline{\eta}_L - 1)\frac{\partial \overline{\eta}_L}{\partial w_L} - \overline{\eta}_L \frac{\partial \overline{\eta}_L}{\partial w_L}\right]}{(\overline{\eta}_L - 1)^2} b_L\right) dw_L = \frac{\left[(\overline{\eta}_L - 1)\frac{\partial \overline{\eta}_L}{\partial c} - \overline{\eta}_L \frac{\partial \overline{\eta}_L}{\partial c}\right]}{(\overline{\eta}_L - 1)^2} b_L dc,$$

which can be expressed as $\frac{dw_L}{dc} = -\frac{\frac{\partial \overline{\eta}_L}{\partial c}}{(\overline{\eta}_L - 1)^2} b_L \Big/ \left(1 + \frac{\frac{\partial \overline{\eta}_L}{\partial w_L}}{(\overline{\eta}_L - 1)^2} b_L\right)$. Using $b_L = \frac{w_L(\overline{\eta}_L - 1)}{\overline{\eta}_L}$, and calculating

$$\frac{\partial \overline{\eta}_L}{\partial c} = (1+\beta)\left[\frac{(LM_c - ML_c)}{L^2}\right] = -(1+\beta)\frac{M}{cL}\left(1 + \frac{M}{L}\right) < 0 \qquad (19a)$$

and

$$\frac{\partial \overline{\eta}_L}{\partial w_L} = \frac{(1+\beta)M}{w_L L}\left[1+\frac{M}{L}+\left(\frac{\delta+\varepsilon(1-\gamma)}{1+\varepsilon(1-\gamma)}\right)\left(1+\frac{M}{L}\right)\right] > 0 \qquad (19b)$$

(see Appendix D) the relationship between the unskilled wage formation and outsourcing cost can be written as follows

$$\frac{dw_L}{dc} = -\frac{\frac{\partial \overline{\eta}_L}{\partial c}\frac{w_L}{\overline{\eta}_L}}{\overline{\eta}_L - 1 + \frac{\partial \overline{\eta}_L}{\partial w_L}\frac{w_L}{\overline{\eta}_L}} > 0\,, \qquad (20)$$

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

Differentiating the implicit wage formation (18) with respect to the profit sharing and the unskilled wage gives

$$\left(1-\frac{\left[(\overline{\eta}_L-1)\frac{\partial \overline{\eta}_L}{\partial w_L}-\overline{\eta}_L\frac{\partial \overline{\eta}_L}{\partial w_L}\right]}{(\overline{\eta}_L-1)^2}b_L\right)dw_L = \frac{\left[(\overline{\eta}_L-1)\frac{\partial \overline{\eta}_L}{\partial \tau}-\overline{\eta}_L\frac{\partial \overline{\eta}_L}{\partial \tau}\right]}{(\overline{\eta}_L-1)^2}b_L d\tau\,.$$

This can be simplified by using $\frac{\partial \overline{\eta}_L}{\partial \tau} = -(1+\beta)\frac{M}{L}\left(1+\frac{M}{L}\right)\left[\frac{\varepsilon}{e}\frac{de}{d\tau}-\frac{\varepsilon}{w_H}\frac{\partial w_H}{\partial \tau}\right]$ with $\frac{de}{d\tau} = \frac{\partial e}{\partial \tau}+\frac{\partial e}{\partial w_H}\frac{\partial w_H}{\partial \tau}$, which yields the negative expression $\frac{\partial \overline{\eta}_L}{\partial \tau} = -\frac{M}{L}\left(1+\frac{M}{L}\right)\frac{\varepsilon\gamma\cdot(1+\beta)}{[1+\varepsilon(1-\gamma)]\cdot\tau} < 0$. Therefore we have

$$\frac{dw_L}{d\tau} = -\frac{\frac{\partial \overline{\eta}_L}{\partial \tau}\frac{w_L}{\overline{\eta}_L}}{\overline{\eta}_L - 1 + \frac{\partial \overline{\eta}_L}{\partial w_L}\frac{w_L}{\overline{\eta}_L}} > 0\,, \qquad (21)$$

so that profit sharing for skilled workers will have a positive effect on the domestic unskilled wage.

