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Abstract

This paper shows whether a revenue-neutral restructuring of taxes on labour has effects on the real wage and employment. We will discuss under which circumstances the composition of the tax wedge does matter from a theoretical point of view. Furthermore, we will estimate the influence of this composition on the real product wage. Empirical estimations are done with Austrian data.

Keywords: labour taxation, tax reform, real wages

JEL classification: E24, H22, J32, J51

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1 Introduction

Tax reform discussions in the last years have been concentrated on lowering the tax burden on labour. In general, it is proposed to finance such a reform with higher taxes on other factors of production (e.g. natural resources). A more or less neglected aspect in the political discussion is the revenue-neutral restructuring of labour income taxation itself. We will show that there exist remarkable theoretical and empirical results in this field.

We are interested in the effects of restructuring the taxation of labour on the real product wage and on employment. The restructuring consists of a change in the composition of the tax wedge. The tax wedge is the difference between the real product wage an employer has to pay and the real consumption wage an employee takes home.

If such a reform has favourable effects on the employment situation it would be an option for reforming the taxation of labour. In the theoretical literature there exist contradicting results on the effects of such a reform. The results depend on the kind of labour market imperfection (Koskela and Schöb 1999; Picard and Toulemonde 1999; Goerke 2002a; Goerke 2002b).

In empirical studies there is often no distinction made between the parts of the tax wedge assuming that only the total tax wedge matters for the real wage and employment. Empirical work on this subject often discuss only the effects of the overall wedge on wage-setting (e.g. Bean et al. 1986, Knoester and van der Vindt 1987, Daveri and Tabellini 2000).

Tyrväinen (1995) tests the restriction of one single coefficient on different parts of the tax wedge in a wage-setting equation. Only for two (USA and Sweden) out of ten OECD countries this restriction was rejected. A wage-setting equation for Austria is estimated in Pichelmann (1993) and Hofer and

Pichelmann (1996). They differentiate between taxes paid by employers and those paid by employees. But their results are not significant.

Our work is a further piece of empirical evidence which should shed light on the issue. We proceed as follows. Section 2 presents theoretical results for our analysis. In Section 3 the empirical model and the data are discussed. Estimations are done with Austrian data. Section 4 presents the estimation results and section 5 concludes.

2 Theoretical Results

Whether it makes a difference which side of the labour market is taxed depends on the theoretical framework. In perfectly competitive markets taxes paid by workers have the same effects on the labour market as taxes paid by firms. In this case it does not matter which side of the labour market is taxed (Dalton 1954; Symons and Robertson 1990; Muysken et al. 1999; Picard and Toulemonde 1999). Sometimes this result is called Dalton's Law or the Invariance of Incidence Proposition (IIP). This equivalence result does not hold in models with imperfect competition.

There are two kinds of the IIP. The effects of a restructuring can be analyzed under the assumption of (1) constant tax revenues or (2) a constant tax wedge. For competitive labour markets the two kinds are equivalent. Our analysis is concentrated on the first version. On imperfectly competitive labour markets this version of the IIP does not hold in any case and does not have to be equivalent with the second version (Goerke 2002a: 218).

Picard and Toulemonde (1999) work out the conditions under which a revenue neutral restructuring of taxes will not change the employment level. They find that a revenue neutral tax reform is irrelevant to employment if the wage setting process depends only on the net wages and the labour costs. This condition is fulfilled in a competitve labour market. Even if the unemployment benefits matter the restructuring is irrelevant if net and gross wages remain constant and if the unemployment benefit depends only on the net wage. They discuss how this conditions are violated by models with imperfect competition on the labour market (minimum gross wages, efficiency wage models and wage bargaining models). If the conditions are violated employment can be changed by restructuring labour taxation. In all the models it turns out that the key condition for irrelevance is that the unemployment benefit is related only to the net wage or a constant. Picard and Toulemonde (1999) discuss only linear taxes. But they mention (p. 9), that the introduction of tax progression will strengthen their results.

It can be shown that in a right-to-manage model with a Nash bargaining solution a revenue-neutral tax reform has effects on wages and employment. (Koskela and Schöb 1999; a similar model can be found in Muysken et al. 1999). The model consists of firms, trade unions and the government. There are many firms and trade unions so that they see the decisions of the government as exogenously given.[1]

The representative firm uses capital *K* and labour *L* to produce the good *Y*. The production function is linear-homogenous, the elasticity of substitution σ is constant and $\rho = (\sigma - 1)/\sigma$:

$$Y = \left(K^{\rho} + L^{\rho}\right)^{\frac{1}{\rho}}. \tag{1}$$

[1] At first sight, the monopoly union model would seem better suited to describe the Austrian case with a centralized wage determination process. But in such a model the trade union is able to set the wage. As we can oberserve bargaining about the wage a right-to-manage model will probably fit better the facts (Goerke 2002b: 12).

We assume imperfect competition on the goods market. The downward sloping demand curve of the firm is given by $D = p^{-\varepsilon}$. The demand elasticity of the firm is $\varepsilon \equiv -D_p\left(p / D\right)$. The production *Y* of the firm equals the demand *D*. The profits of the firm are

$$\pi = pY - \widetilde{w}L - rK \,. \tag{2}$$

The firm considers the interest rate *r* and labour costs $\widetilde{w}$ as given. The wage paid by firms (= labour costs) is the sum of the gross wage *w* and the payroll tax with rate t_p: $\widetilde{w} = w\left(1 + t_p\right)$. To keep things simple we do not consider fixed costs.

The wage elasticity of labour demand $\eta_{L,\widetilde{w}} \equiv L_{\widetilde{w}} w / L < 0$. The profit-maximizing firm demands labour up to the point where the marginal productivity of labour is equal to the real wage corrected with the demand elasticity (Franz 1999:125; Koskela and Schöb 1999).

