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# The Incidence of Employment Subsidies for Vocational Training

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## Abstract

This paper analyses employment subsidies for vocational training under union wage bargaining. The analysis includes an investigation of the consequences of financing the subsidy by a levy on employment, which is the typical way of financing these types of subsidies in many countries. The paper demonstrates high incidence rates of subsidies for vocational training under standard assumptions about the preference structure of the union. The financing scheme appears to counteract the purpose of the subsidy.

*Keywords: Skill level, apprentices, incidence.*

*JEL Classification: J24.*

## 1. Introduction

In most countries, employer-provided training plays a role in human capital formation. National programmes involving work-related training of young people are a common phenomenon. Vocational training in firms as an alternative to school-based education is often an important element in increasing the skill level of the work force. Several countries have—or have had—some form of employment subsidies for furthering vocational training.

In some countries vocational training takes the form of apprenticeship programmes that combine formal education with training and experience at workplace programmes that are subject to externally imposed and monitored training standards. Whilst the prototypical example of a large-scale apprenticeship programme is the German one, extensive apprenticeship programmes also exist in Germany's neighbouring countries: Austria, Denmark and Switzerland. The participation rate in Switzerland is around 75 per cent and the German rate is around 67 per cent (Ryan et al. 2010, p. 5), while the Danish rate is around 45 per cent (Albæk 2009, p. 48).

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As an alternative to school-based education, vocational training has the potential for increasing the share of a youth cohort with completed education. In Europe, vocational training is regarded as a major means of reducing the share of early leavers from education to a target level of below 10 per cent (see European Commission 2010). Employment subsidies might be one of the instruments applied in an attempt at increasing participation in vocational training.

This article analyses the efficiency of employment subsidies for furthering vocational training. Under standard assumptions, employment subsidies affect wage formation, leading to some amount of incidence of the subsidy. The analysis in this article shows high incidence rates of employment subsidies for vocational training. The benchmark case is an incidence rate of one, implying that employment subsidies are completely ineffective in furthering vocational training. Extensions of the benchmark case result in incidence rates both lower and higher than one.

Subsidies for training might constitute a remedy for failures in the market for human capital. Stevens (2001) analyses the ability of training subsidies that firms pay to overcome both market failures in the form of capital market imperfections and "poaching" externalities, where a share of the benefit of training accrues to those firms that hire trained workers. The analysis of the role of asymmetric information between workers and firms in Malcomson et al. (2003) results in a recommendation of a subsidy to firms for completed apprenticeships to overcome incentive problems inherent in apprenticeship contracts. Both Stevens (2001) and Malcomson et al. (2003) are normative papers that analyse whether vocational training subsidies are desirable or not. Acemoglu and Pischke (1999) review the contributions extending Becker's competitive models of human capital formation.

The German system of vocational training is analysed in, for example Dustmann and Schönberg (2009) and Acemoglu and Pischke (1998), who both emphasize the importance of noncompetitive wage setting in human capital formation. A survey by Wolter and Ryan (2011) contains an international overview of vocational training and reviews the various issues related to research on apprenticeship systems.

The analysis of incidence in this article is carried out under the assumption of unionised wage bargaining. Unionisation is a characteristic of many countries that have formal employer-provided training programmes, especially countries with large-scale apprenticeship programmes.[1]

Some amount of incidence of employment subsidies is a standard result in union models (see, e.g., the surveys in Oswald 1985, Booth 1995, Cahuc and Zylberberg 2004 or Layard, Nickell and Jackman 2005). If employment is a normal good, the basic result is incidence rates less than one. This article demonstrates sharper results in the case of employment subsidies for vocational training, as the benchmark case in this article is complete incidence of the employment subsidy.

[1] Collective bargaining agreements cover more than 60 per cent of the contracts in 14 of the 19 continental European countries listed in OECD (2004) Table 3.3.



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The framework is a union wage-setting model, which is the standard framework in labour market policy analysis (see, e.g., Holmlund and Lundborg 1988, and Calmfors and Lang 1995). The simplifying assumption of a union wage-setting model makes possible obtaining analytical solutions, in contrast to more elaborate models of the impact of employment subsidies, which are analysed via calibration and numerical calculation (see, e.g., Brown, Merkl and Snower 2011).

Government intervention to further vocational training is common: According to Steedman (2010), p. 3, "In all the apprentice countries demand is still not adequate to provide for all those seeking apprenticeship and government payments to employers are available in all apprentice countries—except for England—to encourage demand."[2] If large shares of youth cohorts follow the vocational training path, the costs of employment subsidies are substantial. Subsidy schemes for large shares of youth cohorts exist in both Germany (CEDEFOP 2011a), Austria (CEDEFOP 2011b), and Denmark (Albæk 2009).

