The Direct Incidence of Corporate Income Tax on Wages*

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Abstract

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 $1 of additional tax reduces wages by 92 cents in the long run. The incidence of a $1 fall in value added is smaller, consistent with our wage bargaining model. We find only weak evidence of a difference in the effective incidence of taxes paid by multinational companies.

JEL Classifications: H22, H25, H32, H87

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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 UK Trades Union Congress, on the 2007 UK corporation tax cut (FT.com, 2007)

1. 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. Nonetheless, despite its policy relevance, until very recently there has been virtually no econometric investigation of this issue. In a simple model of a small open economy, the post-tax rate of return to investment is fixed and the burden of the corporation tax is passed onto the immobile workforce.[1] However, as Alan J. Auerbach (2006) has pointed out, there are several possible reasons why the tax may nevertheless be partly borne by shareholders.

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: through the wage bargain. We refer to the effective incidence of the tax which we identify as the *direct* incidence of the tax, since it conditions on the pre-tax profit of the firm. It excludes *indirect* effects which determine the level of pre-tax profit, either through changes in 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. Variation in tax payments and

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

effective tax rates arise due both to variation across countries and time in the legal tax system, and also due to firm-specific factors. We identify the effects of taxation using this variation in tax liabilities across firms and time.

The literature on the incidence of taxes on corporate income dates back to Arnold C. 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 in the corporate sector only. Harberger 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 sectors, as it drives down post-tax return to capital. Similar results have been generated by a number of more complex CGE models with a larger number of sectors (see, for example, John B. Shoven 1976).

However, these results depend crucially on, among other things, the assumption of a closed economy, which ties down 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. David F. Bradford (1978) and Laurence J. Kotlikoff and Lawrence H. Summers (1987) show 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: however, there remains an exodus of capital, and the home country 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 a tax which distorts the allocation of capital, as pointed out by Roger H. Gordon (1986).

There have been a number of recent contributions which have developed more sophisticated general equilibrium models of the long-run incidence of taxes on corporate income in an open economy: see William G. Randolph (2006), Jane G. Gravelle and Kent A. Smetters (2006) and Harberger (1995, 2006). Randolph considers a model with two countries and five sectors, with three of the sectors being taxed in the domestic country only. 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 finds 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% of the tax burden. Where the domestic economy is large (as for the US), the tax also increases wages and reduces the return to capital in the foreign country. Gravelle and Smetters (2006) allow 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 which 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 the many studies on 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 Ian M. McDonald and Robert M. 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 company behaviour 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 examines the extent to which rents generated by technological innovation are passed on in higher

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

3 In a recent contribution, using similar data to this paper, John W. Budd, Josef Konings, and Matthew J. Slaughter (2005), investigate whether wages are determined as a share of parent firm profit as well as subsidiary profit.

wages: for example, John Van Reenen (1996) follows both a reduced form and a structural approach to examine this question. Like John M. Abowd and Thomas Lemieux (1993), Van Reenen emphasizes the importance of dealing with the endogeneity of quasi rents: appropriately dealing with endogeneity 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. However, we find these elasticities to be plausible, in that they imply that the effect on wage payments of a marginal increase in quasi rents 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 prediction.

Four other recent papers aim to provide empirical evidence of the incidence of taxes on corporate income.[4] Kevin A. Hassett and Aparna Mathur (2006) use aggregate wage and tax data from 72 countries over the period 1981-2002. They experiment with different measures of the tax rate. They find 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. But 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 by William M. Gentry (2007).

Alison R. Felix (2007) uses 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 finds very large and significant effects of the corporate income tax on wages. The effect tends to be uniform across skill levels. Mihir A. Desai, C. Fritz Foley, and James R. Hines (2007) use 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 find results of a similar magnitude to Randolph (2006): between 45 and 75 percent 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.

Nadine Riedel (2008) also presents a wage-bargaining model in the presence of a simplified corporate tax. Partly based on the empirical results of John W. Budd, Josef Konings, and Matthew J. Slaughter (2005), she models 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 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 finds empirical support for the latter proposition, but not 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 shown, for example, by Lazlo 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 UK over the period 1996 to 2003. Controlling for labour productivity (and hence for the effects of the corporate tax through capital) and relevant other 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-specific 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.