The representative trade union is situated at the firm level and has *N* members. We asssume that all workers (employed or unemployed) are members of the trade union. The objective of the trade union is to maximize the income of its members. Each employed worker supplies one unit of labour. An employed worker has a wage income of *w* and has to pay a wage tax with rate t_w. There is a personal tax allowance *a* and a tax credit *c*. Unemployed workers get an unemployment benefit *b*. We assume individual utility to be linear in wages, i.e. workers are risk neutral. The utilitarian objective function of the trade union can be written as the sum of the income of all workers:

$$V^* = \left[w\left(1 - t_w\right) + t_w a + c\right]L + b\left(N - L\right). \tag{3}$$

The trade union and the firm bargain only about the wage *w*. On the basis of the bargaining result the firm makes the labour demand decision. The bargaining partners consider the tax rates and the unemployment benefits as given. We assume that the outcome of this bargaining is determined by the asymmetric Nash-solution. The fall-back position of the trade union is $V^0 = bN$. In this case all workers are unemployed and get benefits. For simplicity we define $V \equiv V^* - V^0$. The fall-back position of the firm is given by $\pi^0 = 0$. From this information follows the Nash maximand with the bargaining power of the trade union β:

$$\Omega = V^{\beta} \pi^{1-\beta}. \tag{4}$$

The optimal wage can be found with the first order condition $\Omega_w = 0$ and the second order condition $\Omega_{ww} < 0$. Detailed derivations can be found in Koskela and Schöb (1999). We will concentrate on the main results and give some intuitive interpretation.

The effects of a revenue-neutral restructuring on wages can be analyzed by means of the government budget constraint. Government expenditure *G* is equal to the difference between tax revenue *T* and unemployment benefits *B*:

$$G = T - B,$$

$$\text{i.e. } G = \left[\left(t_w + t_p\right)w - t_w a - c\right]L - b\left(N - L\right). \tag{5}$$

On the basis of this constraint we can discuss a revenue-neutral tax reform which reduces the payroll tax rate t_p (paid by firms) and increases the wage tax rate t_w (paid by workers)

$$dG = G_{t_p} dt_p + G_{t_w} dt_w = 0. \tag{6}$$

The effects of the revenue-neutral restructuring are (Koskela and Schöb 1999):

$$\left.\frac{d\tilde{w}}{dt_w}\right|_{dG=0} \begin{Bmatrix} < \\ = \end{Bmatrix} 0 \Leftrightarrow a \begin{Bmatrix} > \\ = \end{Bmatrix} 0 . \tag{7}$$

The intuition of this result is the following. The base of the wage tax is narrower than the base of the payroll tax as there is a non-zero level of tax exemption in form of the personal tax allowance a. The tax base of the payroll tax is wL whereas the wage tax base is $(w-a)L$. As the bases are different the tax reform will lead to a higher marginal tax rate $T^{'} = T_w = t_w + t_p$; i.e. the increase in the wage tax rate has to be higher than the fall in the payroll tax rate. In the revenue-neutral case the average tax rate $\overline{T} = T / w = t_w + t_p - (t_w a + c)/w$ is constant. Please note, T' and $\overline{T}$ are calculated with respect to *w*. Let us measure tax progression as average rate progression (Atkinson and Stiglitz 1980, 37):

$$ARP = \overline{T}_w = (t_w a + c)/w^2 = (T' - \overline{T})/w . \tag{8}$$

If ARP is positive the tax system is progressive. If the difference of the tax rates increases for a given (or in our case falling) wage level tax progression is higher than before. The tax reform in question results in a higher ARP and this effect drives the results (Koskela and Schöb 1999). A higher progressivity decreases the gross wage rate in unionized labour markets because a wage increase turns out to be less profitable from a trade union's point of view. This fall in the wage rate will have positive employment effects. If the tax bases are equal such a reform will have no effects on the gross wage rate and employment. The last result also holds if tax exemption is only in the form of a tax credit, which can be deducted from the tax payments.

All in all, the theoretical models stress the importance of the non-equivalence case. From the right-to-manage model of Koskela and Schöb (1999) we get predictions for the direction of the effects on wages. A revenue-neutral restructuring from payroll to wage taxes should result in lower wages. In section 3 we make up our empirical model and discuss the available data for the Austrian case.

3 Empirical Model and Data

From section 2 and other prior information on the right-to-manage model with taxes on labour we can derive a long-run relationship in form of a wage-setting function. This relationship should be between the real product wage (*WCR*), the labour productivity (*PR*), the unemployment rate (*UR*), the total tax wedge (*TAXT*) and the structure of the tax wedge (*TAXDIFF*). The wage-setting function has the following form:[2]

$$WCR = WCR\left(\underset{+}{PR}, \underset{-}{UR}, \underset{+}{TAXT}, \underset{+}{TAXDIFF}\right) \tag{9}$$

In the theoretical discussion the real product wage (*WCR*) was represented by $\widetilde{w}$. It is calculated by means of the GDP deflator. As a result of the marginal productivity condition *WCR* depends on labour productivity *PR*. It is shown in a very similar right-to-manage model that the wage WCR increases with the bargaing power of the trade union β and the total tax wedge *TAXT* (Muysken et al. 1999). As the bargaining power is an unobservable variable let us assume that β depends negatively on the unemployment rate. Hence the unemployment rate is used as a proxy for the bargaining power. A higher unemployment rate should result in a lower product wage (Tyrväinen 1995). As we have seen in section 2, the structure of the tax wedge (*TAXDIFF*) should have a positive effect on *WCR* because the progressivity decreases if *TAXDIFF* increases.

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[2] Subscripts indicate the direction of the influence derived from the right-to-manage model.

Our data is mainly taken from the national accounts of Austria and from the database of the Austrian Institute of Economic Research (WIFO database). Descriptive statistics and a detailed description of the data are given in Appendix A. Graphs of the time series and their first differences are given in Appendix B. In addition to the explanations in Appendix A we will discuss the overall tax wedge (*TAXT*) and the structure of the tax wedge (*TAXDIFF*).

We assume revenue-neutrality of the tax restructuring. Using the total tax on labour income as a regressor takes this assumption into account. In this way, wage and employment effects of the tax restructuring are not influenced by the level effects.