With respect to financing, several countries have financed employment subsidies for training with a levy on employment (Stevens 2001, p. 485). Firms that do not engage in training pay employment taxes, with the revenue subsidizing other firms that train workers. This article includes an analysis of the effects of this type of financing, finding that financing through employment taxes tends to counteract the purpose of the training subsidy.[3]

In Germany, financing vocational training by a employer levy is limited to the construction industry, where all enterprises pay into a joint fund used for reimbursing enterprise expenditure on training (CEDEFOP 2011a, p. 104) However, an extension of this financing scheme to other sectors is from time to time a policy issue in Germany (see, e.g., IAB 2004)[4]. In Austria, parts of the expenditures for vocational training is paid by the Family Compensation Fund, which is mainly financed by a levy on employers (CEDEFOP 2011b, p. 75). However, most of the various types of employment subsidies are financed out of general government revenue (CEDEFOP 2011b, p. 77). Financing of subsidies for vocational training by a levy on employment takes place on a full scale in Denmark (Albæk 2009).

The relevance of the analysis in this article is not confined to vocational training but can be applied to any groups of employees where attempts are made to further employment by employment subsidies. However, as vocational training is the main example, participants are hereafter termed "apprentices."

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[2] The survey includes Australia, Austria, England, France, Germany, Ireland and Switzerland, which have apprenticeship systems, and Sweden, which does not.

[3] For a treatment of the effects of taxes in models of collective bargaining, see, e.g., Sørensen (1999).

[4] For example, in 2004 the SPD and the Green party proposed in the Bundestag an employment subsidy scheme (Berufsausbildungssicherungsgesetz) for furthering apprenticeship training financed by a levy on employers (see http://dipbt.bundestag.de/dip21/btd/15/028/1502820.pdf).



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The article is organized as follows. The model is presented in section (2) and solved in section (3). The next three sections contain interpretations of the solution: section (4) considers a benchmark case in which the union values the employment of apprentices but not their wages. Section (5) extends the analysis to a case in which the union values both their employment and their wages. Section (6) analyses the effects of financing the subsidy by an employment tax. Section (7) discusses the results.

## 2. The Model

This section establishes the framework for analysing the impact of employment subsidies for apprentices. The building blocks are the specification of a union utility function and labour costs, which take into account subsidies for employing apprentices and the financing of the subsidies.

The utility function of the union is assumed to be

$$\Omega = U(n, w_n) + V(a, w_a), U_n > 0, U_{w_n} > 0, V_a > 0, V_{w_a} \gtreqless 0\,, \tag{1}$$

where the arguments are the number of employed workers or union members $n$ , the wage rate of workers $w_n$, the number of employed apprentices $a$, and the wage rate of apprentices $w_a$. The utility function is separable in utility for union members $U()$ and utility of apprentices $V()$, and the notation for the derivatives is $U_n = \partial U/\partial n$.

Demand functions derived from profit maximization are assumed to be

$$\begin{aligned} &n(c,d),\ n_c < 0,\ n_d > 0,\\ &a(c,d),\ a_c > 0,\ a_d < 0, \end{aligned} \tag{2}$$

where $c$ is the costs of employing workers and $d$ the costs of employing apprentices. These costs deviate from the wage rates as a consequence of the policy measures that the article analyses: a subsidy for employing apprentices and an employment tax for financing the subsidy.[5]

The magnitude of the subsidy is denoted $s$, and the total cost of the subsidy scheme is thus $sa$. Complete financing of the costs of subsidies by an employment tax entails the budget constraint $tn = sa$, where $t$ is the employment tax. However, to isolate the effect of financing in the deductions, I assume that the employment tax on workers covers the share $\theta$ of the subsidy costs, while the share $1 - \theta$ comes from other sources. The magnitude of the employment tax is thus $t = \theta sa/n$.

[5] The notation for the derivatives of the demand functions with respect to labour costs is $n_c = \partial n(c,d)/\partial c$. The same notation is applied in the following, when I differentiate the demand functions with respect to components of the labour costs. I make this notational choice because this notation makes the expressions and the deductions more readable.



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Full financing is a special case, as nothing prevents setting $\theta = 1$ after the derivations.

The costs of employing workers, $c$, and apprentices, $d$, become

$$c = w_n + t = w_n + \theta s a/n \tag{3}$$
$$d = w_a - s.$$

The cost of employing members is the wage rate plus the tax financing the cost of the subsidy for employing apprentices, while the cost of employing apprentices is the wage rate minus the subsidy.

