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Funding public health care: A flat−rate premium might be bad for employment

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Abstract

If "tax progression is good for employment in popular models of trade union behaviour" (Koskela and Vilmunen, 1996), then a flat−rate premium, as proposed as a means of funding for public health care, is bad. This note shows that replacing existing (proportional) social security contributions by a lump−sum payment increases labour costs and thus reduces employment. This result holds − for empirically relevant parameters − even in a more general case than the one considered by Koskela and Vilmunen. Policy advisers should be aware that in imperfect competitive labour markets the prima facie attractiveness of a flat−rate premium is not for sure.

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1 Introduction

Funding of social security in Europe has come under pressure, the health care system is a case in point. In particular in countries with low or only moderate economic growth the strain on revenues is strong. Expenditures have been rising steadily due to additional demand for health care services and ageing populations. In countries where funding is very closely connected to the total wage bill, like in France or Germany, poor labour market performance has started what some call "the erosion of the financial basis", which in turn leads to an increasing tax burden on remaining jobs. This tax burden has been suspected, though, – actually since quite a long time – of being a major impediment to employment growth and thus a major cause of high unemployment figures (see e.g. OECD, 1995).[1]

One specific idea to lower the tax burden and to promote employment is the replacement of earnings-dependent contributions by a flat-rate premium. For Germany the Council of Economic Advisors for instance is favouring such a step. The Netherlands have just introduced fixed payments as one element of funding. In terms of public economics the replacement of a payroll tax by a lump-sum tax is proposed.[2] This proposal has the obvious appeal of a sharp cut in marginal tax rates. In opposition to other proposals that try to include additional sources of income, such as interest, capital gains or rents, there is, at least in theory, an obvious efficiency gain.

The textbook arguments for the introduction of a flat-rate premium are straightforward, at least in the basic perfect market model. Cutting the marginal tax rate and raising a lump-sum tax to assure equal yield, raises labour supply and leads to more employment at lower gross wages. It is this replacement of a distorting second-best tax on which the alleged predominance of the flat-rate premium is based.

The dominance of the premium, however, hinges crucially on the assumption of perfect competition and can thus be strongly flawed. This note shows that in "popular models" of trade union behaviour the flat-rate premium causes completely adverse effects by increasing wages and reducing employment. In doing so the line of reasoning that the structure of taxation matters is a little lengthened.

2 The algebra of tax progression

The following argumentation is presented in the form used by Koskela and Vilmunen (1996). The analysis is just an application of their model.
The model consists of a representative trade union and a firm (or an association of employers). The union's utility function is given by

$$V = \left(u\left(w^{n}\right) - u^{0}\right) L \tag{1}$$

[1]For a survey of taxation and employment see e.g. Nickell and Layard, 1999, or Bovenberg, 2003. The extent to which wage-related contributions can be treated as taxes is an interesting question. I assume, rather roughly, as it is now common in many papers, that social security contributions are equivalent to a proportional income or payroll tax.

[2]In Germany contributions have to be paid only up to a certain threshold. Contributions are thus equivalent to a proportional income tax up to this level. The threshold also roughly marks an income level that entitles the worker to leave the compulsory public system and to opt for private insurance.

with $\frac{\partial u^0}{\partial w} = 0$, $\frac{\partial u^0}{\partial L} = 0$, where $u(w^n)$ is utility derived from net income (w^n), u^0 is the union's fallback position and L is employment (of union members).[3]

In what follows I am concentrating on the monopoly-union and the right-to-manage case, but the results also hold for the efficient-bargaining model. Assuming that the number of hours per worker is fixed and normalising it (e.g. per year) to 1, we can write net income as (abstracting from all other sources of income)

$$w^n = (1 - s - \tau)\, w + \tau a - p \tag{2}$$

where:

w	:=	labour cost or earned (gross) income
s	:=	social security contribution rate
τ	:=	marginal income tax rate
a	:=	tax exemption (basic allowance)
p	:=	health care premium (flat rate)

Throughout the text I will use the words wage(s), wage rate and income interchangeably. Actually w stands for the cost per one unit of labour (per worker). I define $\tilde{\tau} = \tau + s$ as the combined marginal tax. Note that it is assumed that there is a linear income tax function, thus progression is indirect, since the marginal income tax rate is constant. More general tax schedules are discussed at the end of this section.

