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ABSTRACT

Income Taxes and the Composition of Pay*

According to the standard principal-agent model, the optimal composition of pay should balance the provision of incentives with the individual demand for insurance. Do income taxes alter this balance? We show that the relative share of PRP on total pay is reduced by higher average taxes, and is affected in a complex way by higher marginal tax rates. Empirical evidence based on the British Household Panel Survey, which exploits the UK 1999 Tax Reform, supports the theoretical predictions of the tax-augmented principal-agent model.

JEL Classification: J33, H24

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Introduction

Performance related pay (PRP) is often heralded as a tool which helps aligning the employee's incentives with those of the firm (See Lazear, 1999), and as a compensation device more suitable to the spreading information – intensive production technologies and new ways of organizing labour (see Freeman, 1999). Many believe that PRP has beneficial effects on worker commitment, work morale and productivity, and this belief is supported by empirical evidence – see for instance OECD, 1995, and Doucouliagos, 1995).

Standard principal agent theory shows that the appropriate level of pay-performance sensitivity should balance risk and incentives, and that this balance depends on the cost of effort, the degree of risk aversion of the parties and the distribution of shocks affecting individual and firm performance (see Prendergast, 1999). An additional factor affecting PRP which has been overlooked in the literature is the structure of income taxation. In this paper, we incorporate the tax structure, which we characterize with the average and the marginal tax rate, into the standard principal-agent model, and study how changes in the selected tax variables affect the optimal composition of pay[1].

We believe that this is a useful extension, because of two broad trends characterizing many OECD economies. On the one hand, average personal taxes for average production workers have declined in most OECD countries from 1996 to 2004 (OECD, 2004). This decline has been accompanied by changes in the structure of the marginal tax rates, and in some countries by a consistent reduction in the top marginal tax. On the other hand, flexible compensation policies – with their emphasis on the relationship between performance and pay – are spreading in modern economies together with the diffusion of organizational changes and new information technologies. While there are several reasons behind these trends, a common denominator is the desire to improve economic efficiency. This paper suggests that a by-product of tax reforms which reduce average and marginal income taxes is the increase in the relative share of PRP on total pay.

Starting with Malcomson and Sartor, 1987, and Lockwood and Manning, 1993, the relevant literature has focused mainly on the relationship between taxation and pay, and on the implications of such relationship for the unemployment rate. One key result in this area is that, when labour supply is endogenous, the effect of tax progressivity on wages is

[1] As argued by Garen, 1994, a promising way of testing the implications of the principal-agent model is the method of comparative statics, which studies how PRP varies with changes in income taxation.

ambiguous. Rather than following this literature and its emphasis on the implications of taxation for total pay, this paper focuses instead on the effects of taxation on the composition of pay.

We show that the relative share of performance related pay over total pay unambiguously declines when average income taxes increase. We also show that the effect of an increase in marginal tax rates on the share of PRP is ambiguous and cannot be signed a priori. We submit these theoretical results to empirical scrutiny by using UK data. The United Kingdom is interesting in this area for two reasons: first, the UK government has actively encouraged the diffusion of PRP in the private sector[2]. As described for instance by Booth and Frank, 1999, since 1991 a substantial share of total pay in the UK was exempt from income taxes if received as PRP. The large increase in the percentage of employees receiving PRP led the government to phase out these tax breaks from 1997 onwards, and to abolish them starting from the year 2000. Second, the UK has experienced a significant tax reform in 1999, which has affected both marginal and average tax rates. We use the exogenous changes produced by this reform to identify the relationship between income taxation and PRP.

Our empirical investigation uses the data drawn from 7 waves (1997-2003) of the British Household Panel Survey (BHPS), a longitudinal representative survey of British households, which covers the years before and after the 1999 Tax Reform. Consistently with the theoretical predictions of the tax – augmented principal-agent model, we find that the share of PRP on total pay increases when the average tax rate decreases. We also find that lower marginal tax rates raise the relative importance of PRP. Importantly, the size of these effects is relatively large: our empirical estimates suggest that a 10 percent reduction in the marginal and average tax rates increase the share of PRP on total pay by 2.80 and 7.99 percent respectively.

The paper is organized as follows: the model of PRP and taxation is presented in the next section. The empirical strategy is discussed in Section 2, and the data are introduced in Section 3. Section 4 briefly illustrates the UK Tax Reform of 1999. The following section presents and discusses the results. Conclusions follow.

[2] There is a growing literature on the use of PRP in the public sector. In this paper, however, we focus only on the private sector.

1. The Theoretical Model

The premise of agency theory is that a principal designs contracts to guide appropriate actions by an agent (Prendergast, 1999). Consider a static model, where the agent - the employee - is assumed to take some action (effort). A component $\mu_o \geq 0$ of this action is observed by both parties, but a component μ is not observed by the principal - the employer. The action affects the measure of performance Y according to the relationship

$$Y = \mu_o + \theta\mu + \varepsilon \qquad [1]$$

where i is for the agent, θ is the productivity of the action μ, and ε is a random component, which impairs the inference of the action from the observation of output. We restrict our attention to linear compensation schemes of the sort

$$W = a + b(Y - \mu_o) \qquad [2]$$

where W is gross pay, a is the fixed component which remunerates observable effort and b is the "piece rate" on performance above the minimum level of observable effort. Employees are risk averse and care about their net pay $W - T(W)$, where T is the tax function. Using the second order approximation of *T*

$$T(W) = T(a + b\theta\mu) + \tau b\varepsilon + \frac{\tau'}{2} b^2\varepsilon^2 \qquad [3]$$

where $\tau = T'(W)$ is the (progressive) marginal tax rate and $\tau' = T''(W)$[3], expected gross wages and taxes are respectively $EW = a + b\theta\mu$ and

$$ET(W) = T(a + b\theta\mu) + \lambda b^2\sigma_\varepsilon^2 \qquad [4]$$

where $\lambda = \frac{\tau'}{2}$. Moreover, the variance of taxes is $Var(T) = \tau^2 b^2 \sigma_\varepsilon^2$, where we ignore for the

[3]One prime for the first derivative and two primes for the second derivative.

sake of simplicity the moments of order higher than 2.