As $\partial d/\partial w_a = 1$ and $\partial d/\partial s = -1$, the derivatives of the costs of employing members become

$$\frac{\partial c}{\partial w_a} = \theta s \frac{\partial (a/n)}{\partial d} < 0, \tag{4}$$
$$\frac{\partial c}{\partial s} = \theta \frac{a}{n} - \theta s \frac{\partial (a/n)}{\partial d} > 0,$$
$$\frac{\partial c}{\partial w_a} + \frac{\partial c}{\partial s} = \theta \frac{a}{n} > 0\,.$$

An increase in the wage rate of apprentices decreases the employment of apprentices (relative to the employment of members, $a/n$), reduces the cost of the subsidy scheme and the employment tax, and thus lowers the cost of employing members. An increase in the subsidy increases the employment tax to finance the subsidy both for incumbent apprentices and for the new apprentices hired as a consequence of the increase of the subsidy, and thus increases the cost of employing members. When the wage rates of apprentices increase by the same amount as the subsidy, the costs of employing apprentices remain unaltered, but the increase in the subsidy financed by the employment tax increases the cost of employing members. No employment tax, $\theta = 0$, implies $\partial c/\partial w_a = 0$ and $\partial c/\partial s = 0$.

The derivatives of the demand functions with respect to the wage rate of apprentices are

$$n_{w_a} = n_d + n_c \frac{\partial c}{\partial w_a} \tag{5}$$
$$a_{w_a} = a_d + a_c \frac{\partial c}{\partial w_a}\,.$$

An increase in the wage rate of apprentices increases the demand for members via both a direct and an indirect effect through the decrease in the employment tax to finance subsidies. Likewise, an increase in the wage rate for apprentices decreases the employment of apprentices both directly and indirectly through the decreased costs of employing members.



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The impact of the subsidy on the demand for members and apprentices becomes

$$n_s = n_d \frac{\partial d}{\partial s} + n_c \frac{\partial c}{\partial s} = -n_{w_a} + n_c \theta \frac{a}{n} \tag{6}$$
$$a_s = a_d \frac{\partial d}{\partial s} + a_c \frac{\partial c}{\partial s} = -a_{w_a} + a_c \theta \frac{a}{n} ,$$

where the second quality signs follow from application of (4) and (5). An increase in the employment subsidy decreases membership employment both in an amount corresponding to a decrease in the wage rate of apprentices and also as a consequence of the increase in the employment tax, which finances the subsidy. Likewise, an increase in the employment subsidy increases the employment of apprentices corresponding to a reduction of their wage rate and as a consequence of the higher costs of employing members when the employment tax is raised to finance the increase in the subsidy.

When the demand functions (2) are inserted into the utility function (1), the indirect utility function becomes

$$\Lambda = U(n(c,d), w_n) + V(a(c,d), w_a) . \tag{7}$$

This indirect utility function is the basis of the analysis that follows.

## 3. Solution of the Model

This section derives the impact of a subsidy for the employment of apprentices on the wage rates of apprentices and union members. The basic assumptions are that the union aims at maximizing utility and that the union sets the wage rates.

Differentiation of the indirect utility function (7) with respect to the choice parameters of the union yields the first-order conditions for utility maximization. Differentiation with respect to the wage rate for members yields

$$\Lambda_{w_n}(w_n, w_a, s) = U_n n_{w_n} + U_{w_n} + V_a a_{w_n} = 0 . \tag{8}$$

An increase in the wage rate for members results in a gain as employed members enjoy higher income, $U_{w_n}$, a loss as the employment of members decreases as a consequence of the wage increase, $U_n n_{w_n}$, and a gain when the employment of apprentices rises, $V_a a_{w_n}$. The first-order condition implies that the wage of members is increased until the gain of the increase equals the loss.

Differentiation of (7) with respect to the wage rate of apprentices yields

$$\Lambda_{w_a}(w_n, w_a, s) = U_n n_{w_a} + V_{w_a} + V_a a_{w_a} = 0 . \tag{9}$$



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The wage rate for apprentices is set to balance the gains and the losses of an increase in the wage rate: a gain for employed apprentices, $V_{w_a}$, a loss as employment of apprentices is reduced, $V_a a_{w_a}$, and a gain as employment of members increases, $U_n n_{w_a}$. The two equations (8) and (9) implicitly determine the wage rate of members $w_n$ and the wage rate of apprentices $w_a$ as functions of the subsidy $s$. I obtain the multipliers by differentiating these two first-order equations with respect to the choice variables and the policy parameter, and subsequently solve for $\partial w_n/\partial s$ and $\partial w_a/\partial s$.

