THE DIRECT INCIDENCE OF CORPORATE INCOME TAX ON WAGES

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We examine how far taxes on corporate income are directly shifted onto the workforce. We use data on 55,082 companies located in nine European countries over the period 1996–2003. We identify this direct shifting through cross-company variation in tax liabilities, conditional on value added per employee. Our central estimate is that the long run elasticity of the wage bill with respect to taxation is -0.093. Evaluated at the median, this implies that an exogenous rise of $1 in tax would reduce the wage bill by 75 cents. We find only weak evidence of a difference for multinational companies.

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"On corporation tax, the Chancellor got his priorities wrong today.
The public will simply not understand why, when businesses are
enjoying record profits, the Chancellor found money to cut their tax payments".

"The TUC is not in favour of companies paying excessive taxes,
but we do expect them to pay fair taxes".

Brendan Barber, General Secretary of the UK Trades Union Congress,
on the 2007 UK corporation tax cut (FT.com, 2007)

I. INTRODUCTION

A central issue in the distribution of tax burdens is the effective incidence of the corporation tax. This has been the subject of study for nearly 50 years in theoretical, and in Computable General Equilibrium (CGE) models.[1] Nonetheless, despite its policy relevance, until very recently it received virtually no econometric investigation.

This paper re-examines the extent to which taxes on corporate income are passed on to workers in the form of lower wages. We make two main novel contributions. First, we model a new mechanism by which corporate taxes may be passed on in lower wages: the wage bargain. We differentiate two aspects of the effective incidence of the tax. Differently from previous contributions, we identify the *direct* incidence of the tax: given the pre-tax profit of the firm, a higher tax bill will directly reduce the quasi-rent over which the workers and the company can bargain. The *indirect* incidence instead has an effect on wages through determining the level of pre-tax profit, by affecting either investment or output prices. Second, we test the size of this effect using unconsolidated firm-level accounting data for over 55,000 companies in nine major European countries over the period 1996 to 2003. Variations in tax payments and effective tax rates arise due to both differences across countries and over time in the

[1] In a 1994 survey of North American tax professionals undertaken by Slemrod (1995), 75 per cent of respondents believed that corporate income taxes are largely passed on to workers and consumers.

legal tax system, and due to firm-specific factors. We identify the effects of taxation using all of these sources of variation.

The literature on the incidence of taxes on corporate income dates back to Harberger (1962), who developed a model of a closed economy with a corporate sector and a non-corporate sector, and analysed the introduction of a tax only in the corporate segment of the economy. Harberger (1962) showed that the incidence of the tax depended on a number of factors, including the elasticities of substitution between labour and capital used in each sector, and between the goods produced in each sector. His main conclusion was that under reasonable assumptions, the tax is borne by all owners of capital, across both segments of the economy, as it drives down the post-tax return to capital. A number of more complex CGE models with a larger number of sectors generate similar results (see for example Shoven, 1976).

However these results depend crucially on among other things, the assumption of a closed economy, which restricts the supply of capital to the economy. If capital is perfectly mobile between countries, but labour is not, then the results can be very different. Bradford (1978) and Kotlikoff and Summers (1987) showed that the introduction of a tax on corporate income in a home country tends to reduce the world rate of return to capital, and tends to shift capital from the home country to the rest of the world. This shift in capital reduces the return to labour in the home country, and increases the return to labour abroad. As the home country becomes small relative to the rest of the world, the effect on the world rate of return diminishes towards zero. There remains an exodus of capital, and the domestic labour force effectively bears the entire burden of the tax. Indeed given a deadweight loss induced by the outward shift of capital, the cost to the home country labour force can exceed the tax revenue generated. This suggests that a small open economy would be better off taxing immobile labour

directly, compared to imposing a tax which distorts the allocation of capital (Gordon, 1986).

A number of recent contributions have developed more sophisticated general equilibrium models of the long-run incidence of taxes on corporate income in an open economy (Randolph, 2006; Gravelle and Smetters, 2006; and Harberger, 1995; 2006). Randolph (2006) considered a model with two countries and five sectors, with three of the sectors being taxed only in the domestic country. Of critical importance in the model are the assumptions about factor mobility, supply elasticities, and the relative capital intensities of the different sectors. Under reasonable assumptions, Randolph (2006) found that the domestic labour force and owners of domestic capital bear the tax burden roughly in proportion to their factor income shares: labour bears 73 per cent of the tax burden. Where the domestic economy is large (as for the United States), the tax also increases wages and reduces the return to capital in the foreign country. Gravelle and Smetters (2006) allowed for a form of imperfect competition with the possibility that tradable goods are not perfect substitutes across countries. This effectively reduces the mobility of capital, and increases the extent to which owners of capital bear the tax burden.

Of course these models exclude several factors that may be important. In a recent survey, Auerbach (2006) noted a number of such factors including dynamics, investment incentives, corporate financial policy, choice of organisational form and alternative forms of imperfect competition. In this paper, we extend the literature by drawing on many studies of wage determination to investigate how taxes on corporate income can play a role in the wage bargain. Instead of making the simple assumptions that the aggregate stock of labour is fixed, and that labour is paid its marginal product, we investigate the wage bargain at the firm level. To do so, we introduce a tax on

corporate income into the basic efficient bargaining framework of McDonald and Solow (1981), in which the firm and the labour force bargain over both wages and employment.

This generates a previously unexplored channel through which corporate taxes can affect wages. Companies operating in imperfect competition may bargain over the proportion of quasi-rents paid out in wages. We introduce into the bargain a standard tax on domestic corporate income, which is levied on profit net of wages and an allowance for capital expenditure. We refer to the impact of the tax through the wage bargain itself–conditional on value added–as a *direct* effect, which reduces the size of the quasi-rent available to bargain over. Our model specification enables us to identify this effect empirically at the level of an individual firm. We present evidence below suggesting that this *direct* effect is both large and significant.

We distinguish this from *indirect* effects of the tax, which can arise through two channels. First, there may be an effect of a change in the tax liability on the output price, conditional on capital and labour. Second, a change in tax may affect the incentive to invest and hence the capital stock, and indirectly the labour force. Both of these may affect the pre-tax level of value added.[2] The second effect determines the size of the deadweight cost arising from distortions to the behaviour of the company as a result of the tax.

Our paper builds on an empirical literature investigating the extent to which wages are partly determined by sharing in quasi-rents.[3] Part of this literature examined the extent to which rents generated by technological innovation are passed on in higher wages; for example, Van Reenen (1996) followed both a reduced form and a structural

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[2] In an international context, wage bargaining may give a firm an incentive to generate outside options in the form of foreign investment. See, for example, the model by Eckel and Egger (2006).

[3] In a recent contribution, using similar data to this paper, Budd, Konings, and Slaughter (2005) investigated whether wages are determined as a share of parent-firm profit as well as subsidiary profit.

approach to examine this question. Like Abowd and Lemieux (1993), Van Reenen (1996) emphasised the importance of dealing with the endogeneity of quasi-rents. Dealing with endogeneity appropriately can significantly raise the estimated proportion of quasi-rents passed on to the workforce. Our estimates of the elasticity of wage payments with respect to value added are higher than those in the literature are. However, we find these elasticities plausible, in that they imply that the effect of a marginal increase in quasi-rents on wage payments is very similar to the ratio of wage payments to quasi-rents. Our model indicates that a marginal increase in the tax liability has a larger effect, since unlike the pre-tax quasi-rent it is not subject to tax itself. The empirical results support this.

Four other recent papers aim to provide empirical evidence of the incidence of taxes on corporate income.[4] Hassett and Mathur (2006) used aggregate wage and tax data from 72 countries over the period 1981–2002. They experimented with different measures of the tax rate. They found that wages are highly responsive to the corporate tax rate, and more so in small countries. One element of this approach is surprising however. In most of its empirical formulations, the paper adds controls, including a measure of value added per worker in the manufacturing sector. This control is unlikely to be independent of the effects of the tax on corporate income, which the authors are seeking to identify: a higher tax rate should generate a net outflow of capital, which is likely to depress value added per worker. To the extent that their paper identifies a large effect of the tax on wages, conditional on value added per worker, then the effect they identify would also seem to abstract from effects arising indirectly through changes in value added.

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4 A survey of this literature is provided in Gentry (2007).

Felix (2007) employed aggregate data on wages differentiated by skill level from 19 developed countries over the period 1979–2000. Controlling for the openness of the economy, and using alternative measures of the tax rate, Felix (2007) also found very large and significant effects of the corporate income tax on wages. The effect tends to be uniform across skill levels. Desai, Foley, and Hines (2007) used aggregate data on the activities of US companies in around 50 countries in four years to estimate jointly the impact of the corporate income tax on the wage rate and the rate of profit. Fixing the sum of these effects to be unity, they found results of a similar magnitude to Randolph (2006): between 45 and 75 per cent of the corporate tax borne is borne by labour with the remainder falling on capital. Again, fixing the sum of the effects to be unity abstracts from the indirect effects of the deadweight cost, which if included would generate a total effect in excess of unity.