The total tax on labour income can be described by the wedge (*TAXT*) between the real product wage (*WCR*) and the real consumption wage (*WNR*). The wedge is in real terms to take into account the influence of price indices. The product wage equals the real cost of a worker to an employer and the consumption wage are the net wages and salaries in real terms. We measure the tax wedge by the ratio of the real product wage to the real consumption wage. The overall tax wedge is therefore:

$$TAXT = \frac{WC / PGDP}{WN / CPI} = \frac{WCR}{WNR} \tag{10}$$

The wedge includes social security contributions of employers and employees, the tax on labour income, some minor parts and differences between the price indices. All parts which are formally levied on employees (e.g. contributions for social security and the labour income tax) are called "wage tax", parts levied on employers (e.g. contributions for social security) are called "payroll tax" (see Figure 1). The level of the wedge is increasing from 1.42 in 1965 to 1.76 in 1997. But there are also a few years with a falling wedge: e.g. 1971 to 1973, 1986, 1987 and 1989 (see Appendix B).

> Figure 1 about here <

The non-equivalence results are driven by a change in progressivity. We do not directly measure the progressivity of labour taxation. We make use of the fact that the change in progressivity is the result of a change in the composition of the wedge and a difference in the tax bases.

In Austria the two tax bases (payroll tax and wage tax) fulfil the theoretical assumptions. The "payroll tax" consists mainly of employer's compulsory social security contributions, and the "wage tax" consists of the personal income tax, employees' compulsory social security contributions and the compulsory contributions to the chamber of labour. The current social security contribution rate for employers is 21.8 % and for employees 18.2 % of the gross wage for a blue-collar worker. Contributions have only to be paid up to a gross wage of € 3.270,-- per month (ceiling). The personal income tax is also calculated on the basis of the gross wage. The rate schedule consists of marginal tax rates from 0 to 50 %. There are a number of tax allowances (e.g. minimum allowance, employees' social security contributions, work-related expenses, special expenses). Without doubt the base of the wage tax is smaller than that of the payroll tax (Hauptverband der österreichischen Sozialversicherungsträger 2002; OECD 2002).

The change in the composition of the wedge takes place through an increase of the wage tax and a decrease of the payroll tax. Therefore, we use data on the composition of the total tax wedge. We describe the structure of the wedge with the percentage levied formally on the employers (*TAXDIFF)*:

$$TAXDIFF = \left(\frac{WC}{W} - 1\right) \Bigg/ \left(\frac{WC - WN}{W}\right) \tag{11}$$

For the calculation of the total tax wedge (*TAXT*) we use the real product wage (*WCR*) and the real consumption wage (*WNR*), whereas the structure of the wedge (*TAXDIFF*) is derived from the compensation per employee (*WC*), the gross wages and salaries per employee (*W*) and the net wages and salaries per employee (*WN*). A detailed calculation of *WN* can be found in Figure 1. *TAXDIFF* is measured without the price indices to isolate the influence of the structure.

The change in the structure of the wedge has two characteristics (see Appendix B). First, there is a decrease in the employers' part from about 50 % in the 1960s to about 45 % in the 1990s. More and more of the total tax wedge was levied formally on the employees. In our theoretical model this leads to higher progressivity. Second, from time to time there are also increases in the employers' part with (local) maxima in 1968, 1975, 1984 and 1989. At the end of our time period there is a strong decrease to 42.5 % (1997).

The national accounts data of Austria inform about the complete tax wedge and the decomposition of the wedge into the two parts of interest. Unfortunately, we have only annual data about the composition of the tax wedge. Quarterly data is only available for the compensation of employees (*WC*) and the gross wages (*W*), but not for net wages (*WN*). Consequently, we have to use annual data.

After this description of our data we have to check it for non-stationarity. From the graphs of the time series and their first differences in Appendix B two facts can be seen immediately. With the exception of *TAXDIFF* all levels of our series are increasing over time. The first differences do not show such clear-cut developments. Only the first difference of the real product wage (*dWCR*) shows a long lasting decrease.

The following tests are applied to the series in logarithmic form. We use the augmented Dickey-Fuller (ADF) test for unit roots. After a first visual check of the data, we follow the systematic procedure described in Enders (1995: 257).

We check our data for the presence of deterministic regressors (intercept, time trend) and decide about the lag length of the diffference term based on information criteria. And we check whether the residuals of our tests are white noise. If we cannot reject a unit root in the level of our time series we apply the tests to the first differences. The results of these tests are summarized in Table 1:

> Table 1 about here <

The second column of Table 1 reports the ADF test statistics for the level of our time series. In brackets we give information on the assumed data generating process. We cannot reject the null hypothesis of a unit root for all of our data. The results for the ADF tests on the first differences are in the third column of Table 1. We are able to reject the null hypothesis of a unit root for all our time series. We can conclude that all our data is integrated of order one, i.e. I(1).

Our theoretical results are about long run relationships between the levels of the data. We cannot straightforwardly estimate our wage-setting function with the non-stationary data. We could work with the stationary first differences. But in this case, we would loose information about the long-run relationships. Therefore we have to search for cointegrating vectors in our data. We estimate an error-correction model to estimate the long-run relationships and the short-run adjustments in the case of deviations from the long-run equilibrium. We think that in addition to the wage-setting equation there are also other cointegrating vectors in our data (e.g. labour demand equation). As we assume more than one cointegrating vector we use Johansen's procedure for our estimations in Section 4.

4 Estimation results

With the Johansen procedure we make use of maximum likelihood estimators to test for multiple cointegrating vectors (Johansen 1988; Johansen 1995; Johansen 2000; Patterson 2000; Hansen and Juselius 2002).[3]

We estimate our model within a vector error-correction (VECM) framework. At the beginning the five non-stationary variables are treated as jointly endogenous. The number of the variables is denoted by *p*. The variables are in logarithmic form (indicated by lower-case letters) with the exception of the unemployment rate (*UR*). Let us define the vector $z_t' = [wcr_t \quad pr_t \quad UR_t \quad taxt_t \quad taxdiff_t]$ and write the 5-dimensional VAR in the following way:

$$z_t = A_1 z_{t-1} + \ldots + A_k z_{t-k} + \mu + \varepsilon_t, \quad t = 1,\ldots,T. \tag{12}$$

μ is a constant and the errors ε_t are niid $(0,\Sigma)$. k is the maximum lag length of the VAR. In order to distinguish between long-run relationships and short-run adjustments we reformulate our VAR as a VECM:

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{k-1} \Delta z_{t-k+1} + \Pi z_{t-1} + \mu + \varepsilon_t, \quad t = 1,\ldots,T. \tag{13}$$