The reform proposal consists – in a stylised form – of a decrease in s $(ds < 0)$ and the introduction of p.[4] Initially I assume that every worker pays p and that $pL = -wLds$, i.e. revenues are identical under both systems.[5] The labour force is homogeneous. The relaxation of these assumptions is discussed in the next section.

The average tax rate is defined as

$$t = 1 - \frac{w^n}{w} = s + \tau + \frac{\tau a - p}{w} \tag{3}$$

From (2) and (3) it is obvious that any increase in p is equivalent to a decrease of a. In fact the corresponding change in p is

$$dp = -\tau da$$

Numerical example: Let $\tau = 0.4$ and $a = 7500$ EUR, then the introduction of a flat-rate health care premium of $dp = p = 2400$ EUR is equivalent to a decrease of a by 6000 EUR.

To the reader who is familiar with the literature on taxation and (un)employment the effects of the flat-rate premium are now already obvious: Taxation becomes less progressive, which is not "good for employment".

[3]Boeters (2004) calls this version of the income argument the "no alternative employment variant", since the outside option u^0 does not depend on (un-)employment. See his paper for a discussion of the importance of the union's fallback option.

[4]For actual reform proposals $\Delta p = p$ holds, i.e. there is no flat-rate premium in the initial situation. The anlysis is nevertheless undertaken in the form of marginal changes to stay in the framework of Koskela and Vilmunen (1996).

[5]The analysis abstracts from the fact that in many actual systems contributions are formally paid by both, employers and employees. However, this simplicafion does not change neither the analysis nor the results in principal.

Formal analysis

Formally the total wage effect can be decomposed into the change caused by the introduction of the premium (dp) and the decrease of the contribution rate ($ds = d\tilde{\tau}$). Note that the income tax schedule is left unchanged. This might not be the case in actual reform plans.

$$dw = w_{\tilde{\tau}} d\tilde{\tau} + w_p dp \tag{4}$$

It can be shown (see the appendix) that an increase in p leads to an increase of the wage, thus $w_p = \frac{dw}{dp} > 0$.[6] The effect of the cut in the total marginal tax rate $w_{\tilde{\tau}} = \frac{dw}{d\tilde{\tau}}$ is per se indetermined. Corresponding to the Slutsky decomposition in consumer theory, there is a 'substitution effect' ($w^c_{\tilde{\tau}}$), which is negative and an 'income effect', which is positive. Note that for the derivation of the 'substitution effect' trade union utility is held constant (see the appendix).

Koskela and Vilmunen derive the result that "tax progression is good for employment" under the condition of an unchanged tax revenue, $dT = 0$, with $T = \tau (w - a) L$. Their approach combines changes in the tax rate and the tax exemption in such way as to isolate the effect of a pure change in the marginal tax rate. Equivalent to $dT = 0$ in the case of the health-care premium is $dS + dT = 0$, where $S = swL + pL$. I set $dT = 0$, assuming that changes of the income tax schedule are not part of the reform package, leaving the contribution rate and the flat-rate premium as the only fiscal means. Equation (20) of Koskela and Vilmunen then becomes

$$\left.\frac{dw}{d\tilde{\tau}}\right|_{dS=0} = \frac{w^c_{\tilde{\tau}}}{\left[1 + sw_p \left(1 - \epsilon \left(1 + \frac{p}{w}\right)\right)\right]} \tag{5}$$

where $\epsilon = -L_w \frac{w}{L}$ is the elasticity of labour demand.

