
Does a shift in the tax burden create employment?

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According to Dalton's Law it does not matter which side of the market is taxed. This holds for a model of the labour market as well. Nevertheless, it is often maintained that shifting the wedge from employers to employees has favourable effects on employment. That is, a shift from employers' to employees' taxes decreases wages and hence unemployment. This apparent paradox is discussed by analysing the impact of taxes in a wage bargaining model – it is shown that Dalton's Law does not necessarily hold in those models. The findings are illustrated by empirical results concerning tax shifting by employers and employees for the Netherlands. It is found that no employers' taxes are shifted backwards, whereas about 44% of employees' taxes are shifted forwards. These values imply a positive effect on employment of a reduction of the wedge in favour of employers.

I. INTRODUCTION

The relation between taxes, wages and employment has been discussed for more than a decade.¹ Although the results of empirical research are mixed, there is ample evidence for the existence of tax shifting, both of employers' and of employees' taxes. An interesting problem that can be derived from this research concerns the question whether or not taxes must be distinguished between employers' and employees' taxes. According to an old lesson from public finance theory such a distinction is not necessary in an equilibrium model. Consequently it does not matter which side of the market is taxed (Dalton, 1954; Blinder, 1988). But what if the wage setting process is best described by a wage bargaining model instead of an equilibrium model of the labour market? Then we notice different practices. Knoester (1983) does not distinguish between employers' and employees' taxes while in Knoester (1988) he does, although he basically uses the same wage-setting model. Knoester and Van der Windt (1987) don't make this distinction although they follow Brandsma and Van der Windt (1983), who explicitly do. Lever (1991) finds that in a monopoly model of the labour market, neither employers' tax shifting, not

employees' tax shifting occurs. Note that this result implies that it does matter which side of the market is taxed. Finally, Compaijen and Vijlbrief (1994) claim that employers' taxes have a different impact on wages and employment than employees' taxes in their equilibrium model. They concluded that 'shifting the wedge from employers to employees has favourable effects on employment in the Netherlands' (p. 773).

In this paper we investigate the role of taxes both in the context of an equilibrium model and of a bargaining model for the labour market and we discuss extensively whether or not it does matter which side of the market is taxed. Section II uses an equilibrium model of the labour market and starts with a discussion of Dalton's Law. We then analyse the conclusion of Compaijen and Vijlbrief who develop a macroeconomic model for an open economy. In this model they assume equilibrium on both the labour market and the current account. From their simulation results they conclude that a shift in the burden from employers to employees has a positive effect on employment, real wages and production and a negative effect on the real exchange rate. This result is surprising, since in an equilibrium framework Dalton's Law holds. We show that their results follow

¹A seminal article is Brandsma and Van der Windt (1983).

from a confusion between net and gross wages, and when the proper definitions are used Dalton's Law also holds in their analysis.

In Section III we present a general framework of a bargaining model that encompasses the results of both Knoester and Van der Windt (1987) and Lever (1991). We show that Dalton's Law holds in the bargaining model of Knoester and Van der Windt, as is simply assumed by the authors. An important reason for this result is that employment is exogenous in their model. In order to have endogenous employment we also introduce a right-to-manage bargaining model. One variant of such a model is presented in Lever (1991). We show that in the context of a right-to-manage model the presence of threat points in the bargaining process is important. Dalton's Law holds only when the threat points do not depend on wages.

In Section IV we estimate a right-to-manage bargaining model for the Netherlands during the period 1960–1995. We show that Dalton's Law indeed does not hold.

We present our conclusions in Section V.

II. DALTON'S LAW

In their interesting contribution about the relation between unemployment compensation and unemployment in the Netherlands, Compaijen and Vijlbrief (1994) develop a macroeconomic model for an open economy. In this model they assume equilibrium on both the labour market and the current account. In their simulation results they conclude that a reduction in the employers' burden has larger effects on employment and real wages, than a reduction in employees' part of the wedge (of course both reductions cover the same magnitude in terms of percentage points). Hence they conclude that a shift in the burden from employers to employees has a positive effect on employment, real wages and production and a negative effect on the real exchange rate.

This result is surprising, since in an equilibrium framework, Dalton's law holds (Dalton, 1954; Keller, 1980; Muysken and Van Veen, 1996). This law basically states that it does not matter which side of the market is taxed. This implies that the effects on employment, wage costs and net wages are the same, whether employers or employees are taxed. Since the simulation results of Compaijen and Vijlbrief imply that employers' and employees' taxes have a different impact on wage costs, their results basically come down to the proposition that equiproportionate changes in employees' and in employers' taxes will cause a different equilibrium on the labour market. We will show that this result is inconsistent with their theoretical model. For that reason we elaborate first on the effects of taxes in an equilibrium model.

Tax incidence and tax shifting

The effects of taxes on a market have been extensively analysed in public finance theory (Musgrave and Musgrave, 1987; Stiglitz, 1988). An important result is that in discussing effects of taxation one must distinguish between the legal liability for payment or legal burden (statutory incidence) and the actual economic burden (economic incidence) of a tax. The legal burden tells us 'who pays the money', while the economic burden is concerned with the question 'who bears the cost of a tax'. If the final or economic incidence differs from the statutory incidence, shifting has taken place.

If a tax is imposed on a good, an adjustment process towards a new equilibrium starts. For example, in case the tax is levied on the supply side of the market, suppliers will try to raise their supply price (price inclusive of taxes) thus shifting the burden of the tax on to sale prices. This type of shifting is called forward shifting. If, however, the tax is levied on the demand side, a decrease in demand can be expected, lowering the demand price (before-tax-price). This type of shifting is called backward shifting. Note that on the labour market, taxes are levied on both sides of the market. One might wonder whether tax shifting has any implications for the choice of which side of the market is taxed. For example, suppose that employers cannot shift (backwards) an increase in their part of the taxes whereas employees succeed in shifting their part of the tax burden fully forwards. Does this imply that a tax can best (i.e. from the point of view of wage costs and employment) be levied on the employers' side? Or on the employees' side?