Π is a $p \times p$ matrix. The rank *r* of matrix Π is equal to the number of cointegrating vectors. The hypothesis of cointegration is therefore the hypothesis H_1 of reduced rank of Π:

$$H_1(r): \Pi = \alpha\beta', \tag{14}$$

[3] Estimations were done with CATS in RATS Version 1.0 and with Microfit 4.0.

where α and β are $p \times r$ matrices of full rank. The β_{ij} are the cointegrating parameters and the relations $\beta' z_{t-1}$ are the stationary long-run equilibriums. The situation $\beta' z_{t-1} \neq 0$ indicates an error in this equilibrium. The α_{ij} measure the speed of adjustment towards the long-run equilibrium and are called loadings. For illustration we can write down these matrices for an assumed rank of 2:

$$\Pi z_{t-1} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \\ \alpha_{41} & \alpha_{42} \\ \alpha_{51} & \alpha_{52} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} & \beta_{41} & \beta_{51} \\ \beta_{12} & \beta_{22} & \beta_{32} & \beta_{42} & \beta_{52} \end{bmatrix} \begin{bmatrix} wcr_{t-1} \\ pr_{t-1} \\ UR_{t-1} \\ taxt_{t-1} \\ taxdiff_{t-1} \end{bmatrix} \tag{15}$$

If there are more than one cointegrating vector we have an identification problem. In order to just identify the long-run relationships we need r^2 restrictions. In addition, we can test overidentifying restrictions on β and restrictions on α.

The Johansen procedure is implemented through the following steps: (1) pretest the variables on their order of integration, (2) determine the order of the underlying VAR, (3) decide whether to include deterministic terms in the VECM, (4) estimate the VECM and determine the rank of Π, (5) impose the just identifying restrictions on β, (6) test overidentifying restrictions on β and (7) test restrictions on α.

From the pretests in section 3 we know that our five variables are I(1). In addition to the non-stationary variables we include a constant μ in the underlying VAR. Dummies or other non-stochastic elements are not considered.

The order of the underlying VAR is usally decided on the basis of model selection criteria. The Schwarz Bayesian criterion indicates a lag order of 1, whereas the Akaike information criterion points to a lag order of 3 or even higher. A lag order of 1 is not very useful as in this case there would not be lagged first differences in the VECM. So we start with a lag order of 2 and check the residuals of the individual equations in the VAR for serial correlation. For 4 of the 5 individual equations the null hypothesis of no serial correlation can be rejected on the basis of Lagrange multiplier test at a significance level of 10 %. To get rid of the serial correlation we increase the lag order to $k = 3$. With this higher lag order we can reject no serial correlation only in 2 cases at a significance level of 10 %. As our VAR may already be over-parameterized in respect to the number of observations we cannot increase the number of lags and stay with a lag order of 3.

From the unit root tests we know that some of our variables have deterministic trends in the level of the time series and that is why we include unrestricted intercepts in the VECM. This specification allows for linear trends in the data and assumes no trends in the cointegrating relationship.

On the basis of this decisions we estimate our VECM with unrestricted intercepts and a lag order of 3. The Johansen estimates to determine the rank r are given in Table 2:

> Table 2 about here <

The maximum eigenvalue and the trace statistics reject the null hypotheses of $r = 0$ and $r \leq 1$ at a significance level of 5 %. The null hypothesis of $r \leq 2$ cannot be rejected at a level of 5 %. This indicates that there are two cointegrating vectors. Unfortunately, the small sample distributions of the Johansen tests are not known. But due to a small sample bias the tests too often indicate cointegration. Reimers (1992) proposed an adjustment of the statistics. To get rid of the bias the statistics should be scaled down by $(T - pk)/T$, where T is the number of observations. Because of the small number of observations this adjustment factor would be very large in our case (0.55). An application of this extreme adjustment would lead to an acceptance of $r = 0$ which means no cointegration at all.

Further information for our decision is provided by a graphical analysis of the estimated cointegrating relationships (Figure 2). The estimated disequilibrium $\hat{\beta}' z_t$ is shown in the upper graph. The series in the lower graph is corrrected for the short-run effects. This latter series is tested for stationarity in the decision on *r*. Both lower graphs look very much like a stationary series. Summing up the information, we estimate our VECM on the basis of $r = 2$.

> Figure 2 about here <

In the following steps, we have to find out whether one of the two vectors could be our wage-setting equation. We have no clear idea about the nature of the second vector. It could be, for example, a labour demand or a price-setting equation.

To identify the vectors we have to impose restrictions. We try to identify the wage-setting equation and look which variables are part of the second vector. We normalize both vectors on the real product wage *wcr* (Table 3 a). The second normalized eigenvector looks like a wage-setting equation. We impose an additional restriction $\beta_{12} = -\beta_{22}$ to identify the vector β_2. This restriction on the coefficient of labour productivity in a wage-setting equation is well documented in the empirical literature (e.g. Muysken et al. 1999). The wage-setting equation in Table 3 b) looks quite good but we do neither get standard errors nor a test on the restriction in this case.

> Table 3 about here <

Further restrictions are imposed on the first vector. As we have no clear idea about the nature of this vector we will impose and test restriction after restriction until the restricted case is rejected. If the vector is, for example, a kind of price-setting equation we do not see a strong argument for the inclusion of $taxdiff_t$. The concerning restriction $\beta_{51} = 0$ sets up the just identifying case (Table 3 c). The unrestricted coefficients in the wage-setting equation are all significantly different from 0 at the 5 % level and have the theoretically predicted signs. Note, that in the vector the signs are reversed as we have normalized on *wcr*. We still cannot test the restrictions. At least this second restriction on β_1 did no the change the coefficients in the wage-setting equation.

In the overidentifying cases we impose restrictions in addition to the just identifying ones. This restrictions can be tested with a likelihood ratio (LR) test. In Table 3 d) we impose the restriction $\beta_{41} = 0$ to test whether the total tax wedge $taxt_t$ is part of the first vector. This restriction cannot be rejected at a significance level of 10 %. The coefficients of the wage-setting equation are estimated more precisely and do only slightly change. We get nearly the same results for the overidentifying restrictions $\beta_{31} = \beta_{41} = 0$ (Table 3 e).