Proposition 1 *The wage effect of a change in the combined marginal tax rate $\tilde{\tau}$ is negative, if the tax revenue is constant.*

Proof. The pure substitution effect is negative.

$$w^c_{\tilde{\tau}} = w_{\tilde{\tau}} - w_p w < 0 \tag{6}$$

The sign of (5) is thus unambiguously determined by the denominator.

$$D = 1 + sw_p \left(1 - \epsilon \left(1 + \frac{p}{w}\right)\right)$$

Total differencing of S with respect to w and p yields:

$$\begin{aligned} dS &= Ldp + sL \left(1 - \epsilon \left(1 + \frac{p}{w}\right)\right) dw \\ \frac{dS}{dp} &= L + sL \left(1 - \epsilon \left(1 + \frac{p}{w}\right)\right) \frac{dw}{dp} \\ &= LD \end{aligned} \tag{7}$$

If we assume $\frac{dS}{dp} > 0$, i.e. there is no Laffer effect and the revenue increases with a higher premium, then $LD > 0$ and $D > 0$. ■

[6] Note that in Koskela and Vilmunen (1996) the tax exemption is the parameter of interest. The sign of the derivative is therefore reversed.

From (5) we can conclude that a drop of $\tilde{\tau}$ which is fully compensated by an increase in p (i.e. $dS = 0$) unambiguously raises the wage rate w. This is just the Kosekela-Vilmunen result turned upside down.

So far we have been arguing strictly speaking within the monopoly union model. The argumentation for the right-to-manage model, however, is also based on (5) and thus very similar. The results directly carry over. (See the appendix for the algebra.) In the efficient-bargaining model the proof is more complicated. However, from the discussion above it should be clear that apart from some notational differences the policy of interest is equivalent to the case analysed by Koskela and Vilmunen (1996) and their results directly carry over.

Until now the tax function has taken the linear form with indirect progression. Actual tax systems typically consist of at least a few different brackets or even show continuously increasing (up to a maximum) marginal tax rates.[7] This makes the marginal tax rate a function of w with $T''(w) > 0$. This modification however does not change the fundamental result. The endogenous increase of the marginal tax rate, that will then occur, however dampens the wage rise.

Summing up we can say that in "popular models of trade union behaviour" the proposal to fund public health care by a flat-rate premium causes completely adverse effects by increasing wages and reducing employment, just as the work by Koskela and Vilmunen, and others predicts. One should, however, bear in mind that these popular models are not per se adequate descriptions of actual economies. See Boeters (2004) for a discussion of different models.

3 Heterogeneity and combinations of marginal and average tax rate effects

One obvious shortcoming of the previous analysis is its ignorance with respect to heterogeneity. It is not the use of representative agents per se, that is problematic, it is rather the fact that the premium exactly amounts to the average tax relief, i.e. the equal-yield condition is reflected on a one-to-one basis at the level of the representative agent. This is of course a very particular case. Since the policy proposals include – at least for Germany – the liability of all adults to the premium, whether being in or out of the labour force, the tax burden of the representative union member can differ before and after the reform. This is most obvious for single-earner couples, who under the current system profit from the free coverage of the non-working spouse. Note that with this more realistic feature of the reform package $p\bar{L} \neq -wLds$, either because the number of people liable to the premium ($\bar{L}$) is not equal to the number of workers (L) or because of some other measures to balance the budget of the statutory insurance.

Another point is whether the unemployed are also liable. If they were, the result would be quite different, since the difference between net earnings and the outside option would not change (much). It is well known that in the case where unemployment benefits are taxed the same way as earned income, the wage effect of taxation is strongly reduced (see e.g. Bovenberg, 2003). Yet this case is fairly irrelevant in practice, since all versions of the flat-rate premium proposal include what is usually called "social compensation". Thus people with low incomes will not have to pay the full premium. Therefore it is very likely that the premium will be smaller for the unemployed.

[7] Note however that the tax function used in the formal analysis is the now often discussed flat tax.