Riedel (2008) also presented a wage-bargaining model in the presence of a simplified corporate tax. Partly based on the empirical results of Budd, Konings, and Slaughter (2005), she modelled the bargain as being over the sum of the parent firm's profit and the subsidiary's profit. Abstracting from capital, this model predicts that a higher domestic tax rate would tend to increase domestic wages, because it would reduce the cost to the domestic subsidiary of paying wages (since taxable income is net of wages), while not reducing the size of the parent company's profit.[5] Symmetrically, a rise in the tax rate applied to the parent company would tend to reduce wages in the domestic subsidiary, since the total profit to be bargained over would fall, while the cost of paying domestic wages would be unchanged. Riedel (2008) found empirical support for the latter proposition, but not for the former.

[5] Note that this is the exact opposite of the result that would be found if the domestic subsidiary bargained over domestic profit only, but there was an outside option. In this case the higher tax rate would leave the value of the outside option unaffected, leading to a lower domestic wage rate. This effect was showed, for example, by Goerke (1996).

Our empirical analysis differs from these papers in several important respects. We exploit within-firm and cross-firm variation in taxation using firm-level data. We use a panel of unconsolidated firm-level accounting data for around 55,000 companies in Belgium, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom over the period 1996–2003. Controlling for labour productivity (and hence for the effects of the corporate tax through capital) and other relevant company characteristics, we examine whether firms with a higher tax liability pay lower wages, *ceteris paribus*. Analysing this variation enables us to identify the *direct* effect of the tax on wages, while controlling for other effects through the pre-tax level of profit. It does not allow us to identify the scale of *indirect* effects.

We are able to identify the effects of taxation by exploiting firm- and time-specific variation in the tax liability. We therefore do not have to rely solely on changes in the statutory tax system. Tax liabilities can vary across firms with similar levels of profit because of diversity in the form of their economic activity, such as the assets invested in and the sources of finance used, the extent to which profits are shifted between subsidiaries, the extent of losses brought forward from earlier periods, and a number of other reasons. We use lagged values of firm-specific variables based on these factors as instruments for the endogenous tax liability.

Using micro data also allows us to exploit the heterogeneity of companies' behaviour, displaying more cross-sectional variation, which is useful for identifying parameters. We are able to exploit companies' heterogeneity to analyse whether the incidence of the corporate income tax differs according to the type of firm. For example, multinational corporations may differ from domestic companies because they have the option to relocate part or all of their productive activity abroad. Moreover, firms in multinational groups are more likely to shift profit to lower tax jurisdictions. This may

increase their bargaining power, as well as reducing the location-specific profit over which they would be prepared to bargain.

We provide rigorous empirical evidence that, in this bargaining framework, a substantial part of the corporation income tax is passed on to the labour force in the form of lower wages. Our central estimates show that, conditional on value added per employee, in the long run an exogenous \$1 increase in the tax bill tends to reduce real wages at the median by 75 cents.[6] Note that since wage payments are deductible from the tax base, this induced reduction in wages will generally generate a further increase in the tax bill. At the mean statutory tax rate (τ), in our sample 35 per cent, this would imply a further increase in tax of just over 26 cents. Relative to this overall tax increase of \$1.26, the effective incidence on labour is therefore approximately 59 per cent.

Our bargaining model indicates that the effective incidence of an exogenous \$1 rise in pre-tax value added should be lower than this. The model is based on the assumption that the two parties bargain over the share of the post-tax quasi-rent. A rise in pre-tax value added is partly shared by the government in higher taxes. The model predicts that the effective incidence on labour of an exogenous \$1 rise in pre-tax value added should be a fraction $(1-\tau)$ of the effective incidence of an exogenous fall of \$1 in the tax liability. Evaluated at the mean tax rate of 35 per cent, the above result implies that wages would rise by 49 cents (0.75*0.65=0.49) in response to an exogenous \$1 rise in pre-tax value added. In fact, our empirical results indicate that, at the median, the effective incidence of an exogenous \$1 rise in pre-tax value added is 57 cents. The similarity of these two estimates provides support for the hypothesis that firms and workers do indeed bargain over the post-tax quasi-rent.

[6] Calculations are based on the estimated long run elasticity of -0.093 and are detailed in Section IV.D.

The paper is organised as follows. Section II develops the conceptual framework, which allows us to consider the impact of corporate income taxes on the determination of wages, and to differentiate their direct and indirect effects. Section III presents the data used in the empirical section. Section IV discusses various econometric issues, and presents the results. Section V concludes.

II. CONCEPTUAL FRAMEWORK

We employ a simple model to inform the empirical work reported below. We consider the case of a single firm. The wage rate, w, and the labour force, N, are set through efficient bargaining between the firm and a single union representing all the workers in the company. Simultaneously, the firm chooses its capital, K. The model is similar to many used in the literature (see references in Booth, 1995; Blanchflower, Oswald, and Sanfey, 1996; Addison and Schnabel, 2003).

Employees have an outside wage available, $\overline{w}$. This may reflect the wage rate in an alternative job, or an unemployment benefit; it is unaffected by the bargain. The union aims to maximise $(u(w)-u(\overline{w}))N$, where $u(.)$ represents the utility of a single worker and N is the number of workers employed by the firm.

The firm may have the option of shifting its activities to another location, or another activity where, net of the costs of shifting, it can earn an outside post-tax profit π^*. The firm is prepared to bargain over location-specific profit (before wages), that is, the additional profit available by producing locally. Domestic post-tax profit is

$$\pi = F(K,N) - wN - rK - T \; . \qquad (1)$$

$F(K,N)$ is a standard revenue function, depending on capital, labour, and the output price. We interpret F as value added. The cost of capital is rK. Corporation tax, levied at rate τ is denoted T and is defined as

$$T = \tau\{F(K,N) - wN - \alpha rK + \phi\}. \qquad (2)$$

Thus, the tax is levied on revenue net of wage payments and an allowance for the cost of capital, where α is a measure of the generosity of depreciation allowances. In addition however, many other factors can affect the firm's tax position. These include for example, the size of interest payments, the allocation across types of investment which receive different capital allowances, the existence of losses brought forward from an earlier period, the extent to which taxable profit can be shifted abroad to a lower-tax country through manipulating transfer prices, stock relief, or the contribution to an investment reserve or pension fund. We do not explicitly model these factors; rather we include them all in the term ϕ. The existence of this term implies that tax liabilities may vary across firms that have the same revenue, wage payments, and investment. In the empirical work, it is the existence of the factors incorporated in ϕ which allows us to identify the effects of tax independently of F.

We assume that the additional factors determining the tax liability in the outside option are not captured exactly by ϕ. If they were, then this term would drop out of the wage bargain. This assumption is clearly reasonable if the outside option is to shift production abroad to where there is a different tax system. If the outside option is undertaken by the same domestic firm, then some elements of ϕ (for example losses brought forward from earlier periods) could be common with the outside option. However, there are likely to be numerous other factors that will enable us to identify empirically the role of tax through ϕ.

The bargaining power of the firm, μ, may depend on the cost of a temporary dispute with the workforce. The bargaining power of the union is (1-μ); this may depend on the availability of alternative income to the workers in the event of a dispute.

We assume that wages and employment are determined by a Nash bargain, which maximises:

$$B = \{[u(w) - u(\overline{w})]N\}^{(1-\mu)} \{\pi - \pi^*\}^{\mu}. \tag{3}$$

where π is defined by (1) and (2). The first order conditions for maximisation are:

$$(1-\mu)\frac{u'(w)}{u(w) - u(\overline{w})} - \mu\left\{\frac{N(1-\tau)}{\pi - \pi^*}\right\} = 0, \text{ and} \tag{4}$$

$$F_N(K,N) = w - \frac{(1-\mu)}{\mu}\left\{\frac{\pi - \pi^*}{N(1-\tau)}\right\}. \tag{5}$$

Finally, the firm chooses its capital stock by maximising its net of tax profit π. This yields the familiar expression:

$$F_K(K,N) = (1+m)r \tag{6}$$

where m is the effective marginal tax rate (EMTR), $m = \tau(1-\alpha)/(1-\tau)$. The three expressions (4), (5), and (6) jointly determine the values of the wage rate, w, the capital stock, K, and the number of workers employed, N.