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 abroad part or all of their productive activity. 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 a \$1 increase in the tax bill tends to reduce real wages at the median by 92 cents. The comparable figure for a \$1 increase in pre-tax value added is 68 cents. These compare with the median labour share of value added in our sample of 67%. These results are very close to those predicted by the theory.

The paper is organised as follows. Section 2 develops the conceptual framework which allows us to consider the impact of corporate income taxes on the determination of wages, and to differentiate the direct and indirect effects. Section 3 presents the data used in the empirical section. Section 4 discusses various econometric issues, and presents the results. Section 5 concludes.

2. 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 Alison L. Booth 1995; David G. Blanchflower, Andrew J. Oswald, and Peter Sanfey 1996; John T. Addison and Claus Schnabel 2003).

Employees have an outside wage available, $\overline{w}$. This may reflect the wage rate in an alternative job, or 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 of 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 and 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 defined as

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

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, there are many other factors which can affect the firm's tax position. These include, for example: interest payments, the extent to which taxable profit can be shifted abroad to a lower-tax country through manipulating transfer prices, stock relief, losses brought forward from an earlier period, 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 which have the same revenue, wage payments and investment. In the empirical work, it is the existence of the factors incorporated in ϕ which allow 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 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 which 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 the firm of a temporary dispute with the workforce. The bargaining power of the union is $(1-\mu)$; 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 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, which 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, $\overline{w}$:[6]

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

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 is discussed below. Note that α typically varies across firms depending on the mix of assets invested in by the firm.

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. Clearly, again conditional on other factors, a rise in ϕ induces a rise in tax, and this will tend to reduce the wage rate:

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

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6 Since this is based on (4), this specification could also be generated from a right to manage model.

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.

There may also be an indirect effect of a change in ϕ, via a change in value added, *F*. This may reflect 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 prices its tax liability incorporated ϕ is constrained by competition in the output market. Most likely, any change in a company's tax liability not reflected in its competitors' tax bill is unlikely to be passed on in higher prices.

A third effect of taxation in (7) is that the home country tax rate also affects the value of the outside option in the bargain.[7] 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 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 Michael P. Devereux and Rachel 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 (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

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

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 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:

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

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

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.[8] This indirect effect determines the deadweight cost of the tax-induced distortions to capital and labour decisions.

[8] 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.

In the empirical work below, we attempt to identify only the *direct* effect of corporation tax on wages. Below, we estimate a log-linear version of expression (7), where the per-employee location-specific profit gross of wages 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.

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 which 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: the outside option cannot be observed 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 which are part of multinational groups.

As a possible proxy for the outside option, we experiment by including the value added and 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 et al (2005) and Riedel (2008) argue, it is also possible that domestic workers bargain over the entire firm's 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 engaged in a dispute with the 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. This effect can be examined by testing whether the coefficients from the bargaining equation – which reflect 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 higher bargaining strength would respond to an increase in tax by passing a *smaller* proportion of the increase onto the workforce. From (7), we have:

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

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 which we do estimate. We leave evaluation of these effects for future research.

3. Data

The empirical analysis is carried out using a commercially available firm-level world-wide 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 for companies all around the world from 1996 to 2005. In addition, ORBIS contains information on the ownership structure of the firm in 2005, including the number of shareholders, their name, their country of residence and their percentage interest in the company, and the number of subsidiaries, their name and the percentage participation of the parent company.

Initially, we selected only companies that were not defined as "micro" by European Commission (2003).[9] This sample was further restricted as follows. First, it was limited to companies for which unconsolidated data and ownership information were available since 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,

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

observations which showed clear errors and missing values were dropped, along with observations in the first and one hundredth percentile of the distribution for the main variables.[10] Finally, the dynamic model specification and the method of estimation 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 either (i) belonging to a multinational group if they were connected to at least one other company by an ownership link of at least 50% of the capital and that company (either a parent company or a subsidiary) was located in a different country; (ii) belonging to a domestic group if the company was connected to other companies by an ownership link of at least 50% but none of those companies were located in a different country; or (iii) as a stand-alone company if it did not have any ownership links with other companies.