Second-order partial derivatives are

$$\Lambda_{w_n w_n} = U_{nn} n_{w_n}^2 + 2U_{nw_n} n_{w_n} + U_{w_n w_n} + V_{aa} a_{w_n}^2 + U_n n_{w_n w_n} + V_a a_{w_n w_n} < 0\,, \tag{10}$$

and

$$\Lambda_{w_a w_a} = U_{nn} n_{w_a}^2 + V_{aa} a_{w_a}^2 + 2V_{aw_a} a_{w_a} + V_{w_a w_a} + U_n n_{w_a w_a} + V_a a_{w_a w_a} < 0\,. \tag{11}$$

The inequalities follow per assumption. The second-order mixed derivative is

$$\Lambda_{w_n w_a} = U_{nn} n_{w_n} n_{w_a} + U_{w_n n} n_{w_a} + V_{aa} a_{w_n} a_{w_a} + V_{aw_a} a_{w_n} + U_n n_{w_n w_a} + V_a a_{w_n w_a} \lesseqgtr 0\,. \tag{12}$$

This derivative cannot be signed without further assumptions.

I differentiate the first-order condition for the wage rate of members (8) with respect to $s$. Then I apply (6) and (12) and obtain

$$\begin{aligned} \Lambda_{w_n s} &= U_{nn} n_{w_n} n_s + U_{w_n n} n_s + V_{aa} a_{w_n} a_s \\ &= -\Lambda_{w_n w_a} + V_{aw_a} a_{w_n} + \theta \frac{a}{n} E \end{aligned} \tag{13}$$

where $E = U_{nn} n_{w_n} n_c + U_{w_n n} n_c + V_{aa} a_{w_n} a_c$. In the deduction enter changes in the slopes of the demand functions, that is, second-order partial derivatives of the demand functions. I have assumed that $n_{w_n s} = -n_{w_n w_a}$ and $a_{w_n s} = -a_{w_n w_a}$, which holds true if we look away from the financing effect of the subsidy on changes in the slopes of the demand functions.

The impact of an increase in the subsidy corresponds to a decrease in the wage rate of apprentices in the absence of the two last terms on the right-hand side of (13). In contrast to the subsidy, the wage rate of apprentices might enter into the utility function of the union ($V_{w_a} > 0$), giving rise to the middle term on the right-hand side. Although increases in wage rates are not supposed to be financed, increases in the employment subsidy are, thus giving rise to the last term on the right-hand side (when $\theta > 0$).

Next, I differentiate the first-order condition for the wage rate of apprentices (9) with respect to $s$, apply (6) and (11) and obtain the result



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$$\Lambda_{w_a s} = U_{nn} n_{w_a} n_s + V_{aa} a_{w_a} a_s + V_{w_a a} a_s = -\Lambda_{w_a w_a} + V_{w_a a} a_{w_a} + V_{w_a w_a} + \theta \frac{a}{n} F\,, \tag{14}$$

where $F = U_{nn} n_{w_a} n_c + V_{w_a a} a_c + V_{aa} a_{w_a} a_c$. The first term on the right-hand side shows that an increase in the subsidy corresponds to a decrease in the wage rate of apprentices. The next two terms arise when the wage rate of apprentices are included in the utility function of the union. The last term on the right-hand side of (14) takes into account that the subsidy is financed by an employment tax.

The system determining the multipliers with respect to the subsidy becomes

$$\begin{bmatrix} \Lambda_{w_n w_n} & \Lambda_{w_n w_a} \\ \Lambda_{w_n w_a} & \Lambda_{w_a w_a} \end{bmatrix} \begin{bmatrix} \partial w_n / \partial s \\ \partial w_a / \partial s \end{bmatrix} = \begin{bmatrix} \Lambda_{w_n w_a} \\ \Lambda_{w_a w_a} \end{bmatrix} - \begin{bmatrix} V_{a w_a} a_{w_n} \\ V_{w_a a} a_{w_a} + V_{w_a w_a} \end{bmatrix} - \theta \frac{a}{n} \begin{bmatrix} E \\ F \end{bmatrix}. \tag{15}$$

The second-order derivatives (10), (11) and (12) enter into the matrix on the left-hand side, and the derivatives of the first-order condition with respect to the policy parameter, (13) and (14), enter on the right-hand side of (15) (with the sign reversed). The determinant of the Hessian matrix is $D = \Lambda_{w_n w_n} \Lambda_{w_a w_a} - \Lambda^2_{w_n w_a}$, where $D > 0$ per assumption.

I solve the system and re-arrange the different terms with the result

$$\begin{bmatrix} \partial w_n / \partial s \\ \partial w_a / \partial s \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix} - \frac{1}{D} \begin{bmatrix} V_{a w_a} (\Lambda_{w_a w_a} a_{w_n} - \Lambda_{w_n w_a} a_{w_a}) - \Lambda_{w_n w_a} V_{w_a w_a} \\ V_{a w_a} (\Lambda_{w_n w_n} a_{w_a} - \Lambda_{w_n w_a} a_{w_n}) + \Lambda_{w_n w_n} V_{w_a w_a} \end{bmatrix} + \theta \frac{a}{n} \frac{F}{D} \begin{bmatrix} \Lambda_{w_n w_a} - \Lambda_{w_a w_a} \frac{E}{F} \\ \Lambda_{w_n w_a} \frac{E}{F} - \Lambda_{w_n w_n} \end{bmatrix}. \tag{16}$$

The solution consists of three terms on the right-hand side. These three terms corresponds to the three terms on the right-hand side of (15).