With respect to this question, an interesting conclusion from tax shifting analysis in the theory of public finance is known as Dalton's law and states that it simply does not matter which side of the market is taxed. The result in terms of (after-tax) prices and quantities will be the same and is independent of the side of the market that bears the statutory incidence. This theorem is proved and dealt with extensively in Dalton (1954), Keller (1980), Stiglitz (1986) and Musgrave and Musgrave (1987). We will elaborate on this theorem.

In order to define our concepts more precisely, we use the following framework. Let the gross wage be equal to W . Then the wage costs paid by employers, WC , will include payroll taxes and employers' contributions for social security with a share $(E - 1)$ of gross wages; hence $WC = E.W$. And the net wages received by employees, WN , will be net of income taxes and employees' contributions for social security, with a share of $(1 - \Delta)$ of gross wages; hence $WN = \Delta.W$. One can also look at the wedge, which can be defined as the ratio between wage costs and net wages: this is equal to E/Δ . Finally, let the equilibrium wage in absence of taxes be W^* . Related to the gross wage we then have $W^* = \Gamma.W$, with $\Gamma = 1$ at the start of the analysis.

For analytical purposes we will present our analysis in logarithms. These will be expressed as lower case variables.² Then we have now defined, given the equilibrium wage in the absence of taxes, w^* :

$$\begin{aligned} \text{gross wage} & w = w^* - \gamma \\ \text{wage costs} & wc = w + \varepsilon \quad \varepsilon \geq 0 \\ \text{net wage} & wn = w + \delta \quad \delta \leq 0 \end{aligned} \quad (1)$$

In order to look at the division of the wedge according to the statutory burden, one simply has to look at the statutory tax rates. As we have argued, tax shifting occurs when the division of the wedge according to the economic burden is different. This can be illustrated in Fig. 1, which for illustrative purposes assumes long-linear supply and demand curves of labour in absence of taxes, ns and nd , respectively. Point A is the equilibrium without taxes. The equilibrium wage then is equal to w^* . Introduction of employees' taxes shifts the supply curve to the left, to ns' . And when employers' taxes and contributions are introduced, the labour demand curve also shifts to the left, to nd' . This has a decreasing impact on the gross wage. The new equilibrium level is represented by point E.

From Fig. 1 one can easily see that in logarithms the statutory incidence for employers, BE, is equal to $wc - w = \varepsilon$ and that for employees, EC, equals $w - wn = -\delta$. Together they constitute the total wedge, BC, or $\varepsilon - \delta$. The distribution of the economic incidence differs from its statutory counterpart because the transaction price (gross wages) has decreased. The change in the transaction price decreases the employers' burden and increases the employees' burden. Hence, to measure the economic incidence, we correct the statutory burden with the change in the transaction price. It will be clear from Fig. 1 that after the introduction of the taxes, the transaction price has decreased with DE, from w^* to w . Hence, we can derive

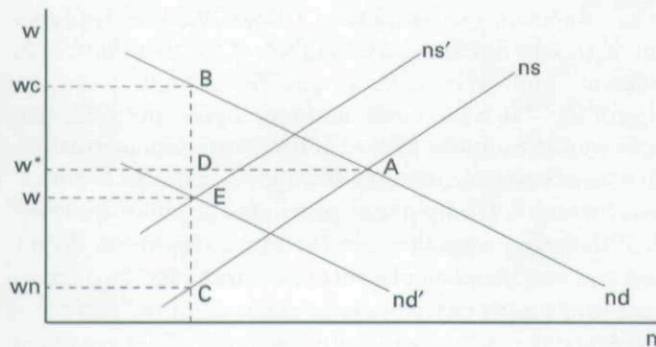


Fig. 1. Taxes and the labour market

that the economic burden for the employers, BD, equals $(wc - w) - (w^* - w) = \varepsilon - \gamma$. The economic burden for employees, DC, then is $(w - wn) + (w^* - w) = \gamma - \delta$. In this context one should realize that the core of the concept of economic burden is the change in the transaction price that occurs after the imposition of the tax. If the transaction price does not change, i.e. $\gamma = 0$, the economic burden is equal to the statutory burden. Consequently, in the measurement of the economic burden, one has to take into account this change in the transaction price.

Both ways of dividing the total burden are summarized in Table 1. It is clear that the decomposition of the wedge according to the statutory burden differs from that according to the economic burden when γ is not equal to zero, i.e. when the gross wage differs from the equilibrium wage. When γ is positive as is the case in Fig. 1, employers have succeeded in shifting part of their burden towards the employees. We will call this backward shifting, since in this case the demand side of the market dominates. In the opposite case the supply side will dominate and forward shifting takes place: then γ is negative. Thus γ is a parameter which indicates whether shifting takes place and in which direction.

Dalton's Law

From the theory of public finance it follows that if a tax is levied on a perfect competitive market, the final or economic burden of a tax does not depend on the statutory incidence: hence it is not relevant on which side of the market the tax is levied. This theorem is proved and dealt with extensively in Dalton (1936), Keller (1980), Musgrave and Musgrave (1987), and Stiglitz (1988) – it is also known as Dalton's Law.³ A corollary of Dalton's Law is that the final or economic burden of a tax depends on the price elasticities of demand and supply. To be more precise, in the context of perfect competition one can easily derive 'an interesting rule – namely that the economic burden of a tax is divided between buyer and seller as the ratio of elasticity of supply

Table 1. Tax burden and distribution of tax change

	Statutory	Economic ($w^* - w = \gamma$)
Employers	$wc - w = \varepsilon$	$wc - w^* = \varepsilon - \gamma$
Employees	$w - wn = -\delta$	$w^* - wn = \varepsilon - \delta$
Total	$wc - wn = \varepsilon - \delta$	$wc - wn = \varepsilon - \delta$
Distribution of tax change	$\frac{wc - w}{w - wn} = -\frac{\varepsilon}{\delta}$	$\frac{wc - w^*}{w^* - wn} = -\frac{\varepsilon - \gamma}{\delta - \gamma}$

²In the case of Greek symbols we have $\varepsilon = \ln E$, $\delta = \ln \Delta$ and $\gamma = \ln \Gamma$.