Table 1 shows the distribution of companies across the nine countries. The table also shows the number of companies that are stand alone (overall around 35%), part of a domestic group (30%), or part of a multinational group (35%). Table 2 indicates the number of observations used in estimation for each company. Over 15,000 companies – over one quarter of the sample of companies used - have data for 8 years; a similar number of companies have either 6 or 7 observations. Table 3 shows the number of observations per year used in the regressions: each year is well represented.

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

4. Empirical Analysis

Based on the conceptual framework in Section 2, and in particular on (7), we consider the following log-linearised dynamic specification for wage rate *w*:

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

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% 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 tax burden on wage rate is only present when there are positive taxes, so we include T only when it is positive. In order to account for the observations with non-positive taxes, we include in $\boldsymbol{Z}$ 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.

There are several econometric issues that 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 $u_{it} = \alpha_i + \varepsilon_{it}$.[11] Much of the recent literature has focussed on finding appropriate instruments for the application of GMM. Manuel Arellano and Stephen R. 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 (e.g. Richard 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. As a consequence, 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 Frank Windmeijer (2000) showed that the system GMM estimator had better finite sample properties than the original AB's differenced GMM estimator and advocated the use of this technique when the series were highly persistent. However, this relied on certain stationarity conditions of the initial observation. In a recent paper, Maurice J.G. Bunn and Frank Windmeijer (2007) have shown 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 below.

[11] 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 (Denis J. Sargan 1958; Lars P. 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 a 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 (David Roodman 2006) in StataCorp (2005) to estimate our models using the GMM technique.

4.1. Variables

The wage rate is calculated as the annual average company wage (i.e. costs of employees (**435**) divided by the total number of employees (**425**)).[12] 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[13], 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.[14] 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. As instruments we use lags of the tax variable, plus country and year-specific measures of the effective marginal tax rate (EMTR), the effective average

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

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

[14] 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.

tax rate (EATR)[15] and the statutory corporate tax rate.[16] These measures are based on the legal tax system, and so are unlikely to be affected by the shocks to individual firms' profit and wages.

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 2000 OECD national average exchange rates.[17] We also investigate the impact of the union density (UD) using a country and year-specific index from the OECD (2004).[18] Table 4 displays some basic descriptive statistics for the main variables.

4.2. Basic Specification

Table 5 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 also 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. 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 (i.e 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

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15 These are calculated according to the methodology proposed by Michael P. Devereux and Rachel Griffith (2003), and are computed from a number of sources.

16 As we discuss later, the instruments used are all differences of variables. In the regression of the first difference of the main tax variable (per employee) on the first differenced EMTR, EATR and the statutory corporation tax, the F test statistic value for the joint significance of these three variables was 61.7 with P-value=0.000.

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

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

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 estimate (Blundell et al., 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. However, surprisingly, all other coefficient estimates are very similar.

GMM estimation results are provided in columns [4] to [8]. The set of instruments used in these specifications are different. 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. The additional instruments used are as follows. Columns [4] and [5] are based on the AB's 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. But every additional lag of our dependent variable to 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 time observation results in a loss of around 55,000 observations per time period. In contrast, the standard GMM-diff and GMM-sys approaches include separate instruments for each time period resulting in a sparse instrument set but larger estimation sample. Three practical problems can result with 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 of a strand of the literature where the standard GMM-diff instruments are combined through addition to create a smaller instrument set (Roodman 2006, 2007).[20] Columns [4] and [6] present results from 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 also rejected, implying a

[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}.

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

problem with the estimators.[21] As the table reports, the degrees of freedom for the over-identifying tests in the case of restricted instrument matrix is much smaller. However, the tests still rejects the null of instrument validity.[22]

We next turn to our preferred estimates which are provided in Column [8] of Table 5. 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 2 onwards of all our variables as predetermined. The columns of the above matrix refer to the different instruments used.

Unlike the rest of Table 5, 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 at 5% but is rejected at 10%. 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 are not serially correlated.