To investigate the role of tax in affecting these three variables, we can begin by expanding $u(w)$ around the observed wage w. This yields $u(\overline{w}) \cong u(w) + u'(w)(\overline{w} - w)$. Making this approximation and substituting into (4) generates an expression similar to (5), but with the marginal product F_N replaced by the outside wage $\overline{w}$:[7]

$$w \cong \mu\overline{w} + (1-\mu)\left\{\frac{F(K,N) - (1+m)rK}{N} - \frac{\tau\phi}{(1-\tau)N} - \frac{\pi^*}{(1-\tau)N}\right\}. \tag{7}$$

[7] Since it is based on equation (4), this specification could also be generated from a right to manage model.

Here the wage is approximately equal to a weighted average of the outside wage and a share of the per-employee location-specific profit, gross of wages. The deductibility of labour costs from taxable income implies that there are only three elements of the home country tax in the expression.

The first is the effect of less than full deductibility of capital expenditure. For a cash flow tax $\alpha = 1$, implying that $m = 0$. However, in the more common case of $\alpha < 1$, the additional tax liability reduces the profit over which the firm is prepared to bargain, thereby reducing the wage rate. This effect is independent of any effect via the capital stock *K*, as discussed below. Note that α typically varies across firms, depending on the mix of assets in which the firm invested.

Second, the other factors determining the tax liability, captured in ϕ, also remain as elements affecting the size of the post-tax profit over which the firm is prepared to bargain. Conditional on other factors, a rise in ϕ induces a rise in tax, and this will tend to reduce the wage rate:

$$\frac{\partial w}{\partial \phi} = -\frac{(1-\mu)}{N}\frac{\tau}{(1-\tau)} < 0. \tag{8}$$

We describe this effect as the *direct* impact of taxation through the wage bargain: a rise in ϕ reduces the wage conditional on the levels of capital, employment, and pre-tax profit. This is the effect identified in the empirical estimation when the wage rate is regressed on the tax liability per employee conditional on *F/N,* proxied by the variable value added per employee. The tax liability itself is likely to be endogenous, as we discuss below.

There may also be an indirect effect of a change in ϕ via a change in value added, *F*. This may be reflected in a change in investment, and hence in the capital stock, *K*. Nonetheless, the more obvious route for such an effect would be through the

effective marginal tax rate m discussed below. A change in ϕ may also reflect a modification in the output price, conditional on a given level of capital and labour. The extent to which the company can pass on in its prices its tax liability incorporated in ϕ is constrained by competition in the output market. It is most probable that any change in a company's tax liability that is not reflected in its competitors' tax bill will not be passed on in higher prices.

A third effect of taxation in equation (7) is that the home country tax rate also affects the value of the outside option in the bargain.[8] The value of the firm's outside option itself may be unaffected by the tax rate (depending on what the outside option is), but the deductibility of wages from the home country tax implies that in the bargain the outside option is effectively grossed up by $(1-\tau)$. This effect of the tax rate mirrors its effect through the firm's discrete location choice. The latter can be affected by the tax rate, even under a cash flow tax (see Devereux and Griffith, 1998).

There may be another *indirect* effect on wages through the impact of the effective marginal tax rate m on the cost of capital in equation (6). This is straightforward to analyse when labour is fixed. In this case, a rise in m induces a fall in K, from (6). In turn, the fall in K induces a reduction in the marginal productivity of labour F_N, which in the absence of bargaining implies a reduction in the wage rate.

The analysis of a rise in m is more complex though when considering an individual firm, or indeed in any case where the labour force is not fixed. To explore the effect of m on the wage rate, we totally differentiate the three first order conditions, allowing w, K, and N to vary in response to a change in m, but holding all outside options constant. This yields:

[8] Goerke (1996) presented a theoretical model identifying the effect of the home country tax rate.

$$N\left\{\frac{1}{\mu}-(w-F_N)\frac{u''(w)}{u'(w)}\right\}dw+\frac{w-F_N}{\mu}dN+\frac{(1-\mu)}{\mu}rKdm=0 \tag{9}$$

$$\left\{\frac{F_N-w}{\mu}+NF_{NN}\right\}dN+NF_{NK}dK=\frac{N}{\mu}dw+\frac{(1-\mu)}{\mu}rKdm \tag{10}$$

and

$$F_{KK}dK+F_{KN}dN=rdm\,. \tag{11}$$

Combining (9), (10), and (11) implies that a sufficient condition for a negative effect of m on w, $\frac{dw}{dm}<0$ is that

$$w<F_N+\mu N\left[\frac{F_{NK}F_{KN}-F_{NN}F_{KK}}{F_{KK}}\right]. \tag{12}$$

Given concavity of the production function, the term in square brackets is positive. Thus a rise in m can reduce the wage rate, even when the wage exceeds the marginal product of capital. We describe the effect of m on w as another *indirect* effect of tax on the wage rate, since it allows for an effect through K and N, and hence through value added.[9] This indirect effect determines the deadweight cost of the tax-induced distortions to capital and labour decisions.

In the empirical work below, we attempt to identify only the *direct* effect of corporation tax on wages. We estimate a log-linear version of expression (7), where the post-tax quasi-rent per employee is captured by two terms: value added per employee and tax per employee. Identification of the *direct* effect of taxation is straightforward: conditional on the other factors, the 'tax per employee' term identifies the effect of ϕ on the wage rate. Because of the potential endogeneity of the tax liability, we instrument this term using two sets of instruments. One measures the legal parameters of the tax

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[9] Note though that part of the effect is direct, since even conditional on K and N, a rise in m reduces the post-tax location-specific profit that is bargained over.

system, and so is common to all companies in the same country and year. The other depends on the firm-specific tax liability. These measures include the use of debt finance, the makeup of capital expenditure, and the extent to which losses from previous periods may be used to reduce current liabilities.

Note that the size of the tax effect is predicted to be larger than that of value added. Interpreting the tax term in the empirical equation as $T^* = \tau\phi / N$, the expected coefficient would be $\partial w / \partial T^* = -(1-\mu)/(1-\tau)$. By contrast, the expected coefficient on the value added per employee term is $\partial w / \partial (F / N) = (1-\mu)$. This difference arises because value added is pre-tax: a marginal addition to value added is shared between the firm, the workforce, and the government. By contrast, a reduction in tax is shared only by the firm and the workforce. This accounts for the fact that the marginal impact of tax is grossed up by $(1-\tau)$.

In the empirical estimation, we also consider heterogeneity across firms. In particular, we compare firms that are part of multinational groups with purely domestic companies. In the model there are two reasons why these may behave differently. First, the outside option of the multinational π^* may be higher, implying that the size of the profit over which the firm is prepared to bargain is lower. This is difficult to test; we cannot observe the outside option since the firm does not in practice choose it. In the empirical estimation, we therefore cannot include the outside option. This means that we may over-estimate the size of the profit over which the firm is willing to bargain, and that the degree of overestimation is higher for multinational firms. This may induce greater negative bias in the estimated coefficients for firms that are part of multinational groups.

As a possible proxy for the outside option, we experiment by including the value added and the tax of the rest of the multinational group. As a proxy for the outside

option, these variables would tend to have a negative impact on the wage. However, as Budd, Konings, and Slaughter (2005) and Riedel (2008) argued, it is also possible that domestic workers bargain over the firm's entire profit, rather than only on the part earned domestically. In this case, these group variables would have a positive impact on the domestic wage.

A second element of heterogeneity between firms is that a multinational may also find it cheaper to transfer production to another plant temporarily while it is engaged in a dispute with a union. This would tend to increase the firm's bargaining power μ, as it can be more patient in waiting to achieve a deal, compared with a firm which does not have this opportunity. We can examine this effect by testing whether the coefficients from the bargaining equation (which reflects bargaining strength) differ between these two groups of firms.

Note that the model predicts that a higher bargaining power of the firm would result in the firm paying a smaller share of any additional profit to the workforce through higher wages. Given the symmetry in the model across all cash flows within the firm, this also implies that a firm with greater bargaining strength would respond to an increase in tax by passing on a *smaller* proportion of the increase to the workforce. From equation (7), we have:

$$\frac{\partial(\partial w/\partial\phi)}{\partial\mu}=\frac{\tau}{(1-\tau)N}>0\,. \tag{13}$$

That is, as the bargaining power of the firm increases, the coefficient on the tax per employee term should rise. That is, a multinational which has greater bargaining power should have a smaller coefficient in absolute terms.

Finally, note that in the empirical work below we do not attempt to identify the *indirect* effect of taxes through the effective marginal tax rate and the capital stock, or through an effect of ϕ on prices, conditional on capital and labour. To evaluate the

former would mean that we could not include other firm-level variables as controls in the equation, since all of them would be affected by the size of the capital stock. Another possible approach would be to identify separately the impact of the effective marginal tax rate on investment and the capital stock, and the impact of the capital stock on value added. These effects would need to be combined with the effects of value added on the wage rate that we do estimate. We leave evaluation of these effects for future research.