The last overidentifying restrictions we test are $\beta_{21} = \beta_{31} = \beta_{41} = 0$. From a non-rejection of these restrictions we would conclude that wcr_t is stationary. We can reject these restrictions at a significance level of 10 %. In addition, our ADF tests cannot reject non-stationarity for wcr_t. Note, that the two tests have different null hypotheses.

The last step in the specification of the long-run system is testing the variables for weak exogeneity. A variable of our VECM, e.g. UR_t, is weakly exogenous if the loadings of this variable $\alpha_{31} = \alpha_{32} = 0$. In this case the equation for ΔUR_t does not have information on the long-run coefficients and

UR_t is weakly exogenous for the parameters of interest α and β. The system can be conditioned on the marginal distribution of ΔUR_t. Such a conditioning can improve the statistical properties of the model (Patterson 2000: 676).

We take the restricted system of table 3 e) and impose restrictions on the loadings α. In effect, we test simultaneously the restrictions on α and β. Each variable is first tested individually for weak exogeneity with respect to the parameters of interest. We find rejection of the null hypothesis of weak exogeneity for wcr_t and pr_t at a significance level of 1 % and for $taxdiff_t$ at the 10 % level. For UR_t and $taxt_t$ weak exogeneity could not be rejected at the 10 % level. Do include a group of exogenous variables we make use of joint tests. Only for the group UR_t and $taxdiff_t$ weak exogeneity was not rejected at the 10 % level. In Table 4 the unrestricted adjustment coefficients are compared with the restricted ones for the overidentified cointegrating vectors of Table 3 d).

> Table 4 about here <

In the restricted case the loadings of $\Delta taxt$ are not significantly different from 0 at a significance level of 10 %. Whereas the loadings of Δwcr and Δpr are significantly different from 0 at the 1 % level. The absolute value of -0.397 of α_{12} means that it takes 2 ½ years that the real product wage wcr has adjusted to its equilibrium value. Also α_{22} has reasonable sign and size. The adjustment process in the wage-setting equation is quite fast.

The specification of the long-run structure is now completed (Table 3 f). We end up with the overidentifying case: $\beta_{31} = \beta_{41} = 0$ and restrictions on α: $\alpha_{31} = \alpha_{32} = 0; \alpha_{51} = \alpha_{52} = 0$. All unrestricted coefficients of β are significantly different from 0 at the 1 % level. The first vector is a relationship between the real product wage and labour productivity. And the second vector is the wage-setting equation. In the long-run there is a slight negative relationship between wcr_t and ur_t. In contrast to this, the relationship between the real product wage and the tax variables ($taxt_t$ and $taxdiff_t$) are rather strong. The results are in line with the wage-bargaining model of section 2. We also tested the residuals of the restricted system. Multivariate tests cannot reject the null-hypothesis of no autocorrelation and normality at the 10 % level (see Hansen and Juselius 2002 for detailed information on these tests).

Note, the VECM in (13) is a kind of reduced form error correction model. Therefore we have not identified the short-run structure. The adjustment coefficients of Table 4 are functions of the error correction coefficients of the structural error correction model. But the long-run relationship $(\beta' z_{t-1})$ is identified as it is the same in the structural and the reduced form of the error correction model (Patterson 2000: 634).

5 Conclusions

In a competitive labour market a revenue-neutral restructuring of taxes on labour has no effects on real wages and employment. But in the more realistic setting of imperfect competition on the labour market such a tax reform is no longer neutral. The effects depend on the kind of labour market imperfection. We argue that within a right-to-manage model a restructuring from payroll to wage taxes will decrease wages and have positive employment effects. This result is driven by the difference in the tax bases and the resulting change in progressivity of labour taxation.

In the empirical part we estimate a VECM with Austrian data. We are able to identify the long-run structure of the model. In particular we get a wage-setting equation as one of the cointegrating relationships. The results are in line with the right-to-manage model. A restructuring from taxes paid by employers to taxes paid by employees has a statistically significant negative effect on the real product wage.

Our sample is too small for the inclusion of additional variables (e.g. unemployment benefits, aggregate demand). In particular, we did not identify a labour demand or price-setting equation. Therefore we lack empirical results for the effects on the employment situation. In addition, we did not answer how the reform influences the purchasing power of workers and aggregate demand. Such results would be necessary to derive clear-cut policy implications.

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Appendix A: Descriptive statistics and detailed description of the data

Variable	Mean	Minimum	Maximum	Standard deviation	Observations
PR	360597	202188	497251	84905	33
TAXDIFF	0.468	0.425	0.508	0.018	33
TAXT	1.56	1.39	1.76	0.11	33
UR	3.85	1.50	7.10	1.89	33
WCR	18504	10666	23997	4126	33

Correlation matrix:

	PR	*TAXDIFF*	*TAXT*	*UR*	*WCR*
PR	1.00				
TAXDIFF	-0.75	1.00			
TAXT	0.93	-0.68	1.00		
UR	0.83	-0.45	0.87	1.00	
WCR	0.99	-0.73	0.92	0.81	1.00

Detailed description:

***PR*:** labour productivity = real GDP (1983 = 100)/employed (employees and self-employed). Sources: WIFO database and own calculations.

***TAXDIFF*:** structure of the wedge = $[(WC/W)-1]/[(WC-WN)/W]$, WC … compensation per employee (nominal, per month, in ATS), W = gross wages and salaries per employee (nominal, per month, in ATS), WN = net wages and salaries per employee (nominal, per month, in ATS). Sources: Österreichisches Statistisches Zentralamt (1979-98) and own calculations.

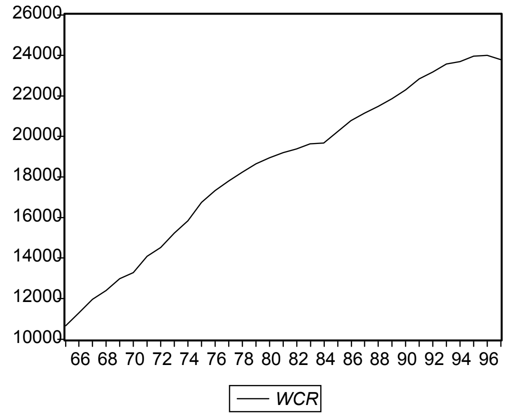
***TAXT*:** overall tax wedge $= WCR/WNR$, WNR = real consumption wage $= 100 \times WN/CPI$, CPI = consumer price index (VPI I, 1983 = 100). Sources: Österreichisches Statistisches Zentralamt (1979-98), WIFO database and own calculations.