With these premises, the certainty equivalent of the uncertain income stream accruing to employee i is

$$CE_w = a + b\theta\mu - T(a + b\theta\mu) - \lambda b^2\sigma_\varepsilon^2 - \phi\frac{\mu^2}{2} - \frac{1}{2}rb^2\sigma_\varepsilon^2(1+\tau^2) \qquad [5]$$

where r is the absolute degree of risk aversion, σ_ε^2 is the variance of the noise, $\phi\frac{\mu^2}{2}$ is the cost of effort and $\frac{1}{2}rb^2\sigma_\varepsilon^2(1+\tau^2)$ is the risk premium[4]. Each employee chooses the optimal level of effort by maximizing her certainty equivalent income with respect to μ, which yields

$$\mu = \frac{b\theta(1-\tau)}{\phi} \qquad [6]$$

Effort above the minimum observable level is increasing in the piece rate and in the productivity of effort, and decreasing in the cost of effort and in the marginal tax rate.

Risk neutral employers take into account both the incentive compatibility constraint (6) and the worker participation constraint

$$CE_w = \bar{U} \qquad [7]$$

where $\bar{U}$ is the reservation level of income. In this environment, profit maximization is equivalent to the maximization of the sum of the employer's and employee's certainty equivalent incomes. The employer's certainty equivalent is

$$CE_\pi = \mu_o + \theta\mu - (a + b\theta\mu) \qquad [8]$$

and the sum of certainty equivalents is

$$CE = \mu_o + \theta\mu - T(a + b\theta\mu) - \lambda b^2\sigma_\varepsilon^2 - \phi\frac{\mu^2}{2} - \frac{1}{2}rb^2\sigma_\varepsilon^2(1+\tau^2) \qquad [9]$$

[4]See Milgrom and Roberts, 1992

Using (6) and (7) into (9), the maximization of CE with respect to the piece rate b yields

$$b = \frac{1}{1+\tau+\frac{2\lambda\phi\sigma_\varepsilon^2}{\theta^2(1-\tau)}+\frac{r\sigma_\varepsilon^2(1+\tau^2)\phi}{\theta^2(1-\tau)}} \qquad [10]$$

If the parameter λ is small enough to be safely ignored, the above expression simplifies into

$$b = \frac{1}{1+\tau+\frac{r\sigma_\varepsilon^2(1+\tau^2)\phi}{\theta^2(1-\tau)}} \qquad [11]$$

The optimal piece rate has the usual properties: it is higher for individuals with lower risk aversion and lower for individuals with low productivity θ and high cost of effort ϕ. The variance of the noise σ_ε^2 also affects negatively the piece rate (see Garen, 1994).

Notice that only extreme and unrealistic values of progressive taxation ($\tau = 1$) can yield a zero piece rate *b*. Variations of τ within a more realistic range affect the size of the piece rate but do not determine whether the employer will or will not pay performance related pay. This willingness instead depends on the productivity and cost of effort, the degree of risk aversion, and the variance of unobserved noise.

Since the employer can tailor the optimal piece rate to the characteristics of the employee and the job, the sorting which occurs in this simple model is regulated by the participation constraint: only individuals who receive at least their reservation utility accept the piece rate designed by the employer[5]. Let the reservation income be equal to income from unemployment ρ. Then $\bar{U} = (1-z)\rho$, where z is the average tax rate, and the fixed component of pay, a, is given by[6]

[5] Booth and Frank, 1999, propose a sorting mechanism for performance related pay.
[6] Here we assume that the average tax rate on unemployment benefits is the same applied to average pay.

$$(a+b\theta\mu)(1-z)-\frac{\phi\mu^2}{2}-\frac{1}{2}rb^2\sigma_e^2=(1-z)\rho \qquad [12]$$

If the employee has no bargaining power in her match with the employer, the above condition holds as equality. Let β measure the relative bargaining power of the employee, who can bargain with the employer for a higher certainty equivalent income. Then the above condition becomes

$$(a+b\theta\mu)(1-z)=(1+\beta)(1-z)\rho+\frac{\phi\mu^2}{2}+\frac{1}{2}rb^2\sigma_e^2 \qquad [13]$$

With this structure in hand, we ask whether the structure of taxation affects the composition of gross pay into the fixed and performance related components. Define R as the ratio of (expected) gross performance related pay to (expected) gross total pay. This ratio increases when the ratio of fixed to variable pay falls. We can show that R is equal to

$$R=\frac{b\theta\mu}{a+b\theta\mu}=\frac{2\theta^2}{\left[\nu\theta^2+\frac{\phi\nu r\sigma_e^2}{(1-\tau)^2}+\frac{2\phi(1+\beta)\rho}{b^2(1-\tau)}\right]} \qquad [14]$$

where ν denotes the coefficient of residual income progression $\nu=\frac{1-\tau}{1-z}$. Differentiation with respect to z and ν yields

Result *The relative share of PRP on total pay declines when average taxation increases. The effect of an increase in progressive taxation on the ratio cannot be signed a priori.*

Proof: See Appendix

The first part of the result depends on the fact that (expected) PRP does not depend on the average tax rate. To see this, re-write expected PRP as

$$b\theta\mu=\frac{b^2\theta^2(1-\tau)}{\phi} \qquad [15]$$

and notice that the piece rate *b* depends only on the marginal tax rate. On the other hand, total pay needs to increase with the average tax rate for the participation constraint to be satisfied. The second part of the result hinges on the fact that both PRP and total pay are reduced when marginal tax rates increase.