III. DATA

The empirical analysis is carried out using a commercially available firm-level worldwide data set called ORBIS, compiled by the Bureau van Dijk (2007). It consists of accounting data from the balance sheet and profit and loss account of companies all around the world from 1996 to 2005. In addition ORBIS contains information on the ownership structure of the firms in 2005, including the number of shareholders, their names, their country of residence and their percentage interest in the company, and the number of subsidiaries, their names, and the percentage participation of the parent company.

Initially, we selected only the companies not defined as 'micro' in European Commission (2003).[10] This sample was further restricted as follows. First, it was limited to companies for which unconsolidated data and ownership information were available; our interest is in the determination of wages at the level of an individual company, rather than at the level of a group of companies. Second, observations which showed clear errors and missing values were dropped, along with observations in the

[10] Selecting non-micro companies involved selecting only companies with at least two subsequent years of recorded total assets greater than €2,000 and at least one employee.

first and one hundredth percentiles of the distribution for the main variables.[11] Finally, the dynamic model specification and the method of estimation we used required companies with at least four continuous years of data. The final sample consists of 55,082 companies located in Belgium, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden, and the United Kingdom.

We used ownership information from the original full set of data to identify companies in the same group in our sample. Companies were classified as: (i) belonging to a multinational group if they were connected to at least one other company in a different country by an ownership link of at least 50 per cent of the capital; (ii) belonging to a domestic group if the company was connected to other companies by an ownership link of at least 50 per cent but with none of those companies located in a different country; or (iii) as a stand-alone company if it did not have any ownership links with other companies.

Table I illustrates the distribution of companies across the nine countries. It also shows the number of companies that are stand-alone (overall around 35 per cent), part of a domestic group (30 per cent), or part of a multinational group (35 per cent). Table II indicates the number of observations used in the estimation for each company. Over 15,000 companies (over one quarter of the sample of companies used) have data for eight years; a similar number of companies have either six or seven observations. Table III shows the number of observations per year used in the regressions; each year is well represented.

[11] The main variables are wage rate, number of employees, fixed assets per employee, tax bill per employee, and value added per employee.

IV. EMPIRICAL ANALYSIS

Based on the conceptual framework in Section II, and in particular on (7), we consider the following log-linearised dynamic specification for wage rate *w*:

$$w_{it} = \sum_{j=1}^{2} \gamma_j w_{i,t-j} + \sum_{j=0}^{2} \left[\beta_j v_{i,t-j} + \delta_j T_{i,t-j} + \boldsymbol{\lambda}_{\mathbf{j}}' \mathbf{Z}_{\mathbf{i,t-j}} \right] + \alpha_i + \alpha_t + \varepsilon_{it} \tag{14}$$

where *i* and *t* index companies and years respectively, *w* is log wage rate, ν is log value added per employee, T is log tax bill per employee, α_i is a company-specific fixed effect, α_t is a year effect, and ε_{it} is the error term. The vector $\mathbf{Z}$ contains other variables associated with wage bargaining such as the outside wage and union density. About 15 per cent of our sample observations contain either a negative or a zero value for the tax liability. We assume that the effect of the actual magnitude of the tax burden on the wage rate is only present when there are positive taxes, so we include T only when it is positive. To account for the observations with non-positive taxes, we include in $\mathbf{Z}$ a dummy variable indicating a non-positive tax liability. We allow for a general dynamic specification, which can also be derived from a static model with an AR(2) process for the disturbance.

Several econometric issues need to be considered before a choice of an appropriate technique is made for the estimation of a dynamic equation of this form. Due to the presence of permanent company-specific unobserved heterogeneity (α_i) which is correlated with the lagged dependent variables and endogenous regressors (ν , T and the outside wage), the pooled OLS and within-group (WG) estimators are inconsistent. It is well recognised in the literature that the most appropriate technique to use in this case is the Generalised Method of Moments (GMM) applied to the first-differenced equation that does not contain α_i. The precise set of moment conditions that

should be used to generate the appropriate instruments depends on the assumptions about the correlation between the regressors and the composite error term $u_{it} = \alpha_i + \varepsilon_{it}$.[12] Much of the recent literature has focused on finding appropriate instruments for the application of GMM. Arellano and Bond (1991) (AB) proposed the use of lagged levels of the variables as instruments for the endogenous differences in the first-differenced model [GMM-diff]. However, later research (for example, Blundell and Bond, 1998 (BB)) has shown that when the series are highly persistent, the levels instruments are weak predictors of the differenced endogenous variables. Therefore, the AB estimator can have very poor finite sample properties in terms of bias and precision. BB proposed the use of additional moment conditions that correspond to the use of lagged differences of endogenous variables as instruments for the model in levels. This GMM estimator is known as system GMM [GMM-sys]. It combines moment conditions for the model in first differences with the moment conditions for the model in levels. BB and Blundell, Bond, and Windmeijer (2000) showed that the system GMM estimator had better finite sample properties than AB's original differenced GMM estimator. They advocated the use of this technique when the series were highly persistent. However, this relied on certain stationarity conditions of the initial observation. Bunn and Windmeijer (2007) showed that when the variance of the unobserved heterogeneity α_i is high relative to the variance of the idiosyncratic error ε_{it}, the performance of the system GMM deteriorates. In summary, whether one uses GMM-diff, or GMM-sys, or even some other method of estimation will depend on the statistical properties of the variables used in the model. Our choice of instruments for our GMM estimation has been based on this discussion. We shall return to the issue of appropriate instruments later when we discuss the results.

[12] We accommodate the time effects using year dummies.

We have used two tests to investigate the validity of our chosen instruments. The first is the Sargan/Hansen test for over-identification (Sargan, 1958; Hansen, 1982) which requires a non-rejection of the null hypothesis being tested. The second is a serial correlation test (Arellano and Bond, 1991) that tests for the presence of serial correlation in the first differenced errors ε_{it}. White noise errors ε_{it} would imply an MA(1) process for the $\Delta\ \varepsilon_{it}$, thus rejecting the null of no first order serial correlation but not rejecting the null of second order serial correlation. We use xtabond2 (Roodman, 2006) in StataCorp (2005) to estimate our models using the GMM technique.

IV.A. Variables

The wage rate is calculated as the annual average company wage (that is, costs of employees (**435**) divided by the total number of employees (**425**)).[13] We also calculate an outside wage. We assume that a worker could move to take up a job in the worst paid company in the same broad industrial sector[14], the same country, and the same year; we take this to be the outside wage in that sector, country, and year. We use the ORBIS measure of value added (**439**).

The tax variable recorded in the profit and loss statement (**430**) is our measure of the tax liability of the firm in each period.[15] As discussed above, this measure is company and time-specific, in that the tax liability depends on many factors specific to the firm's performance in any particular period. We treat the tax liability as endogenous. We use two different sets of instruments. The first set includes the country and year-specific measures of the effective marginal tax rate (EMTR), the effective average tax

[13]. This is the only measure of wage available in the dataset. The variable codes in ORBIS are given in parenthesis in bold.

[14] The broad industrial sector is defined using the NACE Rev 1.1 core codes at the 2-digit level.

[15] This is an approximation, since firms may record a value for the tax liability which differs from their obligation to the tax authorities; however, there is no reason to believe that there should be a systematic bias in using this measure.

rate (EATR)[16] and the statutory corporate tax rate. These measures are based on the legal tax system, and so are unlikely to be affected by the shocks to the individual firm's profit and wages. The second set of instruments is a collection of lagged time-varying firm-specific variables. We use the ratio of tangible fixed assets to total fixed assets as an indicator of the likely value of depreciation allowances for tax purposes. Non-current liabilities as a proportion of total assets are employed as an indicator for the extent to which taxable income is likely to be reduced by interest payments. We also use a binary indicator of whether profit before taxes in previous periods was negative, which may indicate that the company has brought forward taxable losses to set against current profit to reduce current tax liabilities.

All monetary variables are deflated to 2000 prices using OECD country- and year-specific consumer price indexes, and converted to a common currency (US dollars) using the year 2000 OECD national average exchange rates.[17] We also investigate the impact of union density (UD) using a country- and year-specific index from the OECD (2004).[18] Table IV displays some basic descriptive statistics for the main variables and instruments.

IV.B. Basic Specification

Table V presents results for our basic specification using different estimators. This specification includes only value-added per employee (v) and the tax bill per employee (T). All specifications include time dummies and two lags of each variable. Since the preferred specification required two lags of each variable, we have estimated the same model using different methods to illustrate the effect of choice of technique on the estimated coefficients. Column (1) presents the results from a pooled OLS regression.

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[16] These are calculated according to the methodology proposed by Devereux and Griffith (2003), and are computed from a number of sources.

[17] OECD CPIs and exchange rates are taken from www.OECDStat.org

[18] For a review of the effect of union density on labour market performance, see OECD (2006).