³This should not be confused with the famous Dalton's Law from physics!

to elasticity of demand in the relevant range of the demand and supply schedules' (Musgrave and Musgrave, 1987).

Tax shifting usually is analysed by looking at the effects of marginal changes in taxes and consequently Dalton's Law implicitly refers to changes in the variables of our analysis (see also Keller 1980; Musgrave and Musgrave, 1987). Since the distribution of the economic burden can be represented by $(wc - w^*)/(w^* - wn)$ and that of the statutory burden by $(wc - w)/(w - wn)$ - see also Table 1 - Dalton's Law implies:

$$\frac{d[(wc - w^*)/(w^* - wn)]}{d[(wc - w)/(w - wn)]} = 0 \quad (2)$$

that is, the change in the distribution of the economic burden is independent of that of the statutory burden. After some manipulation it can be shown that this implies that the elasticity of wage costs with respect to net wages is independent of the wages.⁴ Or that the elasticities of both wage costs and net wage with respect to the wedge are independent of the wedge. We will concentrate in our further analysis on the elasticity of wage costs with respect to the wedge, which is defined by $dwc/d(\varepsilon - \delta)$ - its independence also implies independence of the elasticity of the net wage. Dalton's Law then requires:⁵

$$\frac{d^2wc}{d(\varepsilon - \delta)^2} = 0 \quad (3)$$

Essentially this implies that wage costs wc should be linear in the wedge $(\varepsilon - \delta)$.

From Fig. 1 it will be clear that the new level of employment also is the same irrespective of the side of the market that is taxed. However, contrary to the case of wages, an increase in employers' premiums and an increase in income taxes both have a negative effect on employment.

The analysis of tax incidence allows us to draw some conclusions. First, we conclude that only if at least one market party bases its decisions on net prices, will the economic burden of the tax differ from the legal burden. In other words, then tax shifting occurs. Second, in the case of tax shifting a new market equilibrium will be achieved with higher wage costs and a lower trading volume than before the tax (increase).⁶ Third, tax shifting does only influence the distribution of the economic burden of a tax - the distribution of the legal burden is of course not influenced. Fourth, the distribution of the economic burden of a tax depends on the price elasticities of demand and supply. The more an economic agent can adjust after a (change in the magnitude of) tax has been levied, the less is his (relative) economic burden. This last conclusion implies that it does not matter

which side of the market is taxed. In a competitive labour market an increase in employees' premiums/taxes has exactly the same effect as an increase in employers' contributions. Fifth, referring to research concerning tax shifting, if Dalton's Law holds then one does not need to split between employers' and employees' taxes because both have exactly the same effect on wage costs, net wages and employment. Note, however, that the effect on gross wages differs implying that if gross wages are to be explained, a distinction must be made. Finally, we have been discussing Dalton's law in a partial equilibrium framework. However, as is shown in Keller (1980), Dalton's law can also be extended to general equilibrium analysis.

We have analysed the influence of taxes on a perfect competitive market. The labour market, however, does not seem to be a perfect competitive market and then of course, an interesting question appears: what happens if the labour market is not competitive? We return to this question in the next section. But first we shall look at the implication of our analysis for the analysis of Compaijen and Vijlbrief.

Dalton's Law and the analysis of Compaijen and Vijlbrief

The model of Compaijen and Vijlbrief (CV) consists of a labour market, a foreign exchange market and a goods market. CV assume that the labour market clears through changes in the gross wage rate. On the foreign exchange market, the real exchange rate matches imports and exports. Recalling Walras' Law, the goods market will also be in equilibrium. In this framework, Dalton's Law fits perfectly well. However, the simulation results show different effects of decreases in employees' and in employers' taxes with respect to employment. In our view this is not possible in such a model set-up. Unfortunately, CV only mention the difference, but do not try to explain it. Let us try.

We have derived Dalton's Law under the assumption of absence of tax illusion. This means that employers focus on wage costs in their demand for labour and employees focus on net wages in their supply of labour. We can easily see that if this is not the case Dalton's Law does not hold. Different employment effects occur for example when employers look at wage costs, and employees are guided by gross wages. Suppose that employers' premiums decrease. Then wage costs decrease, gross wages increase and employment increases. If employees' premiums decrease, however, while the gross wages remain the same, employees do not react and wages and employment do not change. In this case the labour supply curve does not change, but the curve that represents the net wages shifts upwards. This results in unchanged gross wages, unchanged employment and higher

⁴Since the variables are in logarithms, the elasticity of wage costs with respect to net wages is given by dwc/dwn .

⁵Note that since Dalton's Law does require that the elasticity is independent of the wedge, we differentiate this elasticity towards the wedge.

⁶This conclusion holds if price elasticities differ from 0.

net wages. However, if part of the decrease in employees' premiums flows to the employers (this results in a decrease in wage costs and in gross wages), there will be effects on the labour market. The labour supply curve shifts downwards and gross wages decrease while employment increases. The decreasing effect that this has on the wage costs, will enlarge these effects.

Although this may seem a 'strange' kind of analysis, we fear, that it is precisely this point in the CV model that needs criticism. In their simulation model, labour demand depends on net real wage costs, while labour supply depends on gross wages, cf. their Equations 15 and 17. This explains the non-neutral nature of their results. However, if labour supply would depend on net wages in their simulation model – as is assumed to be the case in their theoretical model, cf. their Equation 6 – Dalton's Law holds. That is, in that case both employers' and employees' taxes have the same impact on wage costs.