2. The Empirical Strategy

A clear empirical implication of the standard principal – agent model is that an increase in the average tax pressure reduces the ratio between the variable and the fixed components of pay. In the rest of the paper, we submit this prediction to empirical investigation. On the other hand, since the relationship between marginal tax rates and the composition of pay is ambiguous, we have no precise hypothesis for testing, and we use the empirical analysis to resolve this ambiguity.

In the empirical implementation, we use a log-linear approximation of (14). Since *R* can be either zero or take continuous positive values, we define the following Tobit model

$$\begin{aligned} &\ln(1+R_{it}^{*}) = x'_{it}\gamma_1 + y'_{t}\gamma_2 + \gamma_3 \ln(1-\tau)_{it} + \gamma_4 \ln(1-z)_{it} + v_i + \xi_{it} \\ &\ln(1+R_{it}) = 0 \text{ if } R_{it}^{*} \le 0 \\ &R_{it} = R_{it}^{*} \text{ if } R_{it}^{*} > 0 \end{aligned} \qquad [16]$$

where R^{*} is the latent variable, x_{it} and y_{it} are vectors of individual and aggregate controls, i is for the individual, t for time, and we decompose the normally distributed error term into a time invariant individual effect v and additional noise ξ.

The theoretical model suggests that the composition of pay depends on the cost of effort φ, the index of risk aversion r, the productivity of effort θ, the variance of the noise σ_{ε}^{2}, income from unemployment ρ and the relative bargaining power of the worker β. We proxy the individual cost of effort with age, age squared, marital status, gender, educational dummies, and measures of individual health, which include a dummy for the lack of sleep and a dummy for the recent use of medical facilities; risk aversion is proxied by indicators of smoking attitudes, the participation to lotteries and race; the productivity of effort and the variance of shocks are captured by industry, size, regional and occupational dummies, and by measures of previous job history; the relative bargaining power of the individual is

captured by indicators of the presence of a union in the workplace and by political preferences; finally, income from unemployment is proxied by the national unemployment rate.

The macroeconomic effects on the composition of pay are captured in a parsimonious way with a linear, a quadratic trend and the national unemployment rate. British government policy introduced tax breaks during the 1990s, with the aim of encouraging the diffusion of profit related pay. These breaks were phased out in the late 1990s, and completely eliminated from 2000 onwards. We account for this policy with a dummy equal to 1 for the years 2000 - 2003 (no breaks) and to 0 for the previous years (1997-1999).

Even after conditioning for the set of individual and aggregate controls, the relationship between the composition of pay and the two tax instruments can be plagued by two main factors: a) there are unobserved individual and time invariant characteristics, such as the component of individual ability which is not captured by education and job allocation, or the individual cost of effort, which are likely to affect both PRP and the tax rates; b) there could be reverse causality, running from the composition of pay to the tax instruments. Reverse causality can occur, for instance, if shocks to gross pay affect by construction both the index of tax progressivity and the income tax retention rate $(1-z)$. As discussed by Gruber, 1995, measurement errors in the annual wage can generate a spurious correlation between the gross pay, the average and the marginal tax rate. In particular, positive innovations to the measurement error raise the measured annual wage and reduce the average tax rate. The presence of reverse causality implies that the tax variables in model (16) can be endogenous even after controlling for time invariant individual effects.

We deal with the potential correlation of the tax variables with the unobserved individual effects by replacing the former in the first equation of model (16) with their deviations from the individual means. As shown by Altonji and Shatotko, 1987, this transformation implies that the new tax variables are orthogonal by construction to the time invariant individual effect[7].

We address the endogeneity of the tax variables, which is induced by reverse causality, with the methodology suggested by Smith and Blundell, 1986. For each tax variable, we run an auxiliary regression which includes among the regressors all the

[7] In practice, the first equation in (16) is replaced by

$$\ln(1+R_{it}^{*}) = x'_{it}\gamma_1 + y_t\gamma_2 + \gamma_3\left[\ln(1-\tau)_{it} - \overline{\ln(1-\tau)_{it}}\right] + \gamma_4\left[\ln(1-z)_{it} - \overline{\ln(1-z)_{it}}\right] + \left[v_i + \gamma_3\overline{\ln(1-\tau)_{it}} + \gamma_4\overline{\ln(1-z)_{it}}\right] + \xi_{it}$$

where the upper bar is for the individual means. One implication of this transformation is that the time invariant component of the error term now includes the individual means.

exogenous variables plus the selected instruments. Next, we take the residuals from these regressions and add them to the list of explanatory variables in each Tobit model. This methodology ensures that the estimates of the key parameters γ_3 and γ_4 are consistent, and also allows us to test the weak exogeneity of the tax variables using simple T and F tests[8].

3. The Data

The data set used in this paper is drawn from the seven waves (from 1997 to 2003) of the British Household Panel Survey (BHPS). The BHPS is a nationally representative household survey conducted annually since 1991 on more than 5000 British households, or about 10000 individuals a year. The survey includes information on gross pay and on household and job characteristics, which we use to compute both net pay[9] and individual average and marginal tax rates. Since 1997 (wave 7), interviewed individuals are asked whether their pay include a bonus, the amount of the bonus and whether this amount is gross or net. The key question is

"In the last 12 months have you received any bonuses such as a Christmas or quarterly bonus, profit-related pay or profit sharing bonus, or an occasional commission? "

Overtime pay is explicitly excluded. Those who have received performance related pay are then asked the total amount received, and whether this amount was before or after tax. We select the sub-sample of employees in the private sector, who report positive gross earnings and provide information on all the relevant variables used in the empirical analysis. We restrict further by selecting the individuals aged between 17 and 65 in the case of males, and less than 60 in the case of females, and end up with a sample of 29731 individual-wave observations.