Knowing this, we are able to find an answer to our main question: How does the implementation of profit sharing for high skilled workers influence outsourcing activities? Differentiating (4) in terms of profit sharing gives

$$\frac{dM}{d\tau} = \frac{1}{c}\frac{dw_L}{d\tau} > 0 \tag{22}$$

so that the effect of outsourcing activities is driven by the effect on low skilled wage, which is positive.

We can now summarize our findings which answering: How does the implementation of profit sharing for skilled workers in the presence of outsourcing affect the low skilled workers' wage and outsourcing?

Proposition 3: *In the presence of flexible outsourcing*

(a) higher profit sharing for the skilled worker has a positive effect on the wage for the unskilled labor and

(b) *higher profit sharing for the skilled worker has an enhancing effect on outsourcing, whereas*

(c) *lower cost of outsourcing decreases the wage for the unskilled labour.*

Higher profit sharing increases the skilled labor demand and since the labour inputs have assumed to be complements, also the low skilled labour demand raises. Thus a higher low skilled wage will have a smaller loss for the trade union via less dismissal and the union can set a higher wage. Since higher profit sharing increases the firm's profit, the trade union gets a higher share of this due to higher low skilled wages. But the wage enhancing effect will also induce a higher outsourcing demand, which can be explained by the substitutability of domestic low skilled labour services and foreign intermediate goods, which also determines the positively correlation of domestic low

skilled wage and outsourcing cost. Lower outsourcing cost means for given wage level a higher outsourcing demand and more elastic domestic wage elasticity (see equation (19a), which lies in conformity with empirics). Thus the opportunity for the trade union to set higher wages falls. To avoid outsourcing and make integrated production more attractive, the trade union reacts with a decreasing low skilled wage.

However, up to now we have only been analyzed the direct effect of profit sharing and outsourcing cost on the wage for high skilled worker. Using the above results, we can show the overall effects of outsourcing cost and implementing profit sharing for the high skilled wage. Using equations (20), and (21) jointly with equations (13) and (14), these overall effects can be expressed as $\frac{dw_H}{d\tau} = \underbrace{\frac{\partial w_H}{\partial \tau}}_{+} + \underbrace{\underbrace{\frac{\partial w_H}{\partial w_L}}_{-} \underbrace{\frac{dw_L}{d\tau}}_{+}}_{-} = ?$ and

$$\frac{dw_H}{dc} = \underbrace{\frac{\partial w_H}{\partial w_L}}_{-} \cdot \underbrace{\frac{dw_L}{dc}}_{+} < 0 .$$

Following from this, lower cost of outsourcing will raise the domestic skilled wage and decrease the unskilled wage and thus lead to higher wage gap.

In line with earlier research on homogenous labour force and empirical studies, we also find an ambiguous effect of profit sharing on the domestic skilled wage, so that profit sharing could have a supplementary or complementary character for the base wage.[15]

We can summarize our findings in

Proposition 4: *In the presence of flexible outsourcing*

(a) lower cost of outsourcing, by decreasing the wage for the unskilled labour and increasing the wage for the skilled labour, induces higher wage dispersion, whereas

[15] For theoretical analysis in the case of homogeneous labour see Koskela and König (2008b). There is also some empirical evidence for both properties. Black and Lynch (2004) show by using U.S. data, that profit sharing results in lower regular pay for workers, which implies a compensatory character, but in Wadhwani and Wall (1990) by using UK data and also in Kraft and Ugarkovic (2005) by using German panel data, it has been shown that introducing profit sharing does not reduce the wage, which implies a supplementary character. See also the book by Ugarkovic (2008).