Finally, note that it is not the difference in the change in gross wages that matters as we have demonstrated in the previous section, but the difference in the effect on unemployment that is not in accordance with Dalton's Law.

III. TAXES AND WAGE BARGAINING

A simple model of wage bargaining

An early wage bargaining model, which has been applied to the Netherlands, can be found in Brandsma and Van der Windt (1983) – it has also been used in Knoester and Van der Windt (1987).⁷ In that model it is assumed that wages result from bargaining about wage claims of employees and wage offers of employers. Wage claims from employees result from the notion that the labour share in national income ($W.N/Y$) should at least be equal to ϕ , where employees calculate in terms of net wages. Then the resulting gross wage claim is:

$$W^{cl} = (1/\Delta)\phi Y/N \quad 0 \leq \phi \leq 1 \quad (4)$$

where Δ equals the retention ratio and W^{cl} is the gross wage claim in real terms. Wage offers from employers result from profit-maximizing behaviour, given a CES production structure. Employers take wage costs into account in the bargaining process. Hence, the gross wage offer is:

$$W^0 = (1/E)c.[Y/N]^{1/\sigma} \quad \sigma < 1 \quad (5)$$

where c is a constant and σ is the elasticity of substitution: the latter is assumed to be smaller than unity. Further

E equals $(1 + \text{payroll taxes})$ and W^0 is the gross wage offer in real terms. We formulate wage claim and wage offer as gross wages since bargaining is about gross wages.

An important assumption of the model is that employers set employment before the wage bargaining process starts. Hence wage offers and wage claims are made while employment is given. The bargaining process results in a gross wage, W , which is the geometric average of gross wage offers and wage claims, with weights ψ and $(1 - \psi)$ representing the bargaining power of employers and employees, respectively. The higher ψ is, the higher the bargaining power of employers. We can write this as follows:

$$W = (W^{cl})^{1-\psi} \cdot (W^0)^\psi \quad 0 \leq \psi \leq 1 \quad (6)$$

It is assumed that in the next period employment is adjusted to the demand for labour consistent with the current new wage rate. Then new wage claims and offers result.

Solving Equations 4–6 and taking logarithms yields for wage costs.⁸

$$wc = w^* + (1 - \psi) \cdot (\varepsilon - \delta) \quad (7)$$

We can now analyse the effects of employees' taxes and of employers' contributions. From Equation 7 it follows that both an increase in employees' taxes and an increase in employers' contributions have a positive effect on wage costs. Note the important role of ψ , the bargaining power. If employers have all the bargaining power ($\psi = 1$) then wage costs are not affected by employers' or employees' taxes. This is close to our intuition since in this case there will be no forward shifting and full backward shifting, implying that the tax burden is borne by the employees. Further, Dalton's Law holds in this model too: from Equation 7 one sees that Equation 3 is satisfied because there is no relation between the bargaining power and the wedge. Hence it does not matter which side of the market is taxed. Thus according to their own model, Brandsma and Van der Windt (1983) need not distinguish between employers' and employees' taxes. This is consistent with the implementation of their model by Knoester and Van der Windt (1987).

A right-to-manage model of wage bargaining

The development of employment is unclear in the previous model. It is a model of wage determination, without explicitly paying attention to employment. We therefore develop a bargaining model, somewhat similar to Brandsma and Van der Windt, in which employment is not assumed to be constant but is determined from profit maximization. Moreover, we assume a right-to-manage structure, that is employers set employment after wage bargaining has taken place.

⁷From our perspective it is interesting to note that Brandsma and Van der Windt explicitly allow for a different impact of employees' and employers' taxes, whereas Knoester and Van der Windt (1987), who use the same model, don't do this.

⁸The equilibrium gross wage is: $w^* = (1 - \psi)\ln \phi + \psi \ln c + [1 + (1/\sigma - 1)\psi]\ln(Y/N)$.

We use the Nash bargaining solution as the solution concept.

Employers aim at maximal profits. However, there is a minimum acceptable level of real profits, which we assume to be zero – that is employers want at least to break-even.⁹ Hence, the maximum wage offer is in terms of gross real wage:

$$W^0 = (1/E).Y/N \quad (8)$$

The minimum acceptable level of real profits constitutes a threat point in the bargaining process over wages.

Employees are assumed to aim at a maximal wage sum, net of taxes. Moreover, they also have a threat point in the bargaining process, which results from the notion that the labour share in national income (net of taxes) should at least be equal to ϕ . Hence the minimum acceptable gross real wage is:

$$W^{cl} = (1/\Delta).\phi.Y/N \quad 0 \leq \phi \leq 1 \quad (9)$$

Let the Nash solution provide a good description for the solution of the wage bargaining process. Therefore we assume that employers and unions strive after maximization of the difference between after tax income and the threat point income as defined in Equations 8 and 9. Further, note that as in the previous model, bargaining is about gross wages.

Hence, wage bargaining aims to solve the following problem:

$$\max_w G(W, N) = \{Y - E.W.N\}^\psi . \{\Delta.W.N - \phi.Y\}^{1-\psi} \quad 0 \leq \psi \leq 1 \quad (10)$$

$$S.T. Y(N)/N = c.(E.W)^\sigma \quad \sigma < 1 \quad (11)$$

In Equation 10, the Nash function, the parameter ψ indicates the bargaining power: a higher ψ represents more employers' power. Equation 11 is the demand function for labour, derived from a CES function $Y(N)$, with an elasticity of substitution $\sigma < 1$ and which poses a constraint to the maximization process.

Maximization of the Nash function results in wage costs given by

$$c.(wc)^{1-\sigma} = \frac{\phi + (\Delta/E - \phi)(1 - \sigma)(1 - \psi)}{\Delta/E} \quad (12)$$

Equation 12 shows that the higher the bargaining power of employees is, or the stronger their threat, the higher wage costs will be – this is what one might expect, of course. One also sees that a decrease in the wedge, either due to a decrease in employees' taxes or a decrease in employers' taxes will lead to lower wage costs – again what one should expect. Actually the relation between wage costs and the wedge is important, since if Dalton's Law holds, this

relation must be linear. However, one sees that in Equation 12 the relation between the wage costs and the wedge is non-linear and this implies that Dalton's law does not hold in this type of model – compare Equation 3.