As shown in Table 1, the individuals in our sample in 2003 have an average age close to 38 years, more than half of them are married and about 56% are males; 16% of them work part-time, 96% have a permanent job and one close to 20 percent have a union in the workplace. Only a small minority (7 percent) had a father unemployed at the age of 14,

[8]Under the null of weak exogeneity the variance covariance matrix of the estimates is equivalent to the standard tobit variance covariance matrix. See Wooldridge, 2002.
[9]Following Bardasi and Jenkins, 2004, we compute individual net pay starting from gross monthly earnings. An appendix explaining the computation procedure is available upon request from the authors.

about one third consists of smokers and about one fourth voted for the Labour party in the last election. When we restrict the sample to managers and professionals, we find the part-time and smoking rates are reduced, but the remaining characteristics are broadly unchanged.

The percentage of employees receiving PRP was 33.5 percent in 2003, down from 36.1 percent in 1997. These percentages are very close to those found in the Workplace Industrial Relations Survey (WERS), which reports 37.4 percent in 1998 (see Conyon and Freeman, 2001). Conditional on receiving PRP, the average share of PRP in the sample was 6.4 percent in 2003, down from 6.6 percent in 1997. On average, the marginal tax rate declined from 23.1 percent in 1997 to 22.3 percent in 2003, while the average tax rate increased from 11 percent in 1997 to 12 percent in 2003[10].

[Table 1 about here]

4. The Tax Reform and the abolition of tax breaks for PRP

During the last decade, the UK taxation system has undergone a series of substantial reforms. The key changes for the purpose of this paper are the reduction in the starting marginal tax rate from 20 to 10 percent in 1999, the reduction of the basic marginal tax rate from 23 to 22 percent in 2000, and the introduction of the Working Family Tax Credit (WFTC) in 1999[11]. The WFTC introduced in-work family benefits, with the goal of supporting low income families with children, while avoiding at the same time the reduction of labour supply. In this scheme, a household with a dependent child was entitled to receive tax credits if at least one of the parents worked 16 hours or more a week. The Working Family Tax Credit consisted of a basic credit, which increased with the number of children and was more generous with people working more than 30 hours a week. An additional aspect was that up to the 70% of eligible childcare costs could be deducted from taxes[12]. Compared to the previous system of Family Credit (FC), which was mainly a benefit system not administered by the Inland Revenue, the WFTC benefited around 1,271 million households in 2001, compared to the 817 thousands reached by FC in 1999, and was more generous – see Lydon and Walker, 2004.

A substantial body of economic literature has investigated the effects of the tax reform on alternative outcomes, ranging from labour supply (see Francesconi and van der

[10] The construction of individual marginal and average tax rates is described in the Appendix, Section 2.
[11] The WFTC was replaced in 2004 by the WFC and CTC.
[12] The Working Family Tax Credit introduced also credits for disabled people, which are not relevant for our analysis.

Klaauw,2004) to child poverty (see Brewer et al., 2003). According to these and other studies, the changes in the marginal tax rates taking place in 1999 and 2000 affected the entire income distribution, but the biggest gains were experienced by the households in the 2nd poorest decile, who experienced a 5% increase in their net income.

In the late 1980s, the UK government has promoted with tax breaks the diffusion of performance related pay. The government's main goal was to combat wage "stickiness" and increase wage flexibility. In 1987, tax relief was given on half of PRP up to a limit of the lower of £3000 or 20% of the employee's pay. This ceiling was increased to £4,000 in 1989. Tax relief was extended in 1991 to the whole of the PRP payment. In 1997, the government decided to phase out tax relief on PRP over a three to four year period. The ceiling on relief was reduced to £ 2000 in 1998 and to £ 1000 in 1999. No relief was available since 2000 onwards (see Conyon and Freeman, 2001).

5. Results

In our baseline specification, we use a parsimonious specification of the aggregate effects, replace the tax variables with the deviations from their individual means, and augment the set of independent variables with the residuals of the first stage regressions of the tax variables on the exogenous variables and the selected instruments.

Our instruments exploit the exogenous changes in the marginal tax rates and in the tax bands which took place over the time period. As described in the previous section, the starting marginal tax rate, *TR1*, was reduced from 20 to 10 percent in 1999. This change anticipated the smaller reduction in the basic marginal tax rate, *TR2*, from 23 to 22 percent, which occurred in the year 2000. Since this second change coincided with the phasing out of the tax breaks offered by the government to encourage the diffusion of PRP, the discontinuity in the year 2000 cannot be used as an additional instrument. Therefore, we focus on the discontinuity produced by the change in the starting marginal tax rate.

While the changes in marginal tax rates have occurred only once during the sample period, tax bands have been changed every year. In particular, the lower income limit for the basic marginal tax rate was reduced drastically from 4300 to 1500 pounds in 1999, when the starting marginal tax rate was also reduced. We define the variable *GAP2* as the difference between the upper and the lower limit of the basic marginal tax rate, which we deflate with the consumer price index over the sample period. It turns out that the tax band exhibits an abrupt increase in 1999, and increases mildly in the remaining period.

We expect that the decrease in the lowest marginal tax rate *TR1* and the variations in

the tax band *GAP2* affect both the average and the marginal tax rate of the individuals in the sample, and that this effect can vary across the population. We posit that different groups of individuals may react differently to the tax reform, either because they are touched differently or because of endogenous changes in the allocation of time and, consequently, in the resulting tax rates. We capture this variability in the impact of the tax reform by interacting the lowest marginal tax rate with a female dummy and the intermediate tax rate with a male dummy.

To motivate these interactions, consider for instance the intermediate marginal tax *TR2*. In the year 1999, before the tax was reduced from 0.23 to 0.22, the percentage of males with this marginal tax was 84 percent, compared to only 56 percent for females. Therefore, we would expect males to be touched to a higher extent by the reform. Needless to say, the differential response by gender reflects also how males and females react to the reform in terms of their labour supply and effort decisions. Similarly, the starting marginal tax rate before the reform which reduced it from 0.2 to 0.1 was concentrated mainly among females: close to 51 percent of females had this marginal tax rate in 1998, compared to only 10 percent of males.