Turning to the coefficient estimates, the estimated effects are broadly consistent with the theoretical model presented in Section 2 even though we have added dynamics

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21 In Appendix Table 1, 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) show 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 advocate the use of GMM-diff in this case.

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 unobservable 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 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 -0.094 in column [8] - about six times those reported in columns [1]-[3]. The long-run elasticity is a little lower at -0.075. The short-run elasticity with respect to value added per employee is estimated to be of 0.873, and the longer-run is again slightly lower at 0.819. We explore below the implications of these results for the incidence of the tax.

4.3. Basic Specification with Bargaining Variables

In Table 6, we use the same estimator as in column [8] of Table 5, 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 5 is reproduced in column [1] of Table 6. 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.

[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 the union density as a proxy for the strength of the union in these countries.

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 -0.119. The union density variable has a correctly signed positive and significant (albeit at 10%) coefficient.

In summary, the basic specification results displayed in column [8] of Table 5 do not change much with the addition of variables associated with the bargaining strength. Below, we use column [3] of Table 6 as our preferred model for examining the behaviour of multinationals compared to domestic companies.

4.4. Evaluating the Direct Incidence

As noted above, 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 6, the short-run elasticity is estimated at -0.094 and the long-run elasticity at about -0.075. In column [3], the short-run elasticity is –0.119 and the long-run elasticity is -0.114. Standard errors of both the short-and long-run estimates for column [3] are given in Table 7.

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 a $1 change in the tax liability on total compensation. Calculations are presented in Table 7. 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 96 cents reduction in total compensation in the short run, and a 92 cents reduction in the long run. These are very large effects: virtually the whole of any additional \$1 of tax is passed on in lower wages, and, moreover, this effect happens within one period.

Recall that these are estimates only of the *direct* effects of an increased tax liability. It does 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 7 indicates that the median of the resulting distribution in the short run is 0.70 – that is, a fall of \$1 in value added reduces wage payments by 70 cents. The long run reduction is 68 cents. These figures are very close to the median share of labour compensation in value added in the sample, which is 0.67. Combined with an elasticity of around 1, as shown in the Table, this is consistent with around the marginal impact of 0.67 of a change in value added being passed on in labour compensation.

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 a \$1 increase in value added would need to be grossed up by a factor $1-\tau$ to find the expected impact of a \$1 change in tax liabilities. Our long run estimate of 92 cents in the long run is only slightly smaller than this, evaluated at the median.

In the literature, there are a number of estimates of the elasticity of the wage rate to value added per employee (or equivalently total labour compensation to value added). These previous estimates vary widely, and depend to some extent to the specification and econometric techniques used. For example, estimates from Stephen J. Nickell and Sushil Wadhwani (1990), Abowd and Lemieux (1993) and Van Reenen (1996) vary between 0.2 and 0.4. These compare to estimates of between 0.8 and 1 in Table 6. One possible explanation of this difference is that we use unconsolidated accounting data, which links wage payments of each subsidiary within a group to the value added of that subsidiary.[24] Other studies which 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 above, 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.

4.5. 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 6 column [3] (which is reproduced a column [1] of Table 8 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 2 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 subsamples of the data: in column [2] we consider only stand-alone firms and in column [3] we consider only firms which are part of multinational groups.

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[24] Budd et al (2005) use the same data source as us, and find much lower elasticities. We attribute this primarily to the fact that they use a levels, rather than a log, specification. By contrast, Riedel (2008) also uses the same data, but with a log specification finds a similar range of estimates of the effect of value added to those presented here.

The short run elasticities of the wage rate with respect to tax per employee are consistent with the conceptual framework: the elasticity for companies that are part of multinational groups is lower than that for stand-alone firms. Given the very small effects of the lagged dependent variable for stand alone companies, the long run elasticities for the two groups are very close. The results imply that the long-run incidence of an additional $1 of tax does differ: evaluated at the median of the stand-alone subsample, compensation would fall by 93 cents. For companies that are part of multinational groups, the comparative figure is around 70 cents. This is consistent with multinational groups having stronger bargaining power.