The last term on the right-hand side of (16) is the effect of financing the subsidy by an employment tax. The second term arises when the union places a positive value on a marginal increase in the wage rate of apprentices. The first term on the right-hand side of (16) is the effect of the subsidy without the effect of financing and in the absence of the wage rate of apprentices in the utility function of the union.

The next three sections contain interpretations of the solution. I interpret the three terms of the right-hand side of (16) in turn, first specializing the solution to the simplest case and then analysing the more complex cases.



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## 4. The Union Values Employment of Apprentices

This section interprets a case in which the union values the employment of apprentices but not increases in the wages of apprentices on the margin. Furthermore, this section does not consider the effect of financing the subsidy by an employment tax. The case considered in this section is the simplest and functions as a benchmark. The other two cases, considered in the following sections, contain the benchmark as a special case and are thus more complex.

I first describe how to obtain the special case that this section analyses from the general solution of the maximization problem. The interpretation of the result follows more or less directly from the process of solving the problem.

One assumption in this section is that the union places zero value on further increases in the wage of apprentices, that is, $V_{w_a} = 0$, which implies $V_{w_a w_a} = V_{a w_a} = 0$. The implication is that the second term on the right-hand side of both (15) and (16) vanishes.

Another assumption is that the subsidy is not financed by an employment tax but in some other way that does not affect the wage formation process, $\theta = 0$. This assumption implies that the third expression on the right-hand side of both (15) and (16) goes away.

The remaining part on the right-hand side of (15) is the first term, which is identical with the second column of the matrix on the left-hand side of (15). It thus follows (from Cramer's rule) that the solution is $(\partial w_n/\partial s)^a = 0$ and $(\partial w_a/\partial s)^a = 1$ as stated in (16) [6].

The impact of a subsidy for employing apprentices is an increase in the wages of apprentices by the same amount as the subsidy, while all other variables are unaffected. This sharp result has a simple and intuitive explanation. The basis for the insight is that an increase in the employment subsidy according to (15) has an impact identical to a corresponding decrease in the wage rate of apprentices.

Before the subsidy, the union decided on an optimal combination of the wage rate of members, the employment of members and the employment of apprentices, given the trade-off between the variables determined by the demand functions for members and apprentices. The introduction of the subsidy implies an increase in the employment of apprentices and a decrease in the employment of members. From the point of view of the union this result is not optimal, and the union restores equilibrium by increasing the wage rate of apprentices by the same amount as the subsidy. This increase in the wage rate leaves the employment of apprentices and members at the same level as before the subsidy, and the same holds for the wage level for

[6] To compare the magnitude of the various multipliers, I denote simpler cases than the full solution in (16) by superscripts attached to the multipliers.



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members. The union converts the employment subsidy for vocational training to an income subsidy to apprentices.

The basic assumption worth emphasizing is that the union cares about the employment of apprentices; if not, the union would make the employment of apprentices diminutive by increasing the wage rate of apprentices without bounds.

Given the assumptions in this section, a subsidy for employing apprentices is completely ineffective for obtaining the goal of the subsidy. However, when I analyse an alternative preference structure of the union, this conclusion changes.

## 5. The Union Values Employment and Wages of Apprentices

This section analyses the case in which the union values not only the employment but also the wages of apprentices. This case thus extends the analysis in the previous section, where the union values the employment of apprentices but not their wages.

The assumption is that the union places a positive but diminishing value of a marginal increase in the wages of apprentices, that is, $V_{w_a} > 0$ and $V_{w_a w_a} < 0$. The implication is that the second term on the right-hand side of (16) is non-zero. As this section does not consider the effect of financing the subsidy, the third term on the right-hand side of (16) is zero; the assumption $\theta = 0$ is maintained.

I first analyse a case in which the utility of the union is separable in apprentice employment and wages of apprentices, $V_{aw_a} = 0$; then I extend the analysis to a case in which utility is non-separable in apprentice employment and wages. Separability implies that the entities involving parentheses in the second term on the right-hand side of (16) become zero.

I denote the multipliers with superscript $b$ in the present case. The impact of the subsidy on the wages of apprentices becomes $(\partial w_a/\partial s)^b = 1 - \Lambda_{w_n w_n} V_{w_a w_a}/D$. As $V_{w_a w_a} < 0$ and as utility maximization implies $\Lambda_{w_n w_n} < 0$ and $D > 0$, the result is $(\partial w_a/\partial s)^b < (\partial w_a/\partial s)^a = 1$, where $(\partial w_a/\partial s)^a$ is the multiplier from the previous section with $V_{w_a} = 0$. The wage rate of apprentices thus increases by less than the subsidy.