There is no allowance for company-specific unobservables in this specification, although the standard errors are clustered to account for this. Columns (2) and (3) present results from the WG estimation (OLS on variables entered in mean deviations) and OLS on the first-differenced data respectively. These are two alternative ways of dealing with company-specific unobservables in the estimation. Generally, in the absence of endogenous regressors, the pooled OLS estimator of the coefficient of the lagged dependent variable is upward-biased, while the WG and the OLS on the first-differenced estimators are downward-biased estimates (Blundell, Bond and Windmeijer, 2000). The coefficient estimates on the lagged dependent variables are very different in the three model estimations and are consistent with these biases. Both the pooled OLS and the WG estimates of the coefficient on w_{it-1} are positive, though of very different magnitudes. The first-differenced OLS model estimate of this coefficient is negative. Surprisingly, all other coefficient estimates are very similar.

GMM estimation results are provided in columns (4) to (8). The sets of instruments used in these specifications are different. As noted above, all sets of instruments include country- and time-specific measures of the effective marginal tax rate (EMTR), the effective average tax rate (EATR), and the statutory corporate tax rate. Also included are the following time-varying firm-specific variables in logs: tangible fixed assets as a proportion of total fixed assets, non-current liabilities as a proportion of total assets, and an indicator variable for non-positive profit before tax. Indicator variables to pick up zero values of the logged variables were also included in the set of instruments. Columns (4) and (5) are based on the AB GMM-diff estimation of the first-differenced equation using levels of the endogenous variables as additional instruments. Columns (6) and (7) are based on the BB GMM-sys estimation, which uses levels (first-

differences) of the endogenous variables as instruments for the first-differenced (levels) endogenous variables.

One practical problem with both approaches is that the number of instruments can be numerous. Unlike in two-stage-least-squares (2SLS) where the estimation sample is restricted according to the choice of lag for the instrument, in standard applications of GMM-diff and GMM-sys, a separate instrument is included for each time period. To illustrate this problem, consider our application where T= 8. If we were to apply 2SLS to estimate (14) in first-differences, w_{it-3} can be used as an instrument for $\Delta\, w_{it-1}$ under standard assumptions. This would imply that the estimation sample would be t=4,..,8. However, every additional lag of our dependent variable that is included in the set of instruments would result in the loss of one extra time observation. In our sample where the number of companies is large, every loss of a time observation results in a loss of around 55,000 observations per period. In contrast, the standard GMM-diff and GMM-sys approaches include separate instruments for each time period. This results in a sparse instrument set but a larger estimation sample. Three practical problems can result from the use of a sparse instrument set (Roodman 2007).[19] First, the instruments can be too weak to identify the relevant effects. Second, the precision of the weighting matrix that is used in the GMM estimation is affected. Third, the Sargan/Hansen test has low power. Given these problems, we also investigate the approach in a strand of the literature where the standard GMM-diff instruments are

[19] Taking a simple example to illustrate this issue, consider an AR(1) specification in first-difference as follows: $\Delta y_{it}=\gamma\Delta y_{it-1} + \Delta\varepsilon_{it}$, and the model would be estimated using $t=3,..T$. The instrument matrix for the i the company in the case of AB-diff would be: $Z_i = \begin{bmatrix} y_{i1} & 0 & 0 & 0 & 0 & 0 & 0... \\ 0 & y_{i1} & y_{i2} & 0 & 0 & 0 & 0... \\ 0 & 0 & 0 & y_{i1} & y_{i2} & y_{i3} & 0... \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \end{bmatrix}$.
For example, the instruments for the observation y_{i3}-y_{i2} would be y_{i2} and y_{i1}.

combined through addition to create a smaller instrument set (Roodman 2006, 2007).[20] Columns (4) and (6) present results from the GMM estimation that used the full set of unrestricted instruments, while columns (5) and (7) present results from estimation that used the smaller restricted instrument set.

However, in all cases, the Sargan/Hansen test for over-identification is rejected and the tests for first and second order serial correlations are rejected, implying a problem with the estimators.[21] The table reports that the degrees of freedom for the over-identifying tests in the case of the restricted instrument matrix are much smaller. However, the tests still reject the null of instrument validity.[22]

We next turn to our preferred estimates, which are provided in column (8) of Table V. These results refer to the GMM estimation of the first differenced equation using a set of first differenced instruments. Using a general notation, in the example of footnote 20, the instrument matrix for this GMM estimation is as follows:

$$Z_i = \begin{bmatrix} 0 & 0 & 0 & 0 \\ y_{i2} - y_{i1} & 0 & 0 & 0 \\ y_{i3} - y_{i2} & y_{i2} - y_{i1} & 0 & 0 \\ y_{i4} - y_{i3} & y_{i3} - y_{i2} & y_{i2} - y_{i1} & 0 \\ . & . & . & . \end{bmatrix}.$$

We treat all lags from two upwards of all our variables as being predetermined. The columns of the above matrix refer to the different instruments used.

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[20] This is achieved in *STATA* using the 'collapse' option in estimation command *xtabond2*. Taking the example given in footnote 20, the new instrument matrix would be $Z_i = \begin{bmatrix} y_{i1} & 0 & 0 & . \\ y_{i2} & y_{i1} & 0 & . \\ y_{i3} & y_{i2} & y_{i1} & . \\ . & . & . & . \end{bmatrix}$.

[21] In Table A.I of the Appendix, we have provided the results from OLS and WG estimations of simple univariate AR(1) and AR(2) models. The results are not suggestive of a near unit root in the two main variables w and v. Hence, the need for the estimation of the model using GMM-sys is not present. When we used the GMM-diff estimator, we were only able to find a reasonable specification which passed all the model diagnostics when we used lags 5 or more as instruments. This resulted in a drastic loss of observations and we therefore did not pursue this strategy.

[22] Bunn and Windmeijer (2007) showed that when the variance of the unobserved company-specific heterogeneity (α_i) relative to the variance of ε_{it} increases, the bias in the GMM-sys can become quite high compared to the GMM-diff estimator and they advocate the use of GMM-diff in this case.

Unlike the results in columns (4) to (7) of Table V, for the specification shown in column (8), the tests for over-identification and the tests for first and second order serial correlations are all satisfactory. The Sargan/Hansen test for over-identification is not rejected. The test for first order serial correlation is rejected, while the test for second order serial correlation is not. This is what we would expect if the errors in the levels equation were not serially correlated.

Turning to the coefficient estimates, the estimated effects are broadly consistent with the theoretical model presented in Section II, even though we have added dynamics in the empirical specification. Both the first period and second period lagged wage rate terms have a significant effect on the current wage rate, after controlling for company-specific unobservables and accounting for endogeneity of the regressors. There is some persistence but it is not very high; the coefficients are smaller than the GMM-diff and GMM-sys estimates but are larger than the WG estimates in column (2). The short-run elasticity of the wage rate with respect to the tax per employee is quite large compared to other columns; it is estimated to be -0.095 in column (8), about six times those reported in columns (1) to (3). The long-run elasticity is a little lower at -0.066. The short-run elasticity with respect to value added per employee is estimated to be 0.773, and the longer run is again slightly lower at 0.723. We explore below the implications of these results for the incidence of the tax.

IV.C. Basic Specification with Bargaining Variables

In Table VI, we use the same estimator as in column (8) of Table V, but add variables associated with union bargaining. The new variables include a measure of country- and year-specific aggregate union density, and a measure of the outside option available to

the workers.[23] As a proxy for the latter, we use the minimum of the log wage per employee in that sector and country in a particular year. We also include a dummy for those companies that pay the minimum wage.

For ease of exposition, column (8) of Table V is reproduced in column (1) of Table VI. We add the extra variables one at a time: column (2) includes the aggregate union density variable and column (3) includes additionally the outside-option variables. Since these variables do not vary by company, they are unlikely to have a very strong effect. This is what we find, although the variables have the correct sign. Including these additional controls has little impact on the other coefficients and standard errors. The diagnostic tests change a little: in particular the Sargan/Hansen statistic no longer rejects the null at 10%. The estimated short-run elasticity of T is now slightly higher; for example, in column (3) it is -0.120. The union density variable is correctly signed and is positive and significant at 5%.

In summary, the basic specification results displayed in column (8) of Table V do not change much with the addition of variables associated with the bargaining strength. Below, we use column (3) of Table VI as our preferred model for further investigations. We next examine the behaviour of multinationals compared to domestic companies.

IV.D. Evaluating the Direct Incidence

As already noted, the elasticity of the wage rate with respect to the tax liability per employee, T, is a little higher with the additional bargaining variables. In column (1) of Table VI, the short-run elasticity is estimated at -0.095 and the long-run elasticity at about -0.066. In column (3), the short-run elasticity is -0.120 and the long-run elasticity

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[23] Although union coverage would be a better measure of union strength, we were unable to obtain consistent data series for our sample of countries for the years we have used. Hence, we include union density as a proxy for the strength of the union in these countries.

is -0.093. Standard errors of both the short- and long-run estimates for column (3) are given in Table VII.