Table 2 reports the estimates of the first stage regressions of the marginal and average tax rates on the exogenous variables and the selected instruments. While the former two columns refer to the full sample, the latter two columns are for the sub-sample of managers and professionals. The F test of the joint significance of the additional instruments is reported at the end of the table. Since the value of the test is always above the rule of thumb value of 10, suggested by Stagier and Stock, 1997, we clearly reject the hypothesis that the selected instruments are weak. As expected, a reduction in the lowest marginal tax rate reduces individual marginal and average taxes. A similar effect is obtained by a reduction in relative tax bands.

[Table 2 about here]

Table 3 shows the Tobit estimates of model (16). As in Table 2, we report the estimates for the full sample and for the sub-sample of managers and professionals. While the first and third column in the table treats the tax variables as exogenous, the second and fourth columns report the estimates of augmented specifications, which include the first step residuals. Since these residuals are jointly significant, we cannot reject the hypothesis that the

tax variables are endogenous. Moreover, we compute the standard errors by bootstrapping, using 200 replications. Our results show that an increase in marginal and average tax rates reduce the relative share of PRP in total pay, consistently with the predictions of the tax augmented principal – agent model. We compute the implied elasticities by evaluating the relevant variables at their sample means[13]. It turns out that a 10 percent reduction in the marginal and average tax rates is expected to increase the relative share of PRP on total pay by 2.80 and 7.99 percent respectively. Since the piece rate *b* depends in our model only on the marginal tax rate, our estimates also imply that a 10 percent reduction in the average tax rate decreases total pay by 7.99. These effects are sizeable, and are similar to the estimated effects in the sub-sample of managers, professionals and white collars (-3.50 and -8.15 respectively).

[Table 3 about here]

We investigate the robustness of our results in two directions: first, we use a dynamic specification of the baseline model. Second, we replace the macroeconomic variables with unrestricted time dummies. On the one hand, adding some dynamics may help reduce the problems associated to the dynamic incompleteness of the empirical model specified in (16), as suggested by Wooldridge, 2002. On the other hand, one may question whether a quadratic trend plus the aggregate unemployment rate are sufficient to capture the key macroeconomic effects on the share of PRP. By using unrestricted time dummies, we capture all macro effects, at the price that we cannot use any longer the instruments *TR1* and *GAP2*, which are aggregate variables. Still, we can use the interactions of these instruments with the gender dummy.

Table 4 reports the estimates of the dynamic model, and Table 5 the estimates where time dummies replace the macroeconomic variables. Starting with the former, we compute the long – run elasticities of the share of PRP to changes in the marginal and average tax rates, and find that, in the full sample, these are equal to –4.19 and –4.58 respectively.

[Table 4 about here]

[13] The elasticity of R to the average tax rate is

$$\frac{\partial \ln R}{\partial \ln z} = -\frac{z}{R}\frac{1+R}{1-z}\gamma_3 \Phi\left(\frac{x'\beta}{\sigma}\right)$$

where σ is the estimated variance of the error term, computed as in Wooldridge, 2002, p.532.

Turning to the specification with time dummies, we confirm the qualitative results obtained in Table 3. In this case for the full sample, the estimated elasticities are -0.297 for the marginal tax rate and -0.806 for the average tax rate. We conclude that our key findings are robust to the selected perturbations in the baseline specification.

[Table 5 about here]

The effect of changes in income taxes on the composition of pay is quite substantial. On the one hand, a pure increase in tax progressivity (e.g. a higher marginal tax rate holding constant the average tax rate) reduces the relative importance of PRP. On the other hand, an increase in the proportionality of the tax system (e.g. a higher average tax rate for fixed progressivity) affects negatively the ratio between PRP and total pay. Our empirical evidence for the UK suggests that tax reforms, which decrease either the progressivity or the proportionality of the tax system by changing the tax rates or the tax bands, are likely to have a positive effect on the composition of pay.

Conclusions

In this paper, we have extended the standard principal-agent model to incorporate the effects of the tax structure, which we characterize with the average and the marginal tax rate. Following the suggestion by Garen, 1994, that principal - agent theory is difficult to test empirically because it relies on a number of unobservables, we have used the strategy of verifying whether our data support the comparative statics of our model. The key result is that the ratio of PRP to total pay should decline when the average tax rate increases.

We have carried out an empirical investigation based on seven waves of the British Household Panel Survey, which includes a specific question on the availability and the amount of performance related pay. Our evidence clearly supports the predictions of the tax augmented principal – agent theory, in that we find that an increase in the average tax rate reduces the relative share of PRP. We also find that PRP is reduced by an increase in the marginal tax rate, conditional on a given average tax rate.

The estimated empirical elasticities are sizeable, and suggest that a tax reform which reduces average tax rates by 10 percent is likely to lead, as a side effect, to a significant increase in the relative importance of PRP. Interpreted in the light of the current decline in average personal taxation and increase in the use of flexible compensation packages in many OECD countries, our findings offer an interpretation of these two trends which emphasize how tax reforms which reduce the burden of taxes can induce agents to optimally select more flexible forms of compensation.

Appendix

1. Proof of the Result

The differentiation of R with respect to z, given τ, yields

$$\frac{\partial R}{\partial t} = -\frac{2\theta^2\left[\frac{v\theta^2}{1-z} + \frac{v\phi r\sigma_e^2}{(1-z)(1-\tau)^2}\right]}{\left[v\theta^2 + \frac{\phi v r\sigma_e^2}{(1-\tau)^2} + \frac{2\phi(1+\beta)\rho}{b^2(1-\tau)}\right]^2} < 0$$

The differentiation of R with respect to τ yields instead

$$\frac{\partial R}{\partial \tau} = -\frac{2\theta^2\left[-\frac{\theta^2}{1-t} + \frac{\phi r\sigma_e^2}{(1-t)(1-\tau)^2} + \frac{2\phi(1+\beta)\rho}{b(1-\tau)^2}\left(\frac{1}{b} + \frac{1}{2\frac{\partial b}{\partial \tau}}\right)\right]}{\left[v\theta^2 + \frac{\phi v r\sigma_e^2}{(1-\tau)^2} + \frac{2\phi(1+\beta)\rho}{b^2(1-\tau)}\right]^2}$$

where $\left|\frac{\partial b}{\partial \tau}\right|$ is the absolute value of $\frac{\partial b}{\partial \tau}$. The sign of the above expression is uncertain.