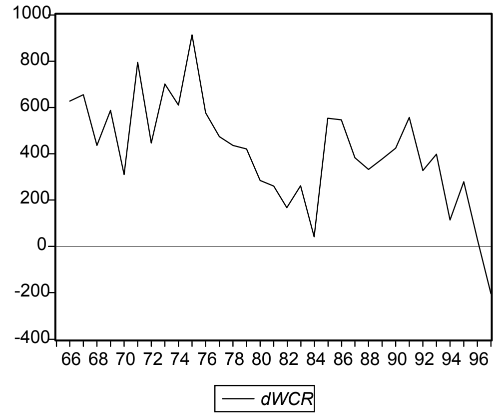
UR: unemployment rate, registered unemployed as a percentage of employees (employed and unemployed). Source: WIFO database.

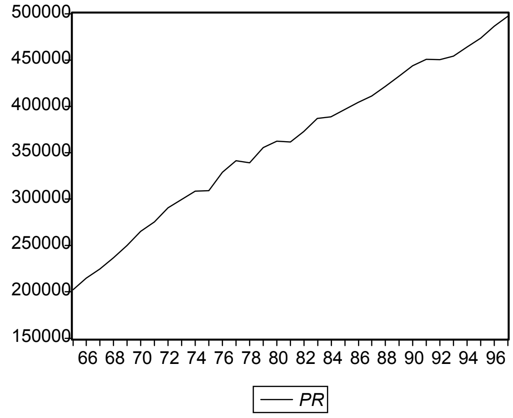
***WCR*:** real product wage = *100WC/PGDP*, *PGDP* = GDP deflator (1983 = 100). Sources: Österreichisches Statistisches Zentralamt (1979-98), WIFO-Database and own calculations

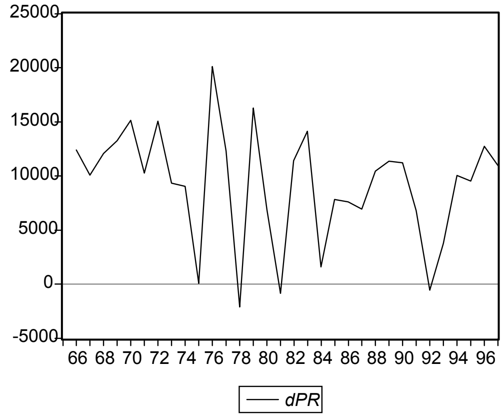
The sample starts in 1965 and ends in 1997.

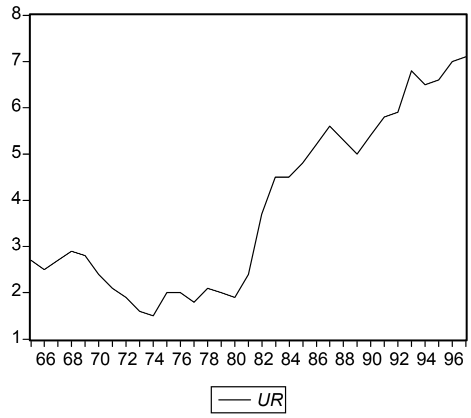
Appendix B: Time series and their first differences (in non-logarithmic form)