This result also has an intuitive explanation: when the union cares about the wages of apprentices, the value of wage increases at the margin is diminishing, and the union will thus not allow the wage rate of apprentices to increase by the full amount of the subsidy. Further increases in the wage rate are not valued to the same extent as previous increases, making a check on the amount that wages for apprentices go up as a consequence of the subsidy. Instead, the union applies a part of the subsidy for other purposes about which the union cares, in particular the employment of apprentices.

Under the assumption in the previous section, the union did not care about the wage rate of the apprentices. This wage rate was thus set for obtaining desired levels



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of the entities that entered into the utility function of the union: employment and wages for members, and employment of apprentices. The outcome in the present case is thus the intuitive, but perhaps paradoxical, result that when the union actually cares about the wages of apprentices, the wage increase as a consequence of an employment subsidy is smaller than when the union does not care. As this result is valid on the margin, it reveals nothing about the levels of the wage rate of apprentices in the two cases.

The effect on the wage rate of members becomes $(\partial w_n/\partial s)^b = \Lambda_{w_n w_a} V_{w_a w_a}/D$. As $V_{w_a w_a} < 0$ and utility maximization implies $D > 0$, the multiplier takes the same sign as $\Lambda_{w_n w_a}$. According to the expression for the second-order mixed derivative in (12), $U_{w_n n} > 0$ is a sufficient but not necessary condition for making $\Lambda_{w_n w_a} > 0$.[7] The property $U_{w_n n} > 0$ is a standard assumption and is fulfilled when the general utility function $U(n, w_n)$ takes functional forms as for example the utilitarian utility function and the CES utility function. When $\Lambda_{w_n w_a} > 0$, I obtain the result $(\partial w_n/\partial s)^b < (\partial w_n/\partial s)^a = 0$ , where $(\partial w_n/\partial s)^a$ is the multiplier from the previous section with $V_{w_a} = 0$. The employment subsidy for apprentices entails a decrease in the wage rate of members.

Next I relax the assumption of separability between the employment and wages of apprentices, $V_{aw_a} \neq 0$, and conduct the analysis under the standard assumption $V_{aw_a} > 0$. Larger employment of apprentices increases the marginal evaluation of increases in wages of apprentices.

For ease of interpretation, I eliminate the derivatives of the demand function for apprentices in the first part in the second bracket in (16). Under standard regularity conditions, demand functions are homogeneous of degree zero in factor prices, implying $0 = a_{w_n} w_n + a_{w_a} w_a$.[8] In the expression for $\partial w_a/\partial s$, the condition for a positive term in the first part of the second bracket in (16) is $\Lambda_{w_n w_n} a_{w_a} - \Lambda_{w_n w_a} a_{w_n} > 0$, which can be rewritten as

$$\Lambda_{w_n w_n} < -\frac{w_a}{w_n} \Lambda_{w_n w_a} . \tag{17}$$

This inequality is likely to be fulfilled for two reasons. First, the wages of apprentices typically constitute less than half of the wages for members. Second, according to the expression for the determinant $D$, on average the second-order partial derivatives dominate the second-order mixed derivative in numerical value, as the geometric average of $|\Lambda_{w_n w_n}|$ and $|\Lambda_{w_a w_a}|$ is larger than $\Lambda_{w_n w_a}$.

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[7] The term in $\Lambda_{w_n w_a}$ involving $V_{aw_a}$ vanishes, as I assume $V_{aw_a} = 0$ in the first part of this section.

[8] The equation follows from applying Euler's theorem for homogeneous functions. For the homogeneity property of the demand function, see e.g. Varian (1992), p. 76. In the following deductions I approximate labour costs by wage rates.



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When the inequality (17) is fulfilled, the first part of the second bracket in the expression for $\partial w_a/\partial s$ in (16) is positive. The implication is $(\partial w_a/\partial s)^c < (\partial w_a/\partial s)^b$, where $(\partial w_a/\partial s)^b$ is the previous multiplier in this section derived under the assumption $V_{aw_a} = 0$. The assumption $V_{aw_a} > 0$ thus implies reduced incidence of the employment subsidy.

Under the assumption $V_{aw_a} > 0$, an increase in the wages of apprentices implies that the union values employment of apprentices higher. This higher valuation of employment implies a moderation of the wage increase of apprentices relative to the case where the valuation of employment is unaffected.

The analysis in this section shows that the union will increase the wage rate of apprentices with less than the subsidy if the union places a positive but diminishing value on further increases in this wage rate. Under the assumptions of this section, an employment subsidy scheme will thus be effective in furthering the employment of apprentices. However, the financing of the subsidy by an employment tax might reverse this conclusion.

## 6. The Subsidy is Financed by an Employment Tax

This section analyses the effect of financing the subsidy by an employment tax. This type of financing is common for subsidies for training purposes.