It is obvious that the inclusion of threat points causes this non-linearity. This can again be seen from Equation 12. If we assume $\phi = 0$, then we find:

$$c.(wc)^{1-\sigma} = (1 - \sigma)(1 - \psi) \quad (13)$$

and it follows that the wage costs are independent of both a change in employers' taxes and a change in employees' taxes: hence $wc = w^*$. That is, irrespective of bargaining power, wage costs will always equal the wage that would prevail without taxes: full backward shifting takes place and there is no forward shifting. Consequently, we conclude that in a right-to-manage model without threat points the wage costs are independent of the tax rate. Note that the result implies that taxes are completely borne by employees. Further we conclude that in such a set-up it does not matter which side of the market is taxed and hence Dalton's law holds.

The result of Equation 13 has also been derived by Lever (1991). However, he derived Equation 13 without taxes, thus with wages as an endogenous variable. Then he followed the procedure of introducing ad hoc employers' and employees' taxes in his estimated relation. He then found in his estimation results that no backward shifting takes place, whereas forward shifting does occur by almost 30%. It is obvious that these results are inconsistent with his theoretical model.

IV. EMPIRICAL EVIDENCE FOR THE NETHERLANDS

As we have discussed above, there is ample reason to expect that Dalton's Law will not hold due to specific characteristics of the process of wage bargaining. In Muysken and Van Veen (1996) we have summarized the results of many studies for the Netherlands, whom all more or less find that Dalton's Law does not hold indeed. However, in most studies this is not recognized explicitly, but mentioned as an empirical result. In general the finding is that for the Netherlands about 15% of employers' taxes is shifted backwards, whereas about 35% of employees' taxes is shifted forward. We will verify this result for the Netherlands during the period 1960–1995 by estimating a wage equation which is derived from a right-to-manage type of bargaining model. Nominal wage costs, wc , depend on production price, py , labour productivity, yn , real gross benefits, $b - pc$, both tax

⁹In the more general case we assume that the minimum acceptable level of real profits is a fraction $\chi (> 0)$ of real income. However, this complicates an analytical solution of the model, without changing the results in a qualitative way.

wedges, $(1 + \varepsilon)$ and $(1 - \delta)$, the price-wedge, $pc - py$, and unemployment, u . See Graafland (1992) or Lever (1991) for the derivation of this type of wage equation from a right-to-manage model.

The data

The data cover the period 1960–1995 and stem from the Netherlands Bureau of Economic Policy Analysis. We have tested for stationarity of the data with the help of the augmented Dickey–Fuller (ADF) test. The results of these tests are reported in Table 2 and from the final column one can conclude that all data show non-stationarity characteristics.

The data show some peculiarities which we will discuss first. The price variables (including the nominal wage rate) show an increase in change in the mid-1970s and the early 1980s, followed by a large decrease in the change in the mid-1980s. The changes were almost always positive, hence there has been a continuous increase in prices and (nominal) wages. Unemployment figures show a gradual increase in the 1970s, followed by a major increase in the aftermath of the second oil-crisis, the first half of the 1980s, and although employment has recovered since then, pre-1980s levels of employment have not been reached (yet).¹⁰ The development of the real gross benefits shows a steady decline in this rate from 1977/1978. This is mainly due to a steady decline in the replacement rate in the Netherlands.

Since the wedge plays a central role in our analysis, we show the development of the employees' part and of the employers' part of the wedge in Fig. 2 as a percentage of

gross wages. This figure reveals first that during the period 1963–1984, changes in the wedge were largely positive. After 1985, both parts of the wedge started to decrease. Second, the employees' wedge is higher than the employers' wedge and the difference has increased. This reflects the shift in the composition of the wedge that has occurred in the Netherlands during the recent decades.

Estimation results

In the long run we assume wage costs, wc , to depend on production price, py , labour productivity, yn , the price-wedge,

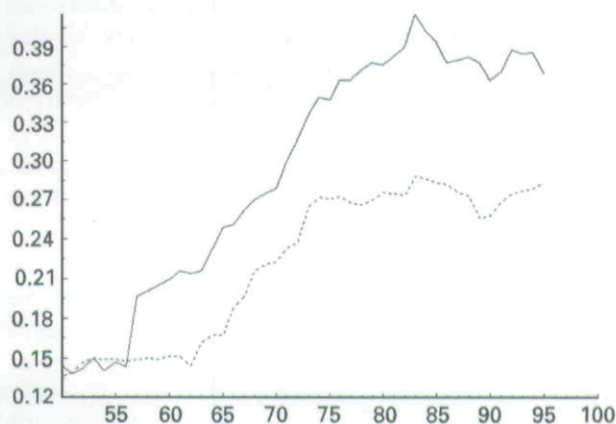


Fig. 2. The development of employers' (----) and of employees' (—) part of the wedge, 1950–1995