Since the wage rate is calculated as total compensation per employee, these estimates are equivalent to the elasticity of total compensation with respect to the tax liability. To use these results to identify the direct incidence of tax, it is useful to calculate the impact of an exogenous \$1 change in the tax liability on total compensation. Calculations are presented in Table VII. We calculate the incidence for each observation in the sample by multiplying the estimated elasticity by the ratio of the wage rate to tax per employee. Based on the column (3) estimates, at the median of the resulting distribution, a \$1 increase in the tax liability leads to a 97 cents reduction in total compensation in the short run, and a 75 cents reduction in the long run. These are very large effects: the majority of any additional \$1 of tax is passed on in lower wages, and this effect happens within one period. Note though that the reduction in wages results in a further increase in the tax liability because of the deductibility of wages from the tax base. At the mean tax rate in the sample, a reduction in wages of 75 cents would generate a rise in tax of around 26 cents ($\tau\Delta w = 0.35*(-0.75) = -0.26$). The change in wages is just under 60 per cent (0.75/1.26=0.59) of the overall change in tax of \$1.26.

Recall that these are estimates only of the *direct* effects of an increased tax liability. They do not include any *indirect* effect through prices or the capital stock, since we are controlling for pre-tax value added per employee. Note also that we would not expect over-shifting in the *direct* effect, which simply measures the distribution of a given location-specific profit between the firm and the workers.

It is also interesting to compare the effects of taxation and value added. Following the same procedure as above, we find the effective incidence of a \$1 change

in value added by multiplying the estimated elasticity by the ratio of the wage rate to value added per employee. Table VII indicates that the median of the resulting distribution in the short run is 0.67. A fall of $1 in value added reduces wage payments by 67 cents. The long-run reduction is 57 cents. These figures are close to the median share of labour compensation in value added in the sample, which is 0.67.

From the theory above, we would expect the incidence of the tax to be higher than the incidence of a change in the pre-tax value added; the theory would suggest that the impact of an exogenous $1 increase in value added would need to be grossed up by a factor $1-\tau$ to find the expected impact of an exogenous $1 reduction in tax. Our estimate of 75 cents in the long run is only slightly smaller than this, evaluated at the median.

There are a number of estimates of the elasticity of the wage rate to value added per employee in the literature. These vary widely and depend on the specification and econometric techniques used. For example, estimates from Nickell and Wadhwani (1990), Abowd and Lemieux (1993), and Van Reenen (1996) vary between 0.2 and 0.4. One possible explanation of the higher elasticities found here is that we use unconsolidated accounting data, which link wage payments of each subsidiary within a group to the value added of that subsidiary.[24] Other studies that use consolidated data may combine separate wage negotiations in different parts of the group; this may reduce the estimated elasticity. We test for the effects of other parts of the group below. In any case, as pointed out already, our estimates of the marginal effect of changes in value added seem plausible in that they are consistent with the average share of value added captured by the labour force.

[24] Budd, Konings, and Slaughter (2005) employed the same data source as used here, and found much lower elasticities. We attribute this primarily to the fact that they use a level, rather than a log, specification. By contrast, Riedel (2008) also used the same data, but with a log specification found a similar range of estimates of the effect of value added to those presented here.

IV.E. Behaviour of Multinationals

Finally, we consider two forms of heterogeneity across firms, both of which involve multinational companies. Both are based on the specification of Table VI column (3) (which is reproduced in column (1) of Table VIII for ease of reference).

First, we investigate whether the estimated parameters differ according to whether a firm is part of a multinational group or not. The conceptual framework in Section II indicated that the stronger the bargaining power of a firm, the lower the proportion of profit before wages that would be passed on to the labour force, and symmetrically, the lower the proportion of any increase in tax that would be passed on to the labour force. To consider differences in bargaining power, we investigate two sub-samples of the data: in column (2), we consider only stand-alone firms and in columns (3) and (4), we consider only firms, which are part of multinational groups.

The short-run elasticities of the wage rate with respect to tax per employee are very similar for the two groups of companies, whilst the long-run elasticity is bigger for international groups (-0.108 for multinationals versus -0.075 for stand-alones). The long-run incidence of an exogenous $1 rise in tax is very similar. At the median of the stand-alone sub-sample, compensation would fall by 73 cents. For companies that are part of multinational groups, the comparative figure is around 70 cents. For value added, the short-run elasticities for the two groups are very close. However, the long-run elasticity, and the long-run incidence of an extra $1 of value added, evaluated at the median, are both slightly higher for companies that are part of multinational groups[25]. Both of these results are consistent with multinational companies having greater bargaining power, although the evidence is not strong.

[25] The long-run elasticity is 0.816 for stand-alones and 0.900 for multinational companies. The long-run incidence of value added is 0.542 for stand-alones and 0.611 for multinationals.

A second effect for multinationals could occur through the outside option. In column (5) we investigate this for multinational companies by including the tax and value added variables for the rest of the multinational group. The group variables are calculated aggregating values over all of the other subsidiaries of the group for which we have data. We express these aggregates as a proportion of the number of the original company's employees. If these terms proxy the outside option of the group, then a higher value added (or lower tax) in the rest of the group may indicate a more valuable outside option and hence a lower domestic wage.

In fact, we do not find any significant effects of these variables. This may of course simply indicate that they are not good proxies for the firm's outside options. Such lack of significance also differs from the results of Budd, Konings, and Slaughter (2005) and Riedel (2008). They find the opposite effect for the value added of the parent firm. The value added of the parent has a positive effect on the wage in the subsidiary. They attribute this to the domestic labour force bargaining over profits in the parent as well as in the subsidiary. However, neither paper includes the tax or value added of the rest of the multinational group, but only the parent. The lack of significance in our results may be due to this difference in our approach. More generally, it may reflect the possibility that the workers may bargain over worldwide profits, a factor that offsets the use of worldwide profit as a proxy for the outside option in the bargain.

V. CONCLUSION

The standard model of a small open economy yields strong results for the effective incidence of a tax on capital located in that country. Given a fixed world rate of return, a tax will raise the pre-tax rate of return, but leave the post-tax rate of return unaffected. The rise in the pre-tax rate of return is achieved by an outflow of capital, which reduces

labour productivity and hence the compensation received by the immobile domestic labour force. There is therefore a presumption that the burden of the tax will be shifted away from the owners of capital to the labour force.

In this paper, we investigate empirically part of this effect. Specifically, in our estimation we analyse the impact of a change in taxation conditional on value added. We interpret this in the context of a wage bargaining model: for a given pre-tax quasi-rent, a higher tax reduces the post-tax quasi-rent available to be bargained over by the firm and the employees. This wage bargain introduces a direct channel by which taxation affects the wage rate, a channel which can be estimated conditional on the value added of the firm. We estimate the size of this direct effect using a large database of over 55,000 companies in nine countries over the period 1996 to 2003.

We do not estimate the *indirect* effect of a change in tax, which affects the wage rate through changing the size of the pre-tax quasi-rent available to be bargained over. More specifically, although by controlling for value added (as an estimate of the pre-tax quasi-rent) we estimate the impact of changes in value added on the wage rate, we do not estimate the impact of the tax on the size of value added. By excluding this effect, our estimate of the direct effect can be interpreted as excluding the effects associated with the deadweight cost of the tax, and any changes in output price.

The results strongly support the hypothesis of a direct effect of corporate income tax through wage bargaining. We find that source-based taxes on corporate income are largely passed on in the form of lower wages. At the median, our results suggest that 75 per cent of an exogenous increase in tax is passed on in lower wages in the long run. These estimates are for the *direct* effect of the tax only, conditional on value added (and hence indirectly conditional on investment); they are additional to possible *indirect* effects through value added.

We also investigate whether the incidence of the corporate income tax on the wage rate differs between stand-alone companies and companies that are part of multinational groups. We find only weak evidence that the companies that are part of multinational groups shift a smaller proportion of any additional tax onto the workforce (or keep a larger proportion of any reduction in tax). This is consistent with such companies having greater bargaining power. We find no effect on the wage rate of the profit or tax liability elsewhere in the multinational group.