The assumption in the deductions is that the employment tax finances the share $\theta$ of the subsidy and that the rest of the subsidy is financed from other sources. The main reason for assuming partial financing is to isolate the effect of financing in the deductions. Full financing is a special case, $\theta = 1$, and the analysis thus comprises the case in which an employment tax completely finances the employment subsidy.

The effect of financing appears as the third term on the right-hand side of (16), restated as

$$\theta \frac{a}{n}\frac{F}{D}\begin{bmatrix} \Lambda_{w_n w_a} - \Lambda_{w_a w_a}\frac{E}{F} \\ \Lambda_{w_n w_a}\frac{E}{F} - \Lambda_{w_n w_n} \end{bmatrix} \begin{matrix} < \\ > \end{matrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix}. \tag{18}$$

The signs do not follow with certainty but are likely to prevail according to the following discussion.

In (18) appears the ratio

$$\frac{E}{F} = \frac{U_{nn}(n_c/a_c)^2 + U_{w_n n}\left(n_c/a_c^2\right) + V_{aa}}{-U_{nn}(n_c/a_c)^2(w_n/w_a) + V_{w_a a}(1/a_c) - V_{aa}(w_n/w_a)} < 0\,. \tag{19}$$

The sign of this fraction stems from $E < 0$ and $F > 0$, where $U_{w_n n} > 0$ is a sufficient condition for obtaining the sign of $E$ in (13), and $V_{w_a a} > 0$ is a sufficient



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condition for obtaining the sign of $F$ in (14). The expression for $E/F$ on the right-hand side of (19) follows from rearranging, approximating cost changes with wages changes (implying $n_{w_n} = n_c$, $a_{w_n} = a_c$, $n_{w_a} = n_d$ and $a_{w_a} = a_d$), and inserting $n_d/n_c = -w_n/w_a$ (which follows when the demand for members is homogeneous of degree zero in factor prices).

The first and the last utility terms in both the numerator and denominator of (19) are identical, and they tend numerically to dominate the mixed derivative utility terms in the middle. Furthermore, the term $w_n/w_a > 1$ attached to the first and the last terms in the denominator tends to make $E/F < 1$. I assume that the numerical value of the $E/F$ ratio is not so much above one that it renders the the following analysis irrelevant.

From $D = \Lambda_{w_n w_n}\Lambda_{w_a w_a} - \Lambda^2_{w_n w_a} > 0$ follows that either $|\Lambda_{w_n w_n}| > \Lambda_{w_n w_a}$ or $|\Lambda_{w_a w_a}| > \Lambda_{w_n w_a}$, or both. The positive sign in the second row of (18) follows when $|\Lambda_{w_n w_n}| > \Lambda_{w_n w_a}$ and $E/F < 1$.

Consider the case where the union values employment but does not value the wages of apprentices, implying that the second term on the right-hand side of (16) vanishes. In this case I have obtained the result $(\partial w_a/\partial s)^d > (\partial w_a/\partial s)^a = 1$, where $(\partial w_a/\partial s)^a$ is the benchmark multiplier from the section analysing the case where the union values only the employment of apprentices. The wage of apprentices increases by more than the subsidy.

The negative sign in the first row of (18) follows when $|\Lambda_{w_a w_a}| > \Lambda_{w_n w_a}$ and the ratio $E/F$ is not far below one. I have obtained $(\partial w_n/\partial s)^d < (\partial w_n/\partial s)^a = 0$ , where $(\partial w_n/\partial s)^a$ is the multiplier in the case where the union does not value further increases in apprenticeship wages. The wage of members tends to decrease as a consequence of the subsidy.

Both of these wage changes pull in the direction of a reduction in the employment of apprentices relative to the employment of members. As the $a/n$ ratio is reduced, subsidies decrease as (consequently) does the employment tax. If one of the inequalities in (18) is not fulfilled, then the other inequality tends to be fulfilled.[9]

The intuition of the result is as follows: Assume that the union reacts to the introduction of the subsidy by increasing the wage rate of apprentices by the amount of the subsidy and leaving the wage rate of members unaltered. In the benchmark case, $\theta = 0$, the union thus restores membership employment, membership wage and the employment of apprentices to the pre-subsidy levels. In the case of financing,

[9] As a check of the analystical results, I have carried out numerical calculations under the assumption of the following functional form $\Omega = n^{\delta} w_n^{1-\delta} + \gamma a^{\epsilon}$. Union utility is concave in apprenticeship employment and Cobb-Douglas in membership employment and wages, where $\gamma$ is a weighting parameter. The wages of apprentices do not enter the utility of the union. The demand functions for members and apprentices are linear in costs. The results of various calculations with alternative parameter values are: (1) subsidies without financing result in complete incidence of the subsidy. (2) When an employment tax finances the subsidy, the wage of apprentices increases by more than the subsidy, and the employment of apprentices is reduced.