Table 2. Unit root tests variables wage equation, 1950–1995

Variable x	Growth rate ^a	x	Δx	ADF ^b	$\Delta^2 x$	I(x)
wc	0.070 (0.041)	-0.68 [t, 1]	-1.71 [c, 0]	-7.04** [n, 0]	I(2)	
py	0.034 (0.024)	-1.18 [t, 1]	-2.77 [c, 0]	-8.40** [n, 0]	I(2)	
pc	0.039 (0.028)	-1.39 [t, 1]	-2.41 [c, 0]	-8.51** [n, 0]	I(2)	
pm	0.021 (0.074)	-2.01 [t, 1]	-4.45** [c, 0]	I(1)		
b^c	0.061 (0.050)	-0.48 [t, 1]	-2.70 [c, 0]	-7.42** [n, 0]	I(2)	
$wc - py$	0.036 (0.027)	-0.14 [t, 1]	-2.64 [c, 0]	-8.68** [n, 0]	I(2)	
pcy	0.005 (0.015)	-1.98 [t, 0]	-5.28** [c, 0]	I(1)		
$b - pc^c$	0.021 (0.038)	-0.26 [t, 0]	-3.94** [c, 0]	I(1)		
yn	0.034 (0.024)	-0.07 [t, 0]	-4.46** [c, 0]	I(1)		
u	0.001 (0.007)	-0.45 [c, 2]	-4.86** [n, 1]	I(1)		
$(1 + \varepsilon)$	0.003 (0.006)	-1.02 [c, 0]	-4.82** [n, 0]	I(1)		
$(1 - \delta)$	0.007 (0.018)	-1.82 [c, 0]	-4.98** [n, 0]	I(1)		

^a Standard deviation between parentheses.

^b The characteristics of the (augmented) Dickey–Fuller test statistic (ADF) are given between brackets [z, #]: $z = [n, c, t]$ indicates neither constant or trend, constant included or trend and constant included, respectively; # corresponds to the number of significant lags included. Significant rejection of non-stationarity is indicated by asterisks (* at the 5% level and ** at the 1% level). The final column summarizes and shows the order of integration I(x).

^c 1954–1995

¹⁰Our data permit us to calculate the labour income quote and it is striking that for the period 1963–1976, the changes in the labour income quote show the same positive pattern as the changes in the wedge.

$pc - py = pcy$, both tax wedges, $(1 + \varepsilon)$ and $(1 - \delta)$, unemployment, u and real net benefits, $b - pc$ - all variables except unemployment are in logarithms. Note that the price wedge captures the influence of changes in the exchange rate, changes in world prices and indirect taxes. Hence the long-run wage equation can be represented by¹¹

$$wc = py + \alpha_1 yn + \alpha_2(b - pc) + \alpha_3(1 + \varepsilon) + \alpha_4(1 - \delta) + \alpha_5 pcy + \alpha_6 u + \text{constant} \quad (16)$$

With respect to the benefit variable, we note that Graafland (1992) uses the replacement rate as an explanatory variable in his wage equations for the Netherlands. His motivation is that the replacement rate affects the aspiration level of unions. Typically he finds significant positive effects. We think, however, that it is not the replacement rate itself that determines that aspiration level, but the level of benefits. Consider, for example, the basic union wage bargaining model of Layard *et al.* (1991). Here wages are set in equilibrium as a mark-up on benefits.¹²

Because of the non-stationarity characteristics in the data, we have rewritten Equation 16 as a dynamic equation in the error correction form. Note that for estimation purposes, this is only appropriate if there exists at least one cointegrating vector among the variables. To test for cointegration, we used a test (labelled WNC) that is developed by Boswijk (1994). The results are reported in Table 3 and show that the null hypothesis of no cointegration is rejected.¹³ Hence, we estimated Equation 16 in the error correction form as in Equation 17

$$\begin{aligned} Dwc - Dpy &= \beta_1 Dyn + \beta_2 Dpcy \\ &+ \beta_3 [wc_{t-1} - py_{t-1} - \alpha_1 yn_{t-1} - \alpha_2 (b_{t-1} - pc_{t-1}) \\ &- \alpha_3 (1 + \varepsilon)_{t-1} - \alpha_4 (1 - \delta)_{t-1} \\ &- \alpha_5 (pc_{t-1} - py_{t-1}) - \alpha_6 u_{t-1} - \text{constant}] \quad (17) \end{aligned}$$

with $Dx = x - x_{-1}$.

The estimation results are presented in Table 3, where the change in real wage costs ($Dwc - Dpy$) is the variable to be explained.¹⁴ The estimation procedure typically is from general to specific. As long as potential endogenous variables are used as explanatory variables, we used Instrumental Variable Estimation (IV) with instrumental variables: Dpm , where pm represents import prices, and lagged values of Dpy , Dpc and Dyn .¹⁵ First, we note that satisfactory results could only be reached when the lag structure was adjusted: the results improved when deleting the one-period lag in the tax variables. This might be due to some kind of forward looking behaviour by the wage negotiators. Second, column (1) shows the results of the ordinary least squares estimates (OLS) of Equation 17. Next, because of the endogeneity of Dyn and $Dpcy$, we tried an instrumental variable estimate and this resulted in a decreasing significance of the endogenous variables. It then follows that Dyn does not differ significantly from 1 and $Dpcy$ does not differ significantly from 0; cf column (2). Pegging these values permits us to continue with OLS techniques because there are no potential endogenous variables in the right-hand side anymore.

Column (3) shows the results of the unrestricted estimate. It appears that the coefficients for the employees' part of the wedge and the price wedge are rather similar and that the coefficient for the employers' part of the wedge does not differ significantly from 1. In the next estimate, presented in column (4), we restricted the coefficients accordingly and these restrictions were not rejected. One sees that the results do not change very much. Finally, one may wonder whether the target wage or threat point is a weighted average of benefits and labour productivity, i.e. $\alpha_1 + \alpha_2 = 1$. This restriction was imposed in the final column (5) of Table 3 and again this was not rejected.

If we use the results from the final column, we find that the long-run solution of our model is given by:¹⁶

$$wc = py + 0.73yn + 0.27(b - pc) + 0.44[(1 - \delta) + (pc - py)] + (1 + \varepsilon) - 1.72u - 0.25 \quad (18)$$

¹¹Note that Equations 16 and 17 the coefficients for py and Dpy , respectively, are assumed to equal 1. This was tested and not rejected.

¹²We constructed the series for net benefits (B) using data for the replacement rate (RR), wage costs (WC), the employers' taxes (tg) and the employees' taxes (tw), yielding $B = RR*(tw/tg)WC$. To measure aspiration levels in real terms, we deflate the net benefits by the consumer price index.