2. From gross to net monthly earnings in the BHPS

The calculation of net usual monthly pay relies on Jarvis and Jenkins, 1995, Bardasi, Jenkins and Rigg, 1999, and Bardasi and Jenkins, 2004. Starting from the most recent usual gross payment received[14], we consider only employees and compute total gross monthly earnings by adding pay from any eventual second job. From total gross earnings, we calculate taxable earnings by subtracting pension scheme contributions, personal allowances and the Performance Related Pay tax relief when eligible. Following Bardasi and Jenkins, 2004, pension contributions are imputed as 4,7% of gross earnings for all waves. Personal allowances are imputed using the first two columns of Table A1. Until 2000, tax relieves were given to employees in the private sector with a positive National Insurance contribution, who

[14] The variable PAYGU measures the usual monthly wage or salary payment before tax and other deductions in current main job

were in a Profit Related Pay (PRP) scheme. The amount of PRP which qualified for tax relief was subject to two statutory limits. The first ceiling corresponded to the 20% of the employee's pay. The second limit was a monetary one. The yearly amount was £4000 in 1997. The ceiling on relief was reduced to £ 2000 in 1998 and to £ 1000 in 1999. No relief was available since 2000 onward.

Tab A1: Personal Allowances and National Insurance contributions.

Year	Non aged allowances (1)		National Insurance contributions					
			Lower Earnings limit (1)	Upper Earnings Limit (1)	Employee contracted in			Contracted out rate
	Personal	Married-couple			Rate at LEL	Main rate	Rate above UEL	
1997	337.8	152.5	268.66	2015	2%	10%	0%	8,4%
1998	349.6	158.3	277.33	2101.67	2%	10%	0%	8.4%
1999	361.3	164.2	286	2166.67	0%	10%	0%	8.4%
2000	365.4	-	290.33	2318.33	0%	10%	0%	8.4%
2001	377.9	-	312	2491.66	0%	10%	0%	8.4%
2002	384.6	-	325	2535	0%	10%	0%	8.4%
2003	384.6	-	333.66	2578.33	0%	11%	1%	9.4%

(1) in £ per month. (1)aged-allowances are not considered because our sample is restricted to individuals below 65. Source: www.hmrc.gov.uk/

Taxable earnings are then employed to compute the individual marginal tax rate and gross tax, using the bands and the rates reported in Table A2. We then compute individual tax credits according to the eligibility criteria.

Table A2: Rate of income tax (1)

Year	Starting rate		Basic rate		Higher rate	
	taxable bands	rate of tax %	taxable bands	rate of tax %	taxable bands	rate of tax %
1997	1-4,100	20	4,101-26,100	23	Over 26,100	40
1998	1-4,300	20	4,301-27,100	23	Over 27,100	40
1999	1-1,500	10	1,501-28,000	23	Over 28,000	40
2000	1-1,520	10	1,521-28,400	22	Over 28400	40
2001	1-1,880	10	1,881-29,400	22	Over 29,400	40
2002	1-1,920	10	1,921-29,900	22	Over 29,900	40
2003	1-1,960	10	1,961-30,500	22	Over 30,500	40

(1) taxable bands refer to annual income. Source: www.hmrc.gov.uk/

Credit amounts and thresholds can be found in Table A3. The tax credits were deducted from the gross tax to compute the net tax. National insurance contributions were imputed to workers according to Table A1. We finally derived the usual net monthly labour income by

subtracting from gross earnings the estimated income net tax, National Insurance contributions, pension contributions and PRP tax relief when eligible.

Table A3: Monthly tax credits.

year	Married couple allowances	WFTC	30 hours credit	Child credits			Childcare tax credit (1)		Income threshold –lone parent or couple (3)
				under11	11-16	16-18	1 child	2+ children	
1997	152,5	-	-	-	-	-	-	-	-
1998	158,3	-	-	-	-	-	-	-	-
1999	164,16	-	-	-	-	-	-	-	-
2000	-	226.6	47.9	89.0	90.57	112.45	450	675	390
2001	-	230.3	48.7	110.9	110.9	114.2	450	675	396.3
2002	-	255.7	49.6	112.7	112.7	115.9	607,5	900	402.6
2003	-	270.8	50.5	114.7	114.7	117.9	607.5	900	409.5

(1) in £ per month. (2) The percentage of allowed childcare costs in credit is 70%. (3) with a taper rate of 55% and a minimum award per month of £2.17. Source: www.hmrc.gov.uk/

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Table 1. Summary Statistics, 1997 and 2003

	1997		2003	
Variables	All sample	Manager and Professionals	All sample	Manager and Professionals
Age	36.7	36.7	37.9	37.2
Married	.57	.57	.55	.56
Gender (male=1)	.56	.51	.56	.52
Part-time	.16	.12	.16	.13
Union in the workplace	.18	.15	.18	.15
Unemployed father	.06	.05	.07	.05
Voted for Labour	.35	.30	.25	.30
Windfall gains	.22	.22	.10	.12
Lack of sleep	.64	.66	.66	.67
White	.96	.96	.93	.95
Permanent job	.94	.95	.97	.96
Smoker	.32	.25	.31	.25
Average tax rate	.11	.13	.12	.14
Marginal tax rate	.231	.24	.223	.24
Net usual monthly earnings (1)	997.5	1176.25	1222.5	.1346
Gross usual monthly earnings (1)	1395.2	1688.2	1616.2	.1827
% with PRP	.361	.44	.335	.43
Monthly net PRP (if positive) (1)	119	159.2	165.13	184.0
Share of PRP on total pay, if PRP>0	.066	.074	.064	.076
Number of individual-wave observations	3322	1672	4301	1884