In the simple model of the previous section we assumed that workers are identical. Another interpretation of the trade union's utility function is that of its median member. Let us consider the case where for the representative union member $-wds \neq p$. So either the representative union member enjoys a tax relief or suffers from a higher tax burden. In contrast to the previous analysis marginal and average tax rates now vary simultaneously. Thus we no longer stick to the idea of isolating the effect of a change in progression by holding the average tax rate constant.[8]

Proposition 2 *For empirical relevant parameters, decreasing the proportional contribution rate (s) and introducing a lump-sum premium (p) increases the wage rate, even if* $dS \neq 0$.

Proof. The total effect on the wage rate (dw) is given by

$$dw = \underset{?}{w_s} \underset{-}{ds} + \underset{+}{w_p} \underset{+}{dp}$$

where $+/-$ indicates the sign of the individual terms. By definition of the reform proposal $ds < 0$ and $dp > 0$. We have seen before that $w_p > 0$. In general the sign of w_s is indetermined. But since

$$\begin{aligned} w_{\tilde{\tau}} &= w_{\tilde{\tau}}^c + w_p w \\ &= (V_{ww})^{-1} L + (V_{ww})^{-1} L_w w \\ &= (V_{ww})^{-1} L [1 - \epsilon] \end{aligned} \tag{8}$$

and $V_{ww} < 0$ by the second order condition for an optimum, the sign of this expression only depends on the elasticity of labour demand (ϵ). Note that (8) is derived under the assumption that $u(w(1-\tilde{\tau}) + \tau a - p) = w(1-\tilde{\tau}) + \tau a - p$, which is a very common form of union utility in the literature. The overall wage effect is then given by

$$\begin{aligned} dw &= (w_{\tilde{\tau}}^c + w_p w)\, ds + w_p dp \\ &= (V_{ww})^{-1} [L ds + L_w (w ds + dp)] \end{aligned} \tag{9}$$

If $|dp| > |wds|$, i.e. the premium is higher than the wage-based contributions, then $dw > 0$ always holds, since $ds < 0$ and $L_w < 0$ and thus

$$L ds + L_w (w ds + dp) < 0$$

But even if the premium makes up only a portion of the tax relief, i.e. $|dp| < |wds|$ the wage effect will not automatically become negative. Only if

$$\begin{aligned} \frac{L}{wL_w} + 1 + \frac{dp}{wds} &> 0 \\ 1 - \frac{1}{\epsilon} &> -\frac{dp}{wds} > 0 \end{aligned}$$

or

$$\epsilon > \frac{1}{1 - \left|\frac{dp}{wds}\right|}$$

[8] The analysis thus departs from the direction of Koskela and Vilmunen (1996). We are no longer interested in isolating the pure progressivity effect, but want to know the total effect of a change in the marginal and the average tax rate.

the result is reversed and wages fall. If e.g. $\omega = |dp/wds| = 0.5$, then the elasticity of labour demand must be smaller than -2 ($\epsilon > 2$) in order to reverse the result. If the premium was only .2 of the previous contribution, the elasticity must be still larger than 1.25 in absolute value. For empirical relevant values of ϵ and ω constellations such that $dw > 0$ can be ruled out.[9] ■

The intuition behind the more general result is that in the first case, where the premium exceeds the wage-based contributions, the total effect is the effect under the constant-revenue condition plus a pure income effect $w_p > 0$. In this case the total wage effect is definitely negative.

In the second case things are a bit more difficult. A lower average tax rate, i.e. a small premium, gives the union an incentive to set a lower wage rate. How big the tax reduction must be, in order to offset the negative effect of a smaller marginal tax rate depends on the "terms of trade", i.e. the possibility to trade income for employment. The stronger labour demand reacts to changes in labour cost, the smaller this incentive (the lower average tax burden) has to be. If labour demand is less elastic, the union will not get enough employment in return for a wage decrease.