¹³We tested for cointegration by using the Johansen-Juselius test as well and again the results indicated cointegration.

¹⁴Note that only if the conditioning variables are weakly exogenous, do the standard errors of the estimated variables have the normal characteristics. We tested for weak exogeneity, using two tests proposed by Boswijk and Urbain (1997). The first one is an orthogonality test (labelled LMO) and the results show that the hypothesis of orthogonality of the regressors cannot be rejected. The other requirement for weak exogeneity (the absence of an error correction term in the marginal model for the conditioning variables) was also tested using an error-correction test and this resulted in acceptance at the 10% level (and nearly acceptance at the 5% level).

¹⁵Although OLS is super-consistent if the data are cointegrated, one must note that this only holds for the long-run parameters, but not for the dynamics of the model if it contains (potential) endogenous explanatory variables.

¹⁶Note that in estimating Equation 17 the estimated coefficients as they are presented in Table 3 are the coefficients between the [...] given in (17), multiplied by β_3 . Thus for example in the last column the estimated coefficient for $(1 - \delta)$ equals 0.235. Then in terms of (17): $\beta_3 - \alpha_4 = 0.235$. Hence α_4 , the long run coefficient in the wage equation, equals $-0.235/\beta_3$. To find the value in Equation 18 we use $\beta_3 = -0.538$ (cf column (5)) of Table 3.

Table 3. Wage equation estimates 1962–1993 (dependent variable $Dwc-Dpy$)

Estimation method	OLS (1)	IV (2)	OLS (3)	OLS (4)	OLS (5)
constant	-0.006 (0.072)	-0.048 (0.093)	-0.069 (0.089)	-0.094 (0.081)	-0.133 (0.032)
$Dyn_{t-(1/2)}^a$	0.651 (0.140)	0.861 (0.518)	1.0	1.0	1.0
$Dpcy^a$	0.417 (0.139)	0.121 (0.285)	0.0	0.0	0.0
$wc_{t-1} - py_{t-1}$	-0.417 (0.142)	-0.507 (0.198)	-0.554 (0.173)	-0.588 (0.176)	-0.538 (0.146)
$yn_{t-(3/2)}$	0.296 (0.080)	0.364 (0.127)	0.400 (0.095)	0.414 (0.094)	0.394 (-)
$b_{t-1} - p_{ct-1}$	0.049 (0.067)	0.077 (0.086)	0.092 (0.083)	0.157 (0.077)	0.144 (0.071)
$(1 + \varepsilon)_t$	1.0453 (0.248)	1.007 (0.299)	0.983 (0.311)	(-)	(-)
$(1 - \delta)_t$	0.092 (0.153)	0.204 (0.201)	0.254 (0.184)	0.287 (0.116)	0.235 (0.059)
$p_{ct-1} - p_{yt-1}$	0.123 (0.133)	0.198 (0.258)	0.252 (0.150)	0.287 (-)	0.235 (-)
u_{t-1}	-0.657 (0.195)	-0.884 (0.395)	-1.009 (0.216)	-0.966 (0.219)	-0.924 (0.201)
R^2	0.866	0.823	0.768	0.734	0.732
DW	2.12	2.30	2.25	2.10	2.04
$\hat{\sigma} (\times 100)$	0.846	0.973	1.066	1.095	1.080
RSS ($\times 1000$)	1.575	2.086	2.726	3.118	3.150
DHW/SAR	F(2, 20) = 1.04	$\chi^2(2) = 4.45$	F(2, 22) = 9.73**	F(2, 24) = 8.35**	F(2, 25) = 8.55**
PF'95	F(2, 22) = 0.47	$\chi^2(2) = 0.79$	F(2, 24) = 0.31	F(2, 26) = 0.35	F(2, 27) = 0.30
LMA	F(1, 21) = 0.15	$\chi^2(1) = 0.83$	F(1, 23) = 0.47	F(1, 25) = 0.08	F(1, 26) = 0.02
ARCH	F(1, 20) = 0.00	F(1, 20) = 0.16	F(1, 22) = 0.19	F(1, 24) = 0.01	F(1, 25) = 0.05
HET	F(18, 3) = 0.12	F(18, 3) = 0.19	F(14, 9) = 0.41	F(10, 15) = 0.59	F(8, 18) = 1.00
NORM	$\chi^2(2) = 0.49$	$\chi^2(2) = 5.22$	$\chi^2(2) = 8.25**$	$\chi^2(2) = 10.41**$	$\chi^2(2) = 9.65**$
RESET (square)	F(1, 21) = 0.03	$\chi^2(1) = 0.01$	F(1, 23) = 0.05	F(1, 25) = 0.47	F(1, 26) = 0.74
RESET (cube)	F(2, 20) = 1.02	$\chi^2(2) = 0.37$	F(2, 22) = 0.22	F(2, 24) = 0.24	F(2, 25) = 0.36
LMO	F(6, 16) = 0.71	$\chi^2(6) = 3.98$	F(6, 18) = 1.60	F(6, 20) = 1.11	F(6, 21) = 1.14
WNC	108.71**	71.71**	79.52**	72.07**	73.79**
CDF	-1.90	-1.97*	-2.54*	-2.31*	-2.08*

Standard errors between parentheses. RSS is the residual sum of squares; DWH is a Durbin–Wu–Hausman test for consistency of the OLS estimates; SAR is Sargan's test for validity of the instruments; PF'95 is a Chow test for parameter constancy up to 1995; LMA is a Lagrange Multiplier test for first-order residual autocorrelation; ARCH is a Lagrange Multiplier test for first-order autoregressive conditional heteroscedasticity; HET is a White test for heteroscedasticity; NORM is PcGive's normality test of the residuals; RESET is Ramsey's specification test; LMO is a LM-test for orthogonality of the regressors; WNC is a Wald statistic for non-cointegration and CDF is a Dickey–Fuller test for unit roots in the long-run solution. Significance levels test statistics: * at 5% and ** at 1%.