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. Thus, although there is some evidence that the effective incidence of the tax is consistent with multinational companies having higher bargaining power, this evidence is not strong. It may also be possible that the symmetry imposed by the conceptual model in Section 2 does not hold in practice.

A second effect for multinationals could occur through the outside option. In column 4 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 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 for 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, et al. (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 which offsets the use of worldwide profit as a proxy for the outside option in the bargain.

5. Conclusions

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 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 92% of an 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), 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.

References

Abowd, John M., and Thomas Lemieux. 1993. "The Effects of Product Market Competition on Collective Bargaining Agreements: The Case of Foreign Competition in Canada". *Quarterly Journal of Economics*, 108, 983-1014.

Addison, John T., and Claus Schnabel. 2003. International Handbook of Trade Unions. Cheltenham: Edward Elgar Publishing.

Arellano, Manuel, and Stephen R. Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies*, 58(2): 277-297.

Auerbach, Alan J. 2006. "Who Bears the Corporate Tax? A Review of What We Know," in *Tax Policy and the Economy*, *Vol. 20*, ed. James M. Poterba, 1-40. Cambridge: MIT Press.

Blanchflower, David G., Andrew J. Oswald, and Peter Sanfey. 1996. "Wages, Profits and Rent-Sharing." *Quarterly Journal of Economics*, 111(1) 227–250.

Blundell, Richard, and Stephen R. Bond. 1998. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models". *Journal of Econometrics*, 87(1) 115-143.

Blundell, Richard, Stephen R. Bond, and Frank Windmeijer. 2000. "Estimation in Dynamic Panel Data Models: Improving on the Performance of the Standard GMM Estimator." In *Nonstationary Panels, Panel Cointegration, and Dynamic Panels*, in *Advances in Econometrics*, Vol. 15, ed. Badi Baltagi. Amsterdam: JAI Press, Elsevier Science.

Booth, Alison L. 1995. *The Economics of the Trade Union.* Cambridge: Cambridge University Press.

Bradford, David F. 1978. "Factor Prices may be Constant, but Factor Returns are not." *Economics Letters*, 1(3):199-203.

Budd, John W., Josef Konings, and Matthew J. Slaughter. 2005. "Wages and International Rent-Sharing in Multinational Firms**"** *Review of Economics and Statistics*, 87(1): 73-84.

Bunn, Maurice J.G., and Frank Windmeijer. 2007. "The Weak Instrument Problem of the System GMM Estimator in Dynamic Panel Data Models". CEMMAP Working Paper 08.

Bureau van Dijk. 2007. ORBIS Database. http://www.bvdep.com/en/ORBIS.html.

Desai, Mihir. A., C. Fritz Foley, and James R. Hines. 2007. "Labor and Capital Shares of the Corporate Tax Burden: International Evidence." ITPF and Urban-Brookings Tax Policy Center Conference of Who pays the Corporate Tax in an Open Economy? Unpublished.

Devereux, Michael. P., and Rachel Griffith. 1998. "Taxes and the Location of Production: Evidence from a Panel of US Multinationals." *Journal of Public Economics*, (68)3: 335–367.

Devereux, Michael P., and Rachel Griffith. 2003. "Evaluating Tax Policy for Location Decision." *International Tax and Public Finance*, 10(2): 107–126.

Eckel, Carsten, and Hartmut Egger. 2006. "Wage Bargaining and Multinational Firms in General Equilibrium." CESifo working paper 1711.

European Commission. 2003. "Commission Recommendation of 6 May 2003 Concerning the Definition of Micro, Small and Medium-Sized Enterprises". *Official Journal of the European Commission* May. 2003/361/EC. Brussels: Commission of the European Communities.

Felix, Alison R. 2007. "Passing the Burden: Corporate Tax Incidence in Open Economies." Unpublished.

FT.com. 2007. "Budget Verdict: Instant Reaction". 21 March. London: The Financial Times Ltd. www.ft.com

Gentry, William. M. 2007. "A Review of the Evidence on the Incidence of the Corporate Income Tax". US Department of the Treasury, Office of Tax Analysis Paper 101.