Obviously Proposition 2 only holds in general, if very high values for ϵ and small numbers of ω can be ruled out. While the latter can be simply assumed to be true for reasonable reform proposals and typical models of union representation, the former deserves further discussion. In general the elasticity of labour demand depends on two major aspects: (i) The source of economic rents. (ii) The set-up of collective bargaining.[10] A general form for the elasticity of labour demand is given by (cf. Hamermesh, 1993, p.24),

$$\epsilon = \epsilon^c + \theta\eta$$

where ϵ^c is the elasticity of labour demand under constant output, θ is labour's share in total cost and η the elasticity of output demand. Note that $\epsilon^c > 0$ and $\eta > 0$ are defined in the same as ϵ. If rents stem from imperfect competition, then the elasticity of output demand η, is the crucial parameter, since in this case η is quite large. An alternative source of pure profits is the existence of a fixed factor. The following table classifies the four cases that result as combinations of (i) and (ii).

	source of rents	
bargaining level	fixed factor	market power
firm	$\epsilon = \epsilon^c < 1$	$\epsilon \gg 1$
industry	$\epsilon < 1$	$\epsilon \lessapprox 1$

The fixed factor and the market power hypotheses are treated as polar cases, i.e. they exclude each other. The table rests upon theoretic arguments as well as empirical evidence (see e.g. Hamermesh, 1993), leaving firm-level bargaining in imperfect goods market as the only potentially relevant case for a high elasticity. On empirical grounds, however, this constellation is the exception not the rule. In European countries bargaining

[9] Note that $\epsilon > 1$ in the Koskela-Vilmunen model. This is typical for models of monopolistic competition. It always holds under a single-input technology with decreasing returns to scale, which can be interpreted as short-run demand.

[10] Note that the monopoly union model can be thought of as a limiting case of the right-to-manage model, where the union has all the bargaining power.

is mostly located at the industry level, sometimes with a spatial dimension. It can also be found in a highly centralised form on the national level.

Summing up we can say that only for a very limited, yet empirically irrelevant, set of parameters the general result derived in the previous section does not hold. With inelastic labour demand the general result carries over to all cases with $dp \neq -wds$. Only if the premium accounts for a small fraction of the contributions, a negative wage effect might occur. But since the ratio in practice will be around one, we can conclude that also in the case where $dp = -wds$ does not hold, the reform proposal will unambiguously cause adverse wage effects.

A slightly more complex case is given, if the union behaviour is determined by some sort of average income and fallback position instead of the median values. In this case the whole distributions of net income and outside options determine in a weighted form trade union behaviour. However, if union preferences are not of a very peculiar form – giving large weight to specific groups of the distribution – it appears rather unlikely that the wage effect will be reversed.

4 Conclusion

A fundamental change in the funding of public health care systems, by switching from a current pay-as-you-go system financed by proportional taxes to one funded by a flat-rate premium is no guarantee for more employment. On the contrary, adverse wage effects of a less progressive system of taxation can arise leading to less employment. This is not only the case for the rather obvious situation where the equal-yield condition, which is very likely to be part of such a reform, is perfectly reflected on the individual level of trade union agents. Even if the average tax burden is reduced, there is only very limited support for expectations of employment gains.

However, this rather pessimistic result rests on two quite strong assumptions: (i) the trade union's outside option is fixed, (ii) only employed workers have to pay the flat-rate premium, not the unemployed. Against this background it should be clear that this note has focused on one particular mechanism that has to be considered in assessing the proposal of a flat-rate premium. There are other aspects and economic effects that can potentially reverse the result presented here, in addition to the caveats already mentioned. The need for further research is hence fairly obvious. In addition to a more general discussion of the effects brought about by collective bargaining over incomes, a next step will be to look at economic mechanisms that counteract the negative effects found here. Bargaining over hours and wages is one candidate, individual labour supply is another obvious extension.