(1) in 2005 prices

Table 2. First stage regressions. Full sample and sub-sample of managers, professionals and white collars.

	ln(1-τ)	ln(1-z)	ln(1-τ)	ln(1-z)
age	-0.000	-0.001	-0.001	-0.001
	[2.85]***	[6.07]***	[2.13]**	[5.49]***
age2	0.000	0.000	0.000	0.000
	[2.89]***	[5.46]***	[1.86]*	[4.92]***
married	-0.001	0.000	-0.001	0.000
	[1.11]	[0.04]	[0.62]	[0.49]
gender (male=1)	0.032	-0.05	-0.171	-0.119
	[1.10]	[2.81]***	[3.74]***	[4.94]***
part time	0.011	0.01	0.008	0.01
	[13.23]***	[18.00]***	[5.85]***	[10.53]***
union in the workplace	0.001	0.000	0.001	0.000
	[1.14]	[0.65]	[1.23]	[0.80]
unemployed father	-0.000	-0.000	-0.000	0.000
	[0.39]	[0.59]	[0.01]	[0.37]
voted for labor	-0.001	-0.000	-0.000	-0.000
	[1.42]	[1.29]	[0.15]	[0.33]
windfall gains	0.000	-0.000	-0.001	0.001
	[0.11]	[0.07]	[0.49]	[1.17]
lack of sleep	-0.000	-0.000	0.001	-0.000
	[0.45]	[0.07]	[0.64]	[0.87]
white	-0.002	-0.001	-0.002	-0.000
	[1.13]	[1.42]	[0.80]	[0.37]
permanent job	0.002	-0.001	0.001	-0.001
	[1.45]	[1.37]	[0.47]	[0.52]
smoker	-0.000	-0.000	-0.001	-0.000
	[0.17]	[0.47]	[1.11]	[0.73]
unemployment rate	-1.545	-2.694	-1.718	-2.559
	[2.81]***	[7.68]***	[1.91]*	[5.12]***
dummy=1 if year>1999	-0.005	-0.015	-0.001	-0.012
	[1.26]	[6.14]***	[0.24]	[3.59]***
marginal tax rate tr1	-1.956	-3.517	-2.197	-3.255
	[2.38]**	[6.68]***	[1.61]	[4.27]***
gap2	-0.078	-0.14	-0.088	-0.129
	[2.36]**	[6.63]***	[1.60]	[4.24]***
female * tr1	-0.21	-0.043	-0.117	-0.034
	[12.92]***	[4.13]***	[4.62]***	[2.39]**
male * tr2	-0.243	0.216	0.707	0.53
	[1.79]*	[2.62]***	[3.32]***	[4.71]***
Observations	29731	29731	13864	13864
F test for the inclusion of instruments	74.26	29.62	25.68	22.94

Note: each regression includes a constant, education, firm size, industry, regional and occupational dummies; controls for the previous job, a linear and a quadratic trend. Robust standard errors. T-statistics within brackets.

Table 3. Tobit estimates, treating tax variables as exogenous and endogenous. Full sample and sub-sample of managers, professionals and white collars. Dependent variable: log(1+R)

	[1]	[2]	[3]	[4]
age	0.003	0.002	0.005	0.004
	[5.96]***	[4.58]***	[6.22]***	[4.45]***
age2	-0.000	-0.000	-0.000	-0.000
	[7.49]***	[6.19]***	[7.29]***	[5.70]***
married	0.011	0.01	0.015	0.013
	[6.89]***	[6.54]***	[6.40]***	[5.37]***
gender (male=1)	0.011	0.005	0.006	0.001
	[6.76]***	[2.47]**	[2.79]***	[0.33]
part time	-0.021	-0.013	-0.016	-0.011
	[9.33]***	[5.49]***	[4.78]***	[2.83]***
union in the workplace	0.01	0.01	0.017	0.018
	[5.58]***	[6.19]***	[6.28]***	[7.62]***
unemployed father	-0.006	-0.006	0.003	0.004
	[2.37]**	[2.13]**	[0.68]	[0.96]
voted Labour	-0.002	-0.001	0.000	0.001
	[1.01]	[0.41]	[0.09]	[0.48]
windfall gain	0.008	0.009	0.007	0.008
	[4.43]***	[4.93]***	[2.78]***	[3.18]***
lack of sleep	-0.003	-0.003	-0.005	-0.005
	[2.06]**	[1.91]*	[2.33]**	[2.33]**
white	0.011	0.012	0.003	0.004
	[2.98]***	[3.07]***	[0.55]	[0.78]
permanent job	0.047	0.045	0.06	0.057
	[10.29]***	[9.02]***	[8.64]***	[7.16]***
smoker	-0.008	-0.007	-0.01	-0.009
	[5.42]***	[5.20]***	[4.36]***	[3.66]***
ln(1-τ)^	-0.085	0.065	-0.091	0.082
	[4.83]***	[2.84]***	[3.95]***	[2.62]***
ln(1-z)^	0.379	0.395	0.409	0.38
	[12.97]***	[10.43]***	[9.50]***	[6.61]***
first stage residuals ln(1-τ)^		-0.153		-0.173
		[10.01]***		[8.60]***
first stage residuals ln(1-z)^		-0.049		-0.003
		[1.96]*		[0.07]
unemployment rate	-0.06	-0.123	0.013	-0.047
	[0.15]	[0.31]	[0.02]	[0.09]
dummy=1 if year>1999	0.002	0.001	0.001	0.001
	[0.55]	[0.42]	[0.22]	[0.14]
Observations	29731	29731	13864	13864

Note: each regression includes a constant, education, firm size, industry, regional and occupational dummies; controls for health, previous job, a linear and a quadratic trend. ^ Deviation of the variable from the individual mean. Robust standard errors in columns (1) and (3). Bootstrapped standard errors in columns (2) and (4). T-statistics within brackets. Three, two and one star for significance levels of 1, 5 and 10 percent.