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Table I

Number and Type of Company, by Country

Country	*Number of companies*				*Number of observations*
	Total	*Stand-alone*	*Part of domestic groups*	*Part of multinationals*	
Belgium	1,954	224	453	1,277	3,408
Finland	1,023	91	467	465	2,833
France	17,505	4,894	5,645	6,966	54,511
Germany	168	24	19	125	319
Italy	8,483	3,212	2,775	2,496	29,021
The Netherlands	303	10	32	261	911
Spain	13,704	6,873	3,906	2,925	42,367
Sweden	2,713	99	1,053	1,561	5,964
United Kingdom	9,229	3,972	1,985	3,272	27,415
Total	**55,082**	**19,399**	**16,335**	**19,348**	**166,749**

Table II
Number of Observations per Company

Years available per firm	*Number of companies*	
	Frequency	*Per cent*
4	12,261	22.3
5	12,217	22.2
6	7,667	13.9
7	7,632	13.8
8	15,305	27.8
Total	**55,082**	**100**

Table III
Observations per Year

Years	*Frequency*	*Per cent*
1999	24,087	14.5
2000	30,614	18.4
2001	32,848	19.7
2002	38,527	23.1
2003	40,673	24.4
Total	**166,749**	**100**

Table IV
Descriptive Statistics for Main Variables and Instruments (in levels)

		Wage rate	*Value added per employee*	*Tax bill per employee*	*Negative tax bill (dummy)*	*Union density*	*Outside wage rate*	*Tangible fixed assets/ fixed assets*	*Non current liabilities/ total assets*	*Negative profit before tax (dummy)*	*EMTR*	*EATR*	*Statutory tax rate*
Belgium	*Mean*	52.6	215.56	13.22	0.14	55.37	17.57	0.68	0.16	0.15	0.06	0.30	0.40
	Median	48.45	78.05	4.54	0	55.6	17.69	0.86	0.10	0	0.06	0.30	0.40
	S.D.	17.11	1,300.09	56.03	0.35	0.25	7.97	0.35	0.17	0.36	0	0	0
Finland	*Mean*	41.97	110.42	14.34	0.14	74.71	7.57	0.65	0.17	0.18	0.15	0.24	0.29
	Median	39.75	60.76	3.32	0	74.8	5.82	0.78	0.10	0	0.15	0.25	0.29
	S.D.	13.41	233.6	52.58	0.35	0.6	6.01	0.33	0.20	0.39	0.01	0.01	0
France	*Mean*	42.94	81.58	7.16	0.18	8.22	2.48	0.65	0.11	0.20	0.14	0.30	0.37
	Median	39.01	53.52	2.49	0	8.2	0.42	0.75	0.06	0	0.14	0.29	0.35
	S.D.	17.15	359.98	46.71	0.39	0.09	3.49	1.75	0.16	0.40	0.01	0.02	0.03
Germany	*Mean*	57.51	137.17	14.92	0.08	23.42	13.41	0.69	0.29	0.21	0.19	0.32	0.39
	Median	54.79	90.25	5.46	0	23.2	8.91	0.84	0.24	0	0.19	0.31	0.38
	S.D.	18.73	168.19	33.33	0.27	0.99	12.14	0.33	0.20	0.41	0.03	0.04	0.05
Italy	*Mean*	32.58	76.13	10	0.03	34.68	11.82	0.69	0.13	0.18	0.19	0.35	0.43
	Median	31.59	56.15	4.68	0	34.8	11.7	0.80	0.09	0	0.18	0.33	0.41
	S.D.	9.3	205.54	30.05	0.16	0.82	9.84	0.30	0.13	0.39	0.04	0.04	0.05
The Netherlands	*Mean*	53.95	209.43	64.1	0.23	22.82	14.56	0.81	0.15	0.21	0.15	0.28	0.35
	Median	51.49	83.93	7.28	0	22.5	11.6	1.00	0.06	0	0.15	0.29	0.35
	S.D.	16.6	817.05	521.39	0.42	0.76	8.79	0.31	0.20	0.40	0	0	0
Spain	*Mean*	31.77	78.02	9.44	0.18	16.19	1.25	0.70	0.14	0.17	0.18	0.29	0.35
	Median	29.21	48.77	2.95	0	16.2	1.12	0.82	0.07	0	0.18	0.29	0.35
	S.D.	13.66	225.86	38.56	0.38	0.08	1.47	0.31	0.33	0.37	0	0	0
Sweden	*Mean*	36.51	96.08	10	0.26	78.12	4.27	0.72	0.25	0.23	0.11	0.23	0.28
	Median	34.34	54.18	3.07	0	78	3.14	0.90	0.18	0	0.11	0.23	0.28
	S.D.	11.02	500.9	53.41	0.44	0.34	4.99	0.34	0.25	0.42	0	0	0
United Kingdom	*Mean*	35.92	77.26	6.4	0.18	29.43	1.62	0.91	0.14	0.15	0.17	0.26	0.30
	Median	33.55	48.26	2.22	0	29.3	1.1	1.00	0.07	0	0.16	0.26	0.30
	S.D.	15.36	347.05	28.83	0.38	0.23	2.24	0.23	0.19	0.36	0.01	0.01	0.01

Note: all values are in thousands of US$ at 2000 prices.

Table V
Wage Equation Model Estimates (standard errors[ii])

Dependent variable: *log(wage rate)*	OLS – levels (1)	Within Group (FE) (2)	OLS – first difference (3)	GMM–diff AB – full instrument matrix (4)	GMM–diff AB – restricted instrument matrix (5)	GMM–sys BB– full instrument matrix (6)	GMM–sys BB– restricted instrument matrix (7)	GMM – uses restricted first difference Instruments (8)
Log(wage rate) t-1	0.665***	0.044***	-0.302***	0.146***	0.236***	0.419***	0.449***	0.121***
	(0.006)	(0.008)	(0.006)	(0.009)	(0.012)	(0.009)	(0.010)	(0.022)
t-2	0.200***	-0.020***	-0.111***	0.052***	0.076***	0.157***	0.152***	0.029***
	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.010)
Log (tax per employee)	-0.016***	-0.014***	-0.013***	-0.014	0.011	-0.169***	-0.191***	-0.095***
	(0.001)	(0.001)	(0.001)	(0.011)	(0.020)	(0.009)	(0.012)	(0.034)
t-1	0.005***	-0.001*	-0.005***	-0.002	-0.008	0.039***	0.048***	0.033***
	(0.001)	(0.001)	(0.001)	(0.004)	(0.007)	(0.004)	(0.005)	(0.010)
t-2	0.000	-0.004***	-0.002***	-0.001	-0.003*	0.010***	0.012***	0.006***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Dummy: neg or zero tax bill	0.064***	0.067***	0.059***	0.249***	0.313***	0.190***	0.121**	0.386***
	(0.002)	(0.002)	(0.002)	(0.042)	(0.069)	(0.040)	(0.050)	(0.078)
t-1	-0.032***	0.007***	0.021***	-0.063***	-0.071***	-0.121***	-0.110***	-0.096***
	(0.002)	(0.002)	(0.002)	(0.011)	(0.016)	(0.011)	(0.013)	(0.019)
t-2	-0.008***	0.012***	0.009***	-0.017***	-0.016***	-0.044***	-0.040***	-0.012**
	(0.002)	(0.002)	(0.001)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
Log (value added per employee)	0.265***	0.281***	0.264***	0.756***	0.621***	1.121***	1.082***	0.773***
	(0.005)	(0.007)	(0.005)	(0.025)	(0.044)	(0.013)	(0.016)	(0.069)
t-1	-0.161***	0.013***	0.092***	-0.149***	-0.163***	-0.432***	-0.418***	-0.136***
	(0.005)	(0.004)	(0.003)	(0.012)	(0.014)	(0.010)	(0.012)	(0.021)
t-2	-0.049***	0.023***	0.041***	-0.034***	-0.034***	-0.131***	-0.122***	-0.022***
	(0.003)	(0.003)	(0.002)	(0.005)	(0.005)	(0.006)	(0.007)	(0.008)
Hansen Test for over-identification				526.24	166.64	1191.31	653.68	45.64
(Degrees of freedom)				(172)	(46)	(227)	(56)	(37)
[p-value]				[0.000]	[0.000]	[0.000]	[0.000]	[0.156]
AR(1)	-13.17		-11.08	-22.40	-17.93	-29.94	-28.92	-13.99
[*p-value*]	[0.000]		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	-10.97		-5.42	-3.21	-2.95	-3.14	-2.90	-1.23
[*p-value*]	[0.000]		[0.000]	[0.001]	[0.003]	[0.002]	[0.004]	[0.219]

Notes: (i) Number of firms in the estimation sample is 55,082 and the total number of observations used is 166,749. (ii) All reported standard errors allow for clustering at the company level. (iii) Additional excluded instruments used in columns (4) to (8) were first differences of EMTR, EATR, statutory corporate tax rate, second and higher order lags of log (tangible fixed assets as a proportion of total fixed assets if positive), log (non-current liabilities as a proportion of total assets if positive) and binary indicators for: non-positive profits excluding taxes, zero tangible fixed assets and non-current liabilities; (iv) *** significant at 1% level; ** significant at 5% level; * significant at 10% level