(b) higher profit sharing for the skilled worker can have a supplementary or compensatory character for the skilled labour.

Due to the substitutability of international outsourcing and domestic low skilled labour services, lower outsourcing cost increases labour demand elasticity and decreases the domestic low skilled wage so that the low skilled labor demand rises. Since low skilled and high skilled labour are complements, also the high skilled labour demand increases so that for given high skilled labour supply, the high skilled wage increases thereby inducing higher wage dispersion, which lies in conformity with empirics.

As we showed, implementing profit sharing affects high skilled wage positively in a direct way. But there is also an indirect channel due to the complementary relationship of labour inputs. Since higher profit sharing induce higher low skilled wage this will reduce the labour demand for both types**.** This leads by assuming a competitively wage formation for high skilled worker to a lower skilled wage. Thus there are two opposed effects: the wage increasing direct effect, which describes the higher skilled labour demand due to higher effort and profit, and the wage decreasing indirect effect, which is described by the lower skilled labour demand due to a higher low skilled wage.

V. Conclusion

In this paper, we have tried to describe a more realistic framework of flexible outsourcing in a partly unionized dual labour market. In western European countries we often observe that unlike low skilled workers, which are organized in trade union, high skilled wages are mostly determined competitively. However, high skilled workers could, unlike the low skilled labour force, directly participate in the firm's success via profit sharing. But this will affect the wage determination of both types of labour and affect the outsourcing demand. Thereby, we answer the following questions: First, how does the implementation of profit sharing for high skilled workers influence outsourcing activities? Second, how does the opportunity of flexible outsourcing and its

cost influence the wage for both types of workers and profit sharing? And third, what is the relationship between profit sharing and wage levels?

In the above analyses we could show that the wage of the high skilled workers will be negatively affected by the wage of the low skilled. The overall effect of implementing committed profit sharing on high skilled wage is ambiguous, since on one side there is a wage increasing direct effect, such that profit sharing has a supplementary character, but on the other side there is a negative indirect effect via the wage for the low skilled worker. We also show that lower outsourcing cost leads to falling wages for the low skilled. However, the high skilled wage does not directly depend on outsourcing cost. Also, here there is only an indirect effect via low skilled wage working. Our analysis shows that lower outsourcing cost will at the same time decrease the low skilled wage and increase the high skilled wage and thus raise the wage dispersion. Also, we could conclude that the effect of profit sharing on outsourcing activities is indirect via the effect on low skilled wage and ambiguous. This follows since outsourcing demand is only affected by the relation of low skilled worker wage and outsourcing cost, where profit sharing affects the low skilled wage. As analyzed in the literature also a flexible profit sharing system could be implemented. Since here the profit share and the wage for high skilled worker would be decided after the wage negotiation for the low skilled, there is no effect of implementing such a system on low skilled wage and thus on outsourcing demand. However, similar to the argumentation of Koskela and König (2008b), it can shown that in the presence of outsourcing such a profit sharing system provides a lower profit share than in the absence of outsourcing.

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Appendix A: Optimal Unskilled Labour Demand

Substituting the RHS of (3) for H into (2b) gives

$$\rho\left[e^a\left(\frac{w_L}{w_H}\right)^a\left(\frac{a}{1-a}\right)^a(L+M)^a(L+M)^{1-a}\right]^{\rho-1}(1-a)e^a\left(\frac{w_L}{w_H}\right)^a\left(\frac{a}{1-a}\right)^a(L+M)^a(L+M)^{-a}=w_L \tag{A1}$$

so that $$\rho\left[e^a\left(\frac{w_L}{w_H}\right)^a\left(\frac{a}{1-a}\right)^a(L+M)\right]^{\rho-1}(1-a)e^a\left(\frac{w_L}{w_H}\right)^a\left(\frac{a}{1-a}\right)^a=w_L \tag{A2}$$

which is equivalent to

$$(L+M)^{\rho-1}\left(\frac{w_L}{w_H}\right)^{a\rho}(1-a)\left(\frac{a}{1-a}\right)^{a\rho}e^{a\rho}=\rho^{-1}w_L\ . \tag{A3}$$

Simplifying (A3) with $m=\left[\rho a^{a\rho}(1-a)^{1-a\rho}\right]^{\frac{1}{1-\rho}}>0$, $\delta=\frac{1-\rho a}{1-\rho}>1$ and $\varepsilon=\frac{\rho a}{1-\rho}>0$, give (5). QED.