^a Endogenous variable; the instruments used are Δp_{yt-1} , Δp_{ct-1} , Δp_{mt} and $\Delta y_{nt-3/2}$.

We can use the results of our long-term solution to calculate long-run unemployment. For that purpose we define ρ as the log benefit ratio in terms of gross wages, such that $b = \rho + wn$ holds. Rewriting Equation 16 the results in¹⁷

From these results it can be concluded that long-run unemployment is basically determined by three major variables: the labour income ratio ($wc - py - yn$), the benefit ratio (ρ) and the wedge. Actually the labour income ratio can be said to represent the markup on

$$u = \frac{-0.73(wc - py - yn) + 0.27\rho + 0.73(1 + \varepsilon) + 0.17(1 - \delta) + 0.17(pc - py) - 0.25}{1.72} \quad (19)$$

¹⁷Equation 19 follows from straightforward rewriting of Equation 18. Note that the variables are in logarithms and $b = wn + p$ and $wn = wc - \varepsilon + \delta$.

prices.¹⁸ Its elasticity with respect to long-run unemployment is -0.42 . The benefit-ratio elasticity of long-run unemployment equals 0.16 . The wedge includes employers' and employees' taxes, indirect taxes and changes in the exchange rate. From our point of view it is in particular interesting to note that employers' taxes have a different impact through the wedge than employees' taxes do: the long-run elasticities are 0.42 and 0.10 , respectively. Thus with respect to unemployment Dalton's Law does not hold.

The Wassenaar accord

Labour relations in the Netherlands are based on the so-called Rheinland model where employers, employees and government discuss desirable developments in wages in the broader framework of economic policy. In this light one must pay attention to the so-called 'Wassenaar Accord', concluded in 1982 where unions and employers agreed that moderation of wages was desirable. One might wonder how this accord has influenced wage determination. In our view, three points are important. First, automatic COLA agreements came under pressure.¹⁹ Until 1982, these agreements were not discussed at all, but after the Wassenaar Accord the automatism of COLA arrangements disappeared. This may explain why producers' prices dominate wage setting after 1982, while consumers' prices were more important before 1982. Second, in Wassenaar the trade-off between wage costs and employment was recognized by all parties. This might appear in a stronger Phillips effect. Third, as far as part of the increase in wage costs was due to the increase in the wedge that took place in the 1970s, the after Wassenaar period is characterized by the lower extent of tax shifting. One has to keep in mind, however, that the effects of Wassenaar were greater in periods of high unemployment, as in the 1980s. As soon as economic circumstances improved, as in the 1990s, at least part of the Wassenaar effect seems to have disappeared. We have tested for the influence of long-term unemployment and structural breaks due to the 'Wassenaar Accord'. We could not find any significant influence on these points. In De Regt *et al.* (1999) we elaborate on the estimation results and show that they are quite robust.

From our results one can observe that there is no incidence of employers' taxes on the gross wage, whereas the employees' burden is shifted by about 44%. These results are quite consistent with the general results found on the Netherlands, which imply a backward shifting of 15% of employers' taxes and a forward shifting of the employees'

burden of 35%.²⁰ Moreover, it does matter which side of the labour market is taxed!

V. CONCLUDING REMARKS

In this paper we discussed problems concerning tax shifting. In particular we focused on the problem of whether it matters which side of the market is taxed. This joins a discussion that started in empirical research by asking whether to make a distinction between employers' and employees' premiums. Recently however, this discussion was shifted to the level of economic policy when a shift in the composition of the wedge to attack the unemployment problem was proposed (Compaijen and Vijlbrief, 1994; Graafland and Huizinga, 1996). We started by elaborating Dalton's Law and conclude that if this law holds, it does not matter which side of the market is taxed and a shift in the composition of the wedge has no influence on unemployment. We showed that this Law holds in a perfectly competitive market, but not necessarily in a wage bargaining model. In the latter type of models it is unlikely that Dalton's Law holds. The specification of the utility function and the threat point seem to be important in reaching this conclusion. Note that if Dalton's Law does not hold, one must split between employees' and employers' taxes in empirical research. Second, if Dalton's Law does not hold, a shift in the composition of the wedge causes, by definition, a change in the wage costs and in employment and then such a shift might be an interesting policy option to fight unemployment. Next, we have shown that the effects that have been found in the simulation by Compaijen and Vijlbrief, who conclude from their equilibrium model that a shift in the composition of the wedge decrease unemployment, are in our view due to an inconsistency in the model. We have further estimated a wage equation for the Netherlands for the period 1962–1993 and found that employees' taxes are shifted forward with an elasticity of 0.44 . Employers, however, do not succeed in shifting their part of the tax burden backwards. These results imply that a shift from the employers' to the employees' part of the wedge decreases wage costs. Finally, Graafland and Huizinga (1996) defend their proposal of a change in the composition of the wedge by arguing that since gross wages are fixed for a certain period, a shift from employers' to employees' taxes will decrease wage costs and increase employment. In our view this will only hold when unions are very shortsighted or can be fooled. In a dynamic context unions will try to catch up

¹⁸This can be seen when we define $x = wc - py - yn$. It then follows that $py = (wc - yn) - x$. Since $(wc - yn)$ equals unit cost, the markup equals $-x$ (which is positive since the labour income ratio is smaller than unity, remember $x = \ln$ labour income ratio). Note further that a high x implies a low markup and this reflects the low profits that correspond to a high labour income ratio.

¹⁹Under automatic COLA consumer inflation is passed on fully in nominal wage increases.

²⁰For an overview, cf. Muysken and Van Veen (1996).

and then the employment effect might disappear. Moreover, the charm of our analysis is that such a strong assumption of the behaviour of unions is not necessary, since in a bargaining model Dalton's Law is unlikely to hold.

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