Goerke, Laszlo. 1996. "Taxes on Payroll, Revenues and Profits in Three Models of Collective Bargaining". *Scottish Journal of Political Economy*, 43(5): 549-565.

Gordon, Roger. H. 1986. "Taxation of Investment and Savings in a World Economy." *American Economic Review*, 76(5): 1086-1102.

Gravelle, Jane G., and Kent A. Smetters. 2006. "Does the Open Economy Assumption really mean that Labor bears the Burden of a Capital Income Tax?". In *Advances in Economic Analysis and Policy*, *Vol. 6(1)*: 1548-1548. Berkeley: Berkeley Electronic Press.

Hansen, Lars P. 1982. "Large Sample Properties of Generalised Method of Moment Estimators." *Econometrica*, Vol. 50(4): 1029-1054.

Harberger, Arnold C. 1962. "The incidence Of the Corporation income Tax." *Journal of Political Economy*, 70(3): 215–240.

Harberger, Arnold C. 1995. "The ABCs of Corporation Tax Incidence: Insights into the Open-Economy Case." in *Tax Policy and Economic Growth*, 51-73. Washington, D.C.: American Council for Capital Formation Center for Policy Research.

Harberger, Arnold C. 2006. "Corporation Tax Incidence: Reflections on what is Known, Unknown and Unknowable". In *Fundamental Tax Reform: Issues, Choices, and Implications*, ed. John W. Diamond and George R. Zodrow. Cambridge: MIT Press.

Hassett, Kevin A., and Aparna Mathur. 2006. "Taxes and Wages." American Enterprise Institute Working Paper 128.

Kotlikoff, Laurence J., and Lawrence H. Summers. 1987. "Tax Incidence." In *Handbook of Public Economics, Vol. 2*, ed. Alan J. Auerbach and Martin Feldstein, 1043–1092. Amsterdam: Elsevier Science, North-Holland

McDonald, Ian M., and Robert M. Solow. 1981. "Wage Bargaining and Employment." *American Economic Review*, 71(5): 896–908.

Nickell, Stephen J., and Sushil Wadhwani. 1990. "Insider Forces and Wage Determination." *Economic Journal,* 100(401): 496–509.

OECD. 2004. *Employment Outlook*. Paris: OECD Publishing.

OECD. 2006. *Employment Outlook*. Paris: OECD Publishing.

Randolph, William G. 2006. "International Burdens of the Corporate income Tax." Congressional Budget Office Working Paper 09.

Riedel, Nadine. 2008. "Taxing Multinational under Union Wage Bargaining". Unpublished.

Roodman, David. 2007. "A Short Note on the Theme of too many Instruments". Center for Global Development Working Paper 125.

Roodman, David. 2006. "How to do Xtabond2: An Introduction to Difference and System GMM in Stata". Center for Global Development Working Paper 103.

Sargan, Denis J. 1958. "The Estimation of Economic Relationships using Instrumental Variables." *Econometrica,* 26(3): 393-415.

Shoven, John B. 1976. "The Incidence and Efficiency Effects of Taxes on Income from Capital." *Journal of Political Economics.* 84(6): 1261–1283.

Slemrod, Joel. 1995. "Professional opinions about tax policy". *National Tax Journal* 48, 121-147.

StataCorp. 2005. *Stata Statistical Software:* Release 9. College Station, TX: StataCorp LP.

Van Reenen, John. 1996. "The Creation and Capture of Rents: Wages and Innovation in a Panel of UK Companies". *Quarterly Journal of Economics* 111, 195-226.

Table 1: 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 2: Number of observations per company

Years available per firm	*Number of companies*	
	Frequency	*Percent*
4	12,254	22.3
5	12,183	22.1
6	7,705	14.0
7	7,635	13.9
8	15,305	27.8
Total	**55,082**	**100**

Table 3: Observations per year

Years	*Freq.*	*Percent*
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 4: Descriptive statistics for main variables (in levels)