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$\theta > 0$, an increase of the wage rate of apprentices by the amount of the subsidy and an unaltered wage rate of members results in increased costs of employing members and consequently a decreased employment of members. But this outcome cannot be optimal from the point of view of the union. The employment tax makes the union worse off, so the union will reduce all three entities that enter the criteria function: the decrease in membership employment is counteracted by a decrease in membership wage and a decrease in the employment of apprentices. The latter is obtained by increasing the wage rate by more than the subsidy (leading to a smaller employment tax and higher employment of members).

The expected effect of the financing scheme is thus a reduction of the employment of apprentices relative to the employment of members. The financing scheme consequently counteracts the purpose of the employment subsidy for vocational training.

## 7. Discussion

Employment subsidies for vocational training is a common instrument for furthering a high skill level of the work force. The theoretical rationale is that these subsidies might have the potential of ameliorating training market failures that lead to under-investment in human capital.

Employment subsidies for furthering vocational training are not expected to have full effect, as wage rates to apprentices are likely to increase. This article has shown good reasons for expecting higher incidence rates than in the general case of subsidies for the employment of union members.

The benchmark case in this article is an incidence rate of one, making employment subsidies for vocational training completely ineffective. This case prevails when the union values the employment of apprentices but not the wages. The employment subsidy moves the constellation of membership employment, membership wage and apprenticeship employment away from a combination that is optimal from the point of view of the union. As the assumption of the analysis is that the union determines the wage rates, the union restores the equilibrium values of membership employment, membership wage and apprenticeship employment by increasing the wages of apprentices by the amount of the subsidy.

When the union values the wages of apprentices, the incidence rate becomes less than one. While higher wages of apprentices increase the utility of the union, the utility increases at a decreasing rate as the increase in apprentice wages becomes larger. The union will thus not increase the wage rate of apprentices by the full amount of the subsidy but instead use the opportunity to make members better off by increasing membership wages and employment. This is the logic underlying the ostensively counterintuitive result that the wages of apprentices increase more when the union does not value apprentice wages compared to the case when the union values further increases in apprentices wages.



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Financing training subsidies by levies on employment is common. This article shows that employment taxes are expected to counteract the purpose of the subsidy. Financing the subsidy by an employment tax increases the cost of employing members and thus reduces membership employment. The union counteracts this drop in membership employment by increasing the wages of apprentices. The combined effects of subsidies and financing in the case where the union does not value further increases in apprentice wages is likely to be an incidence rate above one and a decreased employment of apprentices.

The theoretical analysis in this article might form the basis for an empirical test of the results. If the goal of an empirical analysis is to obtain inference about the preference structure of the union, one line to follow is that of the classic papers of Farber (1978) and MaCurdy and Pencavel (1986). A more modest research agenda is to investigate whether indications of incidence of employment subsidy schemes for vocational training actually exist. As inferred from the results of the present article, knowledge of the preference structure of the union is not sufficient for drawing conclusions about the amount of incidence; the impact of the financing scheme has to be taken into account.

The impetus of this article is the observation that apprentice wages rose considerably after the introduction of employment subsidies for vocational training in Denmark (Albæk 2009). However, the ability of aggregate time series data to form the basis of inference about the incidence of employment subsidies appears limited. Disentangling the amount of incidence of subsidies from the effect of other factors of relevance for the wage formation of apprentices is difficult. Disaggregated data or microdata appear more suited for empirical analysis of the issue of incidence of employment subsidies for vocational training.

Another observation—which is not independent of the previous one—is that the wages of apprentices in Denmark are much higher than the wages in Germany and Switzerland, which have large-scale apprenticeship systems but not large-scale employment subsidy schemes. The average wage rate of apprentices as a share of those of skilled workers is about 50 per cent in Denmark (Albæk 2009) but 27 per cent in Germany and 18 per cent in Switzerland (Ryan et al. 2010, table 6).[10] The ranking of the three countries with respect to apprentice wages is the reverse of the ranking according to the educational attainment mentioned in the introduction, as the participation rate is highest in Switzerland and lowest in Denmark. One explanation for the high apprentice wages in Denmark relative to Germany and Switzerland might be the Danish reliance on substantial employment subsidies for furthering vocational training.

The results in this article raise doubts about the effectiveness of the indiscriminate use of employment subsidies for furthering vocational training. Even when em-

[10] I have converted the ratio of apprentice wages to those of unskilled workers in Figure 3 in Albæk (2009) for the last sample year, 2002, to the ratio of apprentice wages to those of skilled workers.



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ployment subsidies have the potential for alleviating failures in the training market, good reasons exist for expecting the effects of wage formation to counteract the goals of employment subsidies.

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