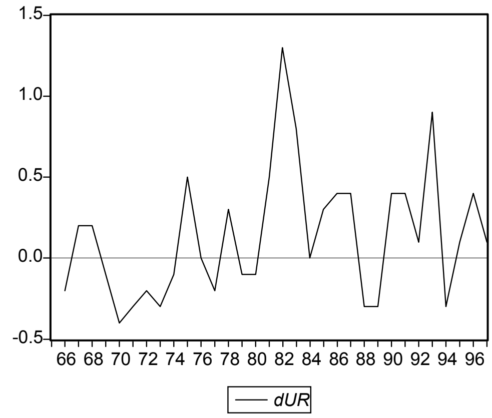












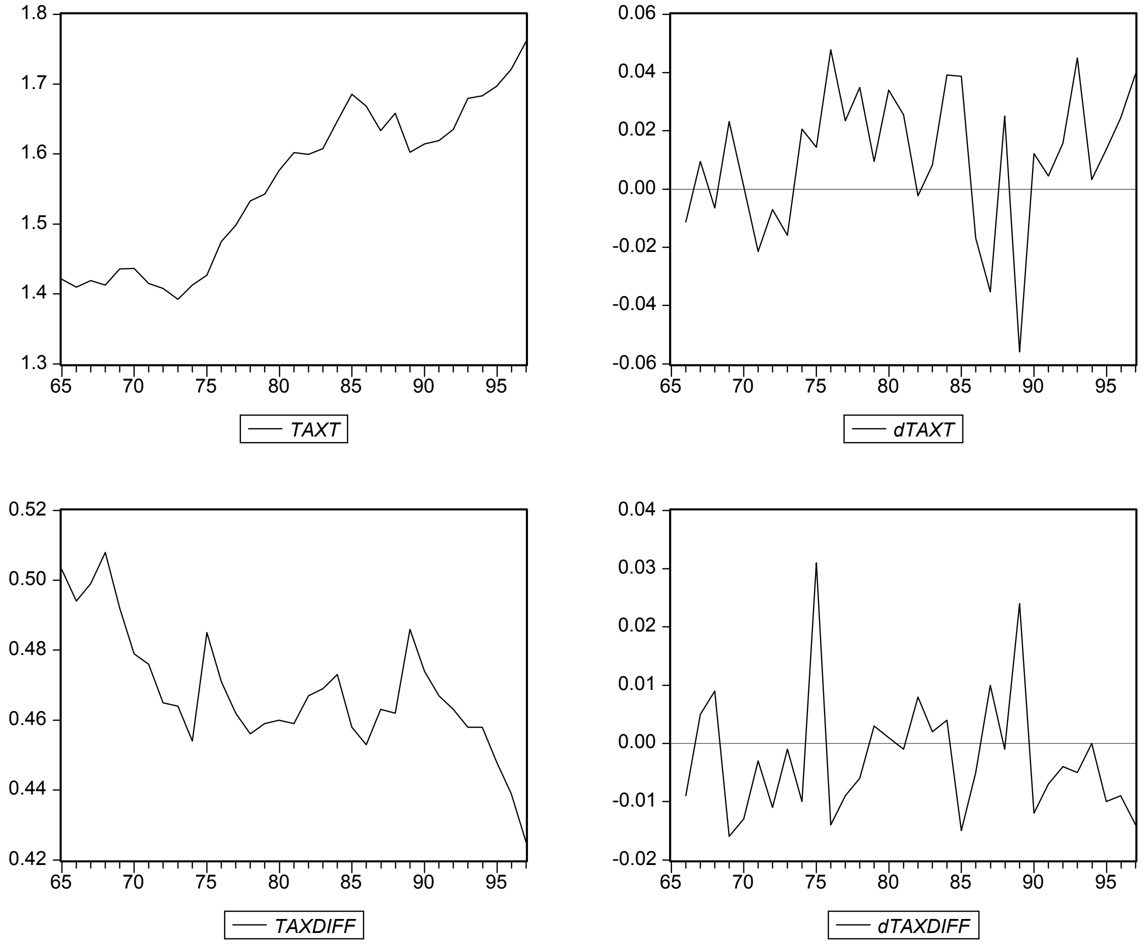

1.8
1.7
1.6
1.5
1.4
1.3
65 70 75 80 85 90 95
TAXT
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
65 70 75 80 85 90 95
dTAXT
0.52
0.50
0.48
0.46
0.44
0.42
65 70 75 80 85 90 95
TAXDIFF
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
65 70 75 80 85 90 95
dTAXDIFF

Table 1: Unit root tests

Variable	x	d(x)	I(x)
pr	-3.06 [t,0]	-4.37 [c,0]***	I(1)
taxt	-1.80 [t,0]	-4.04 [n,0]***	I(1)
taxdiff	-1.39 [c,0]	-5.98 [n,0]***	I(1)
UR	-0.75 [c,3]	-2.00 [n,2]**	I(1)
wcr	-0.48 [t,2]	-2.24 [n,1]**	I(1)

Notes: Variables, except *UR*, in logarithms. Sample from 1965 to 1997.
[z,#]: z = [n,c,t]
n ...... neither constant nor trend included
c ...... constant included
t .... trend and constant included
...... number of lags included
* .... significant rejection of unit root hypothesis at 10 % level
** ...... significant rejection of unit root hypothesis at 5 % level
*** .... significant rejection of unit root hypothesis at 1 % level

Table 2: Johansen estimates

Null	Alternative	Statistic	95% Critical value	90% Critical value
		Cointegration LR test based on maximal eigenvalue statistics		
$r = 0$	$r = 1$	44.2425	33.6400	31.0200
$r \leq 1$	$r = 2$	36.8824	27.4200	24.9900
$r \leq 2$	$r = 3$	18.8538	21.1200	19.0200
$r \leq 3$	$r = 4$	11.7046	14.8800	12.9800
$r \leq 4$	$r = 5$	0.03531	8.0700	6.5000
		Cointegration LR test based on trace statistics		
$r = 0$	$r \geq 1$	111.7187	70.4900	66.2300
$r \leq 1$	$r \geq 2$	67.4761	48.8800	45.7000
$r \leq 2$	$r \geq 3$	30.5937	31.5400	28.7800
$r \leq 3$	$r = 4$	11.7399	17.8600	15.7500
$r \leq 4$	$r = 5$	0.03531	8.0700	6.5000

Notes: 30 observations from 1968 to 1997. Cointegration with unrestricted intercepts and no trends in the underlying VAR. Order of VAR = 3. List of variables included in the cointegrating vector: *wcr, pr, UR, taxt, taxdiff*. List of eigenvalues in descending order: 0.77116; 0.70754; 0.46659; 0.32305; 0.0011763 .

Table 3: Long-run relationships (standard errors in parantheses)

wcr	*Pr*	*UR*	*taxt*	*taxdiff*
		a) normalized eigenvectors		
1.000	-0.818	-0.002	0.134	-0.305
1.000	-1.149	0.017	-0.464	-0.768
		b) restriction to identify β_2 : $\beta_{12} = -\beta_{22}$		
1.000	0.143	-0.057	1.866	1.037
1.000	-1.000	0.009	-0.195	-0.560
		c) just identifying restrictions: $\beta_{12} = -\beta_{22}; \beta_{51} = 0$		
1.000	-0.600	-0.014	0.527	0.000
	(0.045)	(0.005)	(0.211)	
1.000	-1.000	0.009	- 0.195	-0.560
		(0.002)	(0.084)	(0.084)
		d) overidentifying restriction: $\beta_{41} = 0$ LR test: $\chi^2(1) = 2.50$ (p-value: 0.11)		
1.000	-0.623	-0.006	0.000	0.000
	(0.039)	(0.003)		
1.000	-1.000	0.010	-0.262	-0.552
		(0.002)	(0.078)	(0.083)
		e) overidentifying restrictions: $\beta_{31} = \beta_{41} = 0$ LR test: $\chi^2(2) = 4.47$ (p-value: 0.11)		
1.000	-0.712	0.000	0.000	0.000
	(0.029)			
1.000	-1.000	0.010	-0.259	-0.526
		(0.002)	(0.074)	(0.079)
		f) overidentifying restrictions: $\beta_{31} = \beta_{41} = 0$ restrictions on α : $\alpha_{31} = \alpha_{32} = 0; \alpha_{51} = \alpha_{52} = 0$ LR test: $\chi^2(4) = 7.13$ (p-value: 0.13)		
1.000	-0.740	0.000	0.000	0.000
	(0.026)			
1.000	-1.000	0.012	-0.312	-0.518
		(0.002)	(0.069)	(0.073)

Table 4: Adjustment coefficients (t-values in parantheses)