Appendix

Monopoly union

Let trade union utility be described by

$$V = \left(w\left(1-\tilde{\tau}\right) + \tau a - p - u^0\right) L \tag{A.1}$$

with first order condition

$$V_w = \left(1-\tilde{\tau}\right) L + \left(w\left(1-\tilde{\tau}\right) + \tau a - p - u^0\right) L_w = 0 \tag{A.2}$$

By the implicit function theorem we can derive

$$w_{\tilde{\tau}} = -\frac{\partial V_w / \partial \tilde{\tau}}{\partial V_w / \partial w} = -\left(V_{ww}\right)^{-1}\left(-L - wL_w\right) = \left(V_{ww}\right)^{-1} L\left[1-\epsilon\right] \tag{A.3}$$

where $\epsilon = -L_w \frac{w}{L}$, and

$$w_p = -\frac{\partial V_w / \partial p}{\partial V_w / \partial w} = \left(V_{ww}\right)^{-1} L_w \tag{A.4}$$

The next step is to derive what Koskela and Vilmunen (1996, p.68) call the "Slutsky equation for the wage rate". This is a decomposition of the total wage effect caused by a change of $\tilde{\tau}$ in a substitution and an income effect. The substitution effect isolates the effect of the change in the marginal tax rate.

To derive the decomposition we start with the following identity

$$w\left(\tilde{\tau}, g\left(\tilde{\tau}, \upsilon\right)\right) = w^c\left(\tilde{\tau}, \upsilon\right) \tag{A.5}$$

where $w^c(\cdot)$ is the compensated wage function, υ is indirect utility and $g\left(\tilde{\tau}, \upsilon\right) = p$ is the adjustment of p such that, if the marginal rate is increased, the income level is kept constant. Differentiating (A.5) with respect to $\tilde{\tau}$ gives

$$w^c_{\tilde{\tau}} = w_{\tilde{\tau}} + w_p g_{\tilde{\tau}} \tag{A.6}$$

We define $V^*\left(\tilde{\tau}, p\right) = V\left(w^*\left(\tilde{\tau}, p\right)\right)$ as the indirect utility function. Substituting $g\left(\tilde{\tau}, \upsilon\right)$ for p and fixing indirect utility at υ we can write

$$V^*\left(\tilde{\tau}, g\left(\tilde{\tau}, \upsilon\right)\right) = \upsilon \tag{A.7}$$

(A.7) is the so-called compensated indirect utility function. Differentiating it with respect to $\tilde{\tau}$ yields

$$g_{\tilde{\tau}} = -V^*_{\tilde{\tau}} / V^*_p \tag{A.8}$$

Making use of the envelope theorem we find $V^*_{\tilde{\tau}}$ and V^*_p as

$$\frac{dV\left(w^*\left(\tilde{\tau}, p\right); \tilde{\tau}\right)}{d\tilde{\tau}} = \frac{\partial V\left(w^*\left(\tilde{\tau}, p\right); \tilde{\tau}\right)}{\partial \tilde{\tau}} = V^*_{\tilde{\tau}} = -wL \tag{A.9}$$

$$\frac{dV\left(w^*\left(\tilde{\tau}, p\right); p\right)}{dp} = \frac{\partial V\left(w^*\left(\tilde{\tau}, p\right); p\right)}{\partial p} = V^*_p = -L \tag{A.10}$$

Thus $g_{\tilde{\tau}} = -w$. Putting pieces together we can write

$$w^c_{\tilde{\tau}} = w_{\tilde{\tau}} - w_p w = (V_{ww})^{-1} L \tag{A.11}$$

Right-to-manage model

Let profits be defined by

$$\Pi = f(L) - wL \tag{A.12}$$

Bargaining maximises

$$\max_w \Omega = \left[\left(w(1-\tilde{\tau}) + \tau a - p - u^0\right) L\right]^\beta \Pi^{1-\beta} \tag{A.13}$$

with first order condition

$$\Omega_w = \beta \Pi V_w + (1-\beta) V \Pi_w = 0 \tag{A.14}$$

As before we can derive the partial derivatives by making use of the implicit function theorem.