Appendix B: Optimal Skilled Employee Effort

The first-order condition in terms of effort determination from (9) is $U_e = \frac{\tau}{H}\pi_e - h'(e) = 0$, where $h'(e) = e^{(1/\gamma)-1}$ and

$$\tau\frac{\pi_e}{H} = \tau\rho a\left[(eH)^a(L+M)^{1-a}\right]^{\rho-1}(eH)^{a-1}(L+M)^{1-a} = \tau\rho a(eH)^{a\rho-1}(L+M)^{(1-a)\rho} \quad \text{(B1)}$$

Using equation (8) $H = \frac{ma}{1-a}w_H^{-(1+\varepsilon)}w_L^{-(\delta-1)}e^{\varepsilon}$ and equation (5) $L+M = mw_L^{-\delta}w_H^{-\varepsilon}e^{\varepsilon}$ the first-order condition $U_e = \frac{\tau}{H}\pi_e - g'(e) = 0$ can be written after calculations as follows

$$\left[\rho m^{-(1-\rho)}a^{1+a\rho}(1-a)^{1-a\rho}\right]^{\gamma}\tau^{\gamma}w_H^{\gamma[-\varepsilon(1-a)\rho-(1+\varepsilon)(a\rho-1)]}w_L^{\gamma[-(\delta-1)(a\rho-1)-\delta(1-a)\rho]} = \quad \text{(B2)}$$

$$e^{1-\gamma-\gamma[(1+\varepsilon)(a\rho-1)+\varepsilon(1-a)\rho]}$$

where $-\varepsilon(1-a)\rho-(1+\varepsilon)(a\rho-1)=1$, $-(\delta-1)(a\rho-1)-\delta(1-a)\rho=0$ and $1-\gamma-\delta[(1+\varepsilon)(a\rho-1)+\varepsilon(1-a)\rho]=-1$. By substituting these into (B2) gives equation (11). QED.

Appendix C: Optimal Unskilled Wage Setting

The first-order condition associated with $\underbrace{\max}_{w_L} V = (w_L - b_L)L$ s.t. $\pi_L = 0$ and $H = \mu$ can be written as follows

$$V_{w_L} = w_L\left[1-\left(\eta_L + \eta_H\frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H}\right)\right] + b_L\left(\eta_L + \eta_H\frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H}\right) = 0 \quad \text{(C1)}$$

where the own wage elasticity of labour demand is $\eta_L = \delta\left(1+\frac{M}{L}\right)+\frac{M}{L} = \delta + (1+\delta)\frac{M}{L}$, the cross wage elasticity is $\eta_H = \varepsilon\left(1+\gamma\frac{M}{L}\right) = \eta_e$ and the labour demand is $L = mw_L^{-\delta}w_H^{-\varepsilon}e^{\varepsilon} - M^* = mw_L^{-\delta}w_H^{-\varepsilon}e^{\varepsilon} - \left(\frac{w_L}{c}\right)$. The market equilibrium for the skilled labour is

$$w_H = \left[\frac{\mu(1-a)}{ma}\right]^{-\frac{1}{1+\varepsilon}}w_L^{-\left(\frac{\delta-1}{1+\varepsilon}\right)}e^{\frac{\varepsilon}{1+\varepsilon}} \quad \text{(C2)}$$

which can be expressed as equation (12) so that

$$\frac{\partial w_H}{\partial w_L} = -\frac{(\delta - 1)}{1 + \varepsilon(1-\gamma)} \frac{w_H}{w_L} < 0. \qquad \text{(C3)}$$