Table 4. Tobit estimates, treating tax variables as exogenous and endogenous. Full sample and sub-sample of managers and professionals. With lagged variables. Dependent variable: log(1+R)

	[1]	[2]	[3]	[4]
age	0.001	0.000	0.001	0.000
	-1.65	-0.37	-1.85	-0.58
age2	0.000	0.000	0.000	0.000
	(2.96)**	-1.9	(2.78)**	-1.61
married	0.005	0.005	0.007	0.006
	(3.45)**	(3.37)**	(3.04)**	(2.50)*
gender (male=1)	0.006	0.000	0.002	-0.003
	(3.50)**	-0.2	-0.85	-1.28
part time	-0.012	-0.004	-0.008	-0.002
	(5.15)**	-1.7	(2.43)*	-0.53
union in the workplace	0.006	0.006	0.011	0.012
	(3.63)**	(3.85)**	(4.09)**	(4.60)**
unemployed father	-0.003	-0.003	0.004	0.004
	-1.25	-1.21	-0.88	-0.95
voted Labour	0.000	0.000	0.002	0.003
	-0.2	-0.31	-1.12	-1.56
windfall gain	0.007	0.007	0.007	0.008
	(3.63)**	(4.20)**	(2.64)**	(3.17)**
lack of sleep	-0.003	-0.002	-0.004	-0.003
	-1.86	-1.81	-1.8	-1.66
white	0.009	0.008	0.003	0.002
	(2.20)*	(2.12)*	-0.51	-0.41
permanent job	0.036	0.034	0.044	0.041
	(6.83)**	(5.55)**	(5.82)**	(4.84)**
smoker	-0.007	-0.006	-0.009	-0.007
	(4.71)**	(4.47)**	(3.80)**	(3.07)**
ln(1-τ)^	-0.019	0.051	-0.03	0.064
	-1.09	(2.13)*	-1.37	(2.02)*
ln(1-z)^	0.175	0.264	0.209	0.255
	(5.81)**	(6.20)**	(4.76)**	(3.43)**
ln(1-τ)^(-1)	0.017	0.015	0.031	0.023
	-1.01	-0.74	-1.4	-0.97
ln(1-z)^(-1)	-0.122	-0.117	-0.218	-0.225
	(4.32)**	(4.04)**	(5.35)**	(4.44)**
ln(1+R)(-1)	0.744	0.729	0.75	0.735
	(59.39)**	(34.65)**	(46.54)**	(28.99)**
first stage residuals ln(1-τ)^		-0.062		-0.083
		(4.26)**		(4.05)**
first stage residuals ln(1-z)^		-0.124		-0.077
		(4.82)**		-1.83
unemployment rate	0.786	0.766	0.826	0.798
	(1.98)*	(2.01)*	-1.48	-1.48
dummy=1 if year>1999	0.004	0.004	0.006	0.006
	-1.02	-1.18	-1.15	-1.18
Observations	21228	21228	10338	10338

Note: See Table 3

Table 5. Tobit estimates, treating tax variables as exogenous and endogenous. Full sample and sub-sample of managers, professionals and white collars. Dependent variable: log(1+R). With time dummies

	[1]	[2]	[3]	[4]
age	0.003	0.002	0.005	0.004
	[5.97]***	[4.59]***	[6.25]***	[4.51]***
age2	0.000	0.000	0.000	0.000
	[7.50]***	[6.20]***	[7.32]***	[5.88]***
married	0.011	0.01	0.015	0.013
	[6.90]***	[6.54]***	[6.40]***	[4.77]***
gender (male=1)	0.011	0.005	0.006	0.001
	[6.77]***	[2.47]**	[2.79]***	[0.32]
part time	-0.021	-0.013	-0.016	-0.01
	[9.34]***	[5.49]***	[4.78]***	[2.81]***
union in the workplace	0.01	0.01	0.017	0.018
	[5.59]***	[6.20]***	[6.28]***	[8.33]***
unemployed father	-0.006	-0.006	0.003	0.004
	[2.37]**	[2.13]**	[0.68]	[0.88]
voted Labour	-0.002	-0.001	0.000	0.001
	[1.04]	[0.45]	[0.02]	[0.45]
windfall gain	0.008	0.009	0.007	0.008
	[4.39]***	[4.90]***	[2.70]***	[3.51]***
lack of sleep	-0.003	-0.003	-0.005	-0.005
	[2.06]**	[1.91]*	[2.34]**	[2.34]**
white	0.011	0.012	0.003	0.004
	[3.03]***	[3.11]***	[0.57]	[0.79]
permanent job	0.047	0.045	0.06	0.057
	[10.30]***	[9.04]***	[8.69]***	[6.81]***
smoker	-0.008	-0.007	-0.01	-0.009
	[5.43]***	[5.19]***	[4.38]***	[3.57]***
ln(1-τ)^	-0.085	0.065	-0.091	0.082
	[4.83]***	[2.82]***	[3.95]***	[2.43]**
ln(1-z)^	0.381	0.398	0.414	0.386
	[13.04]***	[10.45]***	[9.61]***	[6.72]***
first stage residuals ln(1-τ)^		-0.153		-0.173
		[10.00]***		[9.49]***
first stage residuals ln(1-z)^		-0.05		-0.004
		[1.99]**		[0.10]
Observations	29731	29731	13864	13864

Note: see Table 3