Table VI
Extensions to the Basic Specification (Column (8) from Table V)

Dependent variable: *log(wage rate)*	Basic specification (1)	Basic specification & Union density (2)	Basic specification & All bargaining variables (3)
Log(wage rate)			
t-1	0.121***	0.116***	0.135***
	(0.022)	(0.024)	(0.024)
t-2	0.029***	0.024**	0.031***
	(0.010)	(0.011)	(0.011)
Log (tax per employee)	-0.095***	-0.118***	-0.120***
	(0.034)	(0.035)	(0.037)
t-1	0.033***	0.036***	0.036***
	(0.010)	(0.010)	(0.010)
t-2	0.006***	0.007***	0.007***
	(0.002)	(0.003)	(0.003)
Dummy: negative or zero tax bill	0.386***	0.376***	0.361***
	(0.078)	(0.091)	(0.088)
t-1	-0.096***	-0.094***	-0.089***
	(0.019)	(0.021)	(0.021)
t-2	-0.012**	-0.012**	-0.011*
	(0.005)	(0.006)	(0.006)
Log (value added per employee)	0.773***	0.849***	0.889***
	(0.069)	(0.069)	(0.067)
t-1	-0.136***	-0.145***	-0.155***
	(0.021)	(0.023)	(0.023)
t-2	-0.022***	-0.023**	-0.025***
	(0.008)	(0.009)	(0.009)
Union Density		0.012**	0.013**
		(0.006)	(0.006)
t-1		-0.005	0.003
		(0.004)	(0.006)
t-2		-0.010	-0.005
		(0.009)	(0.008)
Log(industry minimum wage)			0.002
			(0.002)
t-1			0.003*
			(0.002)
t-2			0.004***
			(0.001)
Dummy: Company is min wage company			-0.731
			(0.571)
t-1			0.124
			(0.207)
t-2			0.037
			(0.067)
Over-identification test (Hansen)	45.64	43.71	48.28
(Degrees of freedom)	(37)	(35)	(39)
[p-value]	[0.156]	[0.148]	[0.147]
AR(1)	-13.99	-13.19	-13.30
[p-value]	[0.000]	[0.000]	[0.000]
AR(2)	-1.23	-1.12	-1.24
[p-value]	[0.219]	[0.263]	[0.214]

Notes: (i) See notes to Table V. (ii) All regressions use difference GMM estimates. (iii) Excluded instruments used are the same as in the model of column (8) of Table V.

Table VII
Estimated Incidence from Table VI, Column (3) Results

	Elasticity	Incidence
Short run		
Tax bill	-0.120 (0.037)	-0.970
Value added	0.889 (0.067)	0.670
Long run		
Tax bill	-0.093 (0.031)	-0.751
Value added	0.851 (0.067)	0.569

Note: (i) standard errors in parenthesis. (ii) The reported incidence is the median value.

Table VIII
Difference GMM Estimates (standard error)

Dependent Variable *Log*(*wage rate*)	All companies (1)	Stand-alone companies (2)	Multinational companies (3)	Multinational companies (4)
Lagged log(wage rate)	0.135***	0.079	0.166***	0.093**
	(0.024)	(0.066)	(0.028)	(0.040)
t-2	0.031***	-0.013	0.055***	0.014
	(0.011)	(0.023)	(0.013)	(0.016)
Log (tax bill per employee)	-0.120***	-0.118***	-0.117**	-0.101***
	(0.037)	(0.041)	(0.047)	(0.033)
t-1	0.036***	0.042***	0.029**	0.028**
	(0.010)	(0.013)	(0.014)	(0.014)
t-2	0.007***	0.006	0.004	-0.005
	(0.003)	(0.004)	(0.003)	(0.004)
Dummy: -ve or zero tax bill	0.361***	0.549***	0.391***	0.316
	(0.088)	(0.136)	(0.142)	(0.311)
t-1	-0.089***	-0.149***	-0.045	0.185
	(0.021)	(0.033)	(0.034)	(0.207)
t-2	-0.011*	-0.025***	0.004	0.080
	(0.006)	(0.009)	(0.010)	(0.083)
Log (value added per employee)	0.889***	0.863***	0.837***	0.640***
	(0.067)	(0.068)	(0.133)	(0.105)
t-1	-0.155***	-0.101**	-0.122***	-0.111***
	(0.023)	(0.045)	(0.037)	(0.051)
t-2	-0.025***	-0.001	-0.014	-0.004
	(0.009)	(0.018)	(0.013)	(0.019)
Union density	0.013**	-0.007	0.020**	0.023***
	(0.006)	(0.008)	(0.009)	(0.009)
t-1	0.003	-0.012	0.002	-0.004
	(0.006)	(0.007)	(0.010)	(0.010)
t-2	-0.005	0.017*	-0.017	-0.031**
	(0.008)	(0.009)	(0.014)	(0.015)
Log(industry minimum wage)	0.002	-0.002	-0.001	-0.001
	(0.002)	(0.002)	(0.004)	(0.005)
t-1	0.003*	-0.000	0.005*	-0.000
	(0.002)	(0.002)	(0.003)	(0.003)
t-2	0.004***	-0.000	0.005***	0.001
	(0.001)	(0.002)	(0.002)	(0.002)
Dummy: Co. is min wage company	-0.731	-1.091	-0.751	-0.037
	(0.571)	(1.222)	(1.090)	(0.759)
t-1	0.124	-0.041	-0.213	-0.249
	(0.207)	(0.358)	(0.523)	(0.287)
t-2	0.037	-0.033	-0.074	-0.091
	(0.067)	(0.137)	(0.169)	(0.100)
Log (group tax bill per employee)				0.010
				(0.018)
t-1				-0.011
				(0.010)
t-2				-0.003
				(0.003)

Table VIII
(continued)

Dependent Variable *Log*(*wage rate*)	All companies (1)	Stand-alone companies (2)	Multinational companies (3)	Multinational companies (4)
Dummy: -ve or zero group tax bill				-0.062
				(0.093)
t-1				-0.014
				(0.047)
t-2				-0.006
				(0.020)
Log (group value added per employee)				0.074
				(0.063)
t-1				0.015
				(0.049)
t-2				0.003
				(0.006)
AR(1)	-13.30	-9.61	-5.55	-5.13
[p-value]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	-1.24	-1.97	-1.11	-1.74
[p-value]	[0.214]	[0.048]	[0.265]	[0.081]
Overid. restrictions test (Hansen)	48.28	23.37	23.24	40.00
(Degrees of freedom)	(39)	(19)	(19)	(30)
[p-value]	[0.147]	[0.221]	[0.227]	[0.105]
Observations	166,749	62,955	56,883	35,820
Number of companies	55,082	19,399	19,348	13,717

Note: (i) See notes to Table VII; (ii) Additional excluded instruments used in columns (2) and (3) were first-differences of EMTR, EATR, statutory corporate tax rate, third order lags of log (tangible fixed assets as a proportion of total fixed assets if positive), log (non-current liabilities as a proportion of total assets if positive) and binary indicators for: non-positive profits excluding taxes, zero tangible fixed assets and non-current liabilities; Additionally, third order lags of the group level variables of the additional instruments used in columns (2) and (3) were also used in column (4); (iii) The group variables are calculated by adding up the values for the subsidiaries present in the dataset, excluding the company concerned. The group tax bill and value added are divided by the employment of the subsidiary.

Appendix

Table IA
Persistence of Wage Rate and Value Added per Worker. Simple Univariate AR Models.

	Dependent variable: Log(wage rate)				Dependent variable: Log(value added per worker)			
	Pooled OLS	Within-Group	Pooled OLS	Within-Group	Pooled OLS	Within-Group	Pooled OLS	Within-Group
Lagged log(wage rate)	0.863***	0.080***	0.682***	0.080***				
	(0.003)	(0.008)	(0.006)	(0.008)				
2nd Lag log(wage rate)			0.206***	-0.011**				
			(0.005)	(0.004)				
Log (Value added per employee)								
Lag. log (value added per employee)					0.844***	0.014*	0.616***	0.014*
					(0.003)	(0.008)	(0.006)	(0.008)
2nd Lag. log (value added per employee)							0.274***	-0.075***
							(0.005)	(0.006)
AR(1) test	-23.11		-33.82		-26.55		-24.77	
[p-value]	[0.000]		[0.000]		[0.000]		[0.000]	
AR(2) test	5.79		-18.22		4.15		-30.83	
[p-value]	[0.000]		[0.000]		[0.000]		[0.000]	

Notes: (i) Time dummies are included in all of the above. (ii) The equations were estimated on the same sample as the one used in the main tables using 55,082 companies giving a total of 166,749 observations; (iii) standard errors in parenthesis unless otherwise stated. (iv) *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

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