$$w_{\tilde{\tau}} = -\frac{\partial \Omega_w / \partial \tilde{\tau}}{\partial \Omega_w / \partial w} = -(\Omega_{ww})^{-1} \left[\beta \Pi \frac{\partial V_w}{\partial \tilde{\tau}} + (1-\beta) \Pi_w \frac{\partial V}{\partial \tilde{\tau}}\right] \tag{A.15}$$

Given that the second-order condition $\Omega_{ww} < 0$ holds, the sign of $w_{\tilde{\tau}}$ depends on $\frac{\partial V_w}{\partial \tilde{\tau}} = L[1+\epsilon]$, since $\frac{\partial V}{\partial \tilde{\tau}} < 0$ and $\Pi_w = -L$.

$$w_p = -\frac{\partial \Omega_w / \partial p}{\partial \Omega_w / \partial w} = -(\Omega_{ww})^{-1} \left[\beta \Pi \frac{\partial V_w}{\partial p} + (1-\beta) \Pi_w \frac{\partial V}{\partial p}\right] > 0 \tag{A.16}$$

since $\frac{\partial V_w}{\partial p} = -L_w > 0$, $\frac{\partial V}{\partial p} < 0$ and $\Pi_w = -L$.

In the compensated wage rate function (A.5) $g_{\tilde{\tau}}$ is now given by $g_{\tilde{\tau}} = -\Omega^*_{\tilde{\tau}} / \Omega^*_p$, with $\Omega(\cdot)$ as the Nash maximand as defined in (A.13).

$$\begin{aligned} \Omega_p &= -\beta V^{\beta-1} L \Pi^{1-\beta} \\ \Omega_{\tilde{\tau}} &= -\beta V^{\beta-1} w L \Pi^{1-\beta} \end{aligned}$$

Thus

$$\begin{aligned} w^c_{\tilde{\tau}} &= w_{\tilde{\tau}} - w_p w \\ &= -(\Omega_{ww})^{-1} \left[\beta \Pi \left(\frac{\partial V_w}{\partial \tilde{\tau}} - \frac{\partial V_w}{\partial p} w\right) + (1-\beta) \Pi_w \left(\frac{\partial V}{\partial \tilde{\tau}} - \frac{\partial V}{\partial p} w\right)\right] \\ &= (\Omega_{ww})^{-1} \beta \Pi L < 0 \end{aligned} \tag{A.17}$$

For both models of trade union behaviour we can derive (5) in the following way. The total differential of w is given by

$$dw = w_{\tilde{\tau}} d\tilde{\tau} + w_p dp \tag{A.18}$$

Making use of

$$\begin{aligned} dS &= wLds + Ldp + sLdw + (sw + p)\, L_w dw \\ &= wLds + Ldp + sL\left(1 - \left(1 + \frac{p}{w}\right)\epsilon\right) dw \overset{!}{=} 0 \end{aligned} \tag{A.19}$$

and thus

$$dp = -wds - s\left(1 - \left(1 + \frac{p}{w}\right)\epsilon\right) dw$$

we can finally write

$$\begin{aligned} dw|_{dS=0} &= w_{\tilde{\tau}} d\tilde{\tau} - w_p \left(wds + s\left(1 - \left(1 + \frac{p}{w}\right)\epsilon\right) dw\right) \\ \left.\frac{dw}{d\tilde{\tau}}\right|_{dS=0} &= w_{\tilde{\tau}} - w_p \left(w + s\left(1 - \left(1 + \frac{p}{w}\right)\epsilon\right) \frac{dw}{d\tilde{\tau}}\right) \end{aligned}$$

$$\left.\frac{dw}{d\tilde{\tau}}\right|_{dS=0} = \frac{w_{\tilde{\tau}} - w_p w}{\left[1 + s w_p \left(1 - \left(1 + \frac{p}{w}\right)\epsilon\right)\right]} \tag{A.20}$$

which corresponds to Equation (20) in Koskela and Vilmunen (1996).

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