Equation	α_1	α_2
a) for the overidentified vectors of Table 3 d)		
Δwcr	-0.173 (-3.031)	-0.373 (-3.226)
Δpr	-0.420 (-3.668)	0.492 (2.125)
ΔUR	-1.080 (-0.375)	-2.978 (-0.511)
$\Delta taxt$	0.154 (1.265)	0.076 (0.307)
$\Delta taxdiff$	-0.177 (-0.926)	0.488 (1.260)
b) restricted adjustment coefficients for the overidentified vectors of Table 3 d) restrictions: $\alpha_{31} = \alpha_{32} = 0; \alpha_{51} = \alpha_{52} = 0$ LR test: $\chi^2(4) = 7.13$ (p-value: 0.13)		
Δwcr	-0.191 (3.071)	-0.397 (-3.424)
Δpr	-0.524 (-4.186)	0.610 (2.609)
ΔUR	0.000	0.000
$\Delta taxt$	0.100 (0.736)	0.359 (1.408)
$\Delta taxdiff$	0.000	0.000

Figure 1: Calculation of net wages and salaries

Real product wage (*WCR*)
= *WC/GDP* deflator (*PGDP*)

↑

Compensation of employees (*WC*)

-	Employers' contributions for social security	payroll tax
-	Imputed contributions of government and financial integrated or public enterprises	
-	Employers' contribution for private pension	
=	Gross wages and salaries (*W*)	
-	Personal income tax (Labour income tax)	wage tax
-	Employees' contributions for social security	
-	Contributions to the chamber of labour (compulsory)	
=	Net wages and salaries (*WN*)	

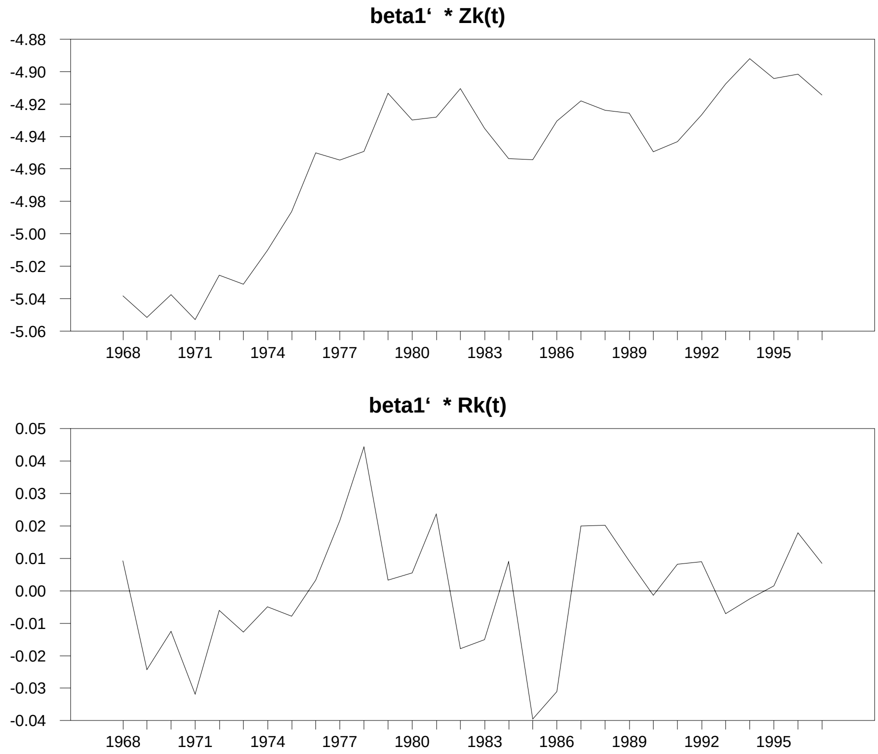
↓

Real consumption wage (*WNR*)
= *WN*/consumer price index (*CPI*)

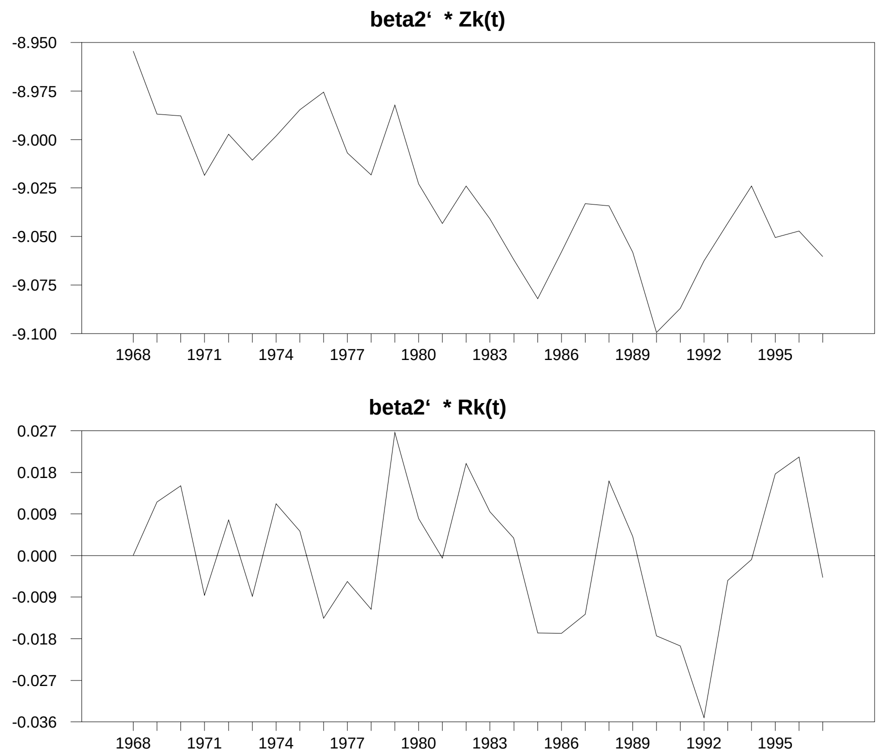
Source for the calculation of *WN*: Österreichisches Statistisches Zentralamt (1990: 73).

Figure 2: The two cointegrating relations (only rank restriction imposed)

a) First cointegrating relationship



b) Second cointegrating relationship



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