Using (C3) gives $\frac{\partial w_H}{\partial w_L}\frac{w_L}{w_H} = -\frac{(\delta-1)}{1+\varepsilon(1-\gamma)} < 0$, which all together implies equation (18) because $\delta - \frac{\varepsilon(\delta-1)}{1+\varepsilon(1-\gamma)} = \frac{\delta+\varepsilon-\delta\varepsilon\gamma}{1+\varepsilon(1-\gamma)} = \frac{1}{1-\rho}\left[\frac{1-\rho-(1-\rho a)\rho a\gamma}{1-\rho+\rho a(1-\gamma)}\right] = \beta$ .QED.

Appendix D: Effects on Low Skilled Wage

Differentiating $\overline{\eta}_L = \beta\left(1+\frac{M}{L}\right) + \frac{M}{L} > 0$ with respect to w_L gives

$$\frac{\partial \overline{\eta}_L}{\partial w_L} = (1+\beta)\left(\frac{L\frac{dM}{dw_L} - M\frac{dL}{dw_L}}{L^2}\right) = (1+\beta)\frac{M}{w_L L}\left(\frac{dM}{dw_L}\frac{w_L}{M} - \frac{dL}{dw_L}\frac{w_L}{L}\right) \qquad \text{(D1)}$$

where $\frac{dM}{dw_L}\frac{w_L}{M} = 1$ from (4) and $\frac{dL}{dw_L} = \frac{\partial L}{\partial w_L} + \frac{\partial L}{\partial w_H}\cdot\frac{\partial w_H}{\partial w_L}$, where $\frac{\partial L}{\partial w_L} = -\delta m w_L^{-\delta-1} w_H^{-\varepsilon} e^{\varepsilon} - 1/c$, $\frac{\partial L}{\partial w_H} = -\varepsilon m w_L^{-\delta} w_H^{-\varepsilon-1} e^{\varepsilon} + \varepsilon m w_L^{-\delta} w_H^{-\varepsilon} e^{\varepsilon-1} e_{w_H}$ and from (13) $\frac{\partial w_H}{\partial w_L} = -\frac{(\delta-1)}{1+\varepsilon(1-\gamma)}\frac{w_H}{w_L} < 0$. By using these $\frac{dL}{dw_L}\frac{w_L}{L} = \left(\frac{\partial L}{\partial w_L} + \frac{\partial L}{\partial w_H}\cdot\frac{\partial w_H}{\partial w_L}\right)\frac{w_L}{L}$ can be expressed as follows

$$\frac{dL}{dw_L}\frac{w_L}{L} = \frac{w_L}{L}\left[-\frac{\delta}{w_L}(L+M) - \frac{M}{w_L} + \left[-\frac{\varepsilon}{w_H}(L+M) + \frac{\varepsilon\gamma}{w_H}(L+M)\right]\frac{\partial w_H}{\partial w_L}\right]. \qquad \text{(D2)}$$

This expression can be simplified to $\frac{dL}{dw_L}\frac{w_L}{L} = -\frac{(L+M)}{L}\left[\frac{\varepsilon(1-\gamma)+\delta}{1+\varepsilon(1-\gamma)}\right] - \frac{M}{L}$ so that $\frac{dL}{dw_L}\frac{w_L}{L} < 0$. Therefore, we have

$$(1+\beta)\frac{M}{w_L L}\left(\frac{dM}{dw_L}\frac{w_L}{M} - \frac{dL}{dw_L}\frac{w_L}{L}\right) = (1+\beta)\frac{M}{w_L L}\left[1 + \frac{M}{L} + \left(\frac{\varepsilon(1-\gamma)+\delta}{1+\varepsilon(1-\gamma)}\right)\left(1+\frac{M}{L}\right)\right] > 0 \qquad \text{(D3)}$$

QED.