		Wage rate	*Value added per employee*	*Tax bill per employee*	*Negative tax bill (dummy)*	*Union density*	*Outside wage rate*
Belgium	*Mean*	52.60	215.56	13.22	0.14	55.37	17.57
	Median	48.45	78.05	4.54	0	55.60	17.69
	S.D.	17.11	1,300.09	56.03	0.35	0.25	7.97
Finland	*Mean*	41.97	110.42	14.34	0.14	74.71	7.57
	Median	39.75	60.76	3.32	0	74.80	5.82
	S.D.	13.41	233.60	52.58	0.35	0.60	6.01
France	*Mean*	42.94	81.58	7.16	0.18	8.22	2.48
	Median	39.01	53.52	2.49	0	8.20	0.42
	S.D.	17.15	359.98	46.71	0.39	0.09	3.49
Germany	*Mean*	57.51	137.17	14.92	0.08	23.42	13.41
	Median	54.79	90.25	5.46	0	23.20	8.91
	S.D.	18.73	168.19	33.33	0.27	0.99	12.14
Italy	*Mean*	32.58	76.13	10.00	0.03	34.68	11.82
	Median	31.59	56.15	4.68	0	34.80	11.70
	S.D.	9.30	205.54	30.05	0.16	0.82	9.84
The Netherlands	*Mean*	53.95	209.43	64.10	0.23	22.82	14.56
	Median	51.49	83.93	7.28	0	22.50	11.60
	S.D.	16.60	817.05	521.39	0.42	0.76	8.79
Spain	*Mean*	31.77	78.02	9.44	0.18	16.19	1.25
	Median	29.21	48.77	2.95	0	16.20	1.12
	S.D.	13.66	225.86	38.56	0.38	0.08	1.47
Sweden	*Mean*	36.51	96.08	10.00	0.26	78.12	4.27
	Median	34.34	54.18	3.07	0	78.00	3.14
	S.D.	11.02	500.90	53.41	0.44	0.34	4.99
United Kingdom	*Mean*	35.92	77.26	6.40	0.18	29.43	1.62
	Median	33.55	48.26	2.22	0	29.30	1.10
	S.D.	15.36	347.05	28.83	0.38	0.23	2.24

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

Table 5: Dependent variable: log(wage rate)

	[1] OLS - levels	[2] Within Group (FE)	[3] OLS – first difference	[4] GMM–diff AB – full instrument matrix	[5] GMM–diff AB – restricted instrument matrix	[6] GMM–sys BB– full instrument matrix	[7] GMM–sys BB– restricted instrument matrix	[8] GMM – uses restricted first diff as instruments
Log(wage rate)								
t-1	0.665***	0.044***	-0.302***	0.155***	0.244***	0.387***	0.480***	0.133***
	(0.006)	(0.008)	(0.006)	(0.010)	(0.012)	(0.010)	(0.010)	(0.028)
t-2	0.200***	-0.020***	-0.111***	0.055***	0.079***	0.160***	0.177***	0.034***
	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.007)	(0.005)	(0.013)
Log (tax per employee)	-0.016***	-0.014***	-0.013***	-0.024*	-0.004	-0.208***	-0.220***	-0.094**
	(0.001)	(0.001)	(0.001)	(0.013)	(0.020)	(0.012)	(0.012)	(0.047)
t-1	0.005***	-0.001*	-0.005***	-0.003	-0.006	0.051***	0.063***	0.027*
	(0.001)	(0.001)	(0.001)	(0.005)	(0.006)	(0.005)	(0.004)	(0.014)
t-2	0.000	-0.004***	-0.002***	-0.001	-0.002	0.015***	0.013***	0.005
	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
Dummy: negative or zero tax bill	0.064***	0.067***	0.059***	0.143**	0.15	0.056	-0.008	0.356**
	(0.002)	(0.002)	(0.002)	(0.061)	(0.098)	(0.057)	(0.057)	(0.152)
t-1	-0.032***	0.007***	0.021***	-0.034**	-0.032	-0.099***	-0.063***	-0.078**
	(0.002)	(0.002)	(0.002)	(0.016)	(0.023)	(0.015)	(0.014)	(0.037)
t-2	-0.008***	0.012***	0.009***	-0.012***	-0.009*	-0.046***	-0.021***	-0.009
	(0.002)	(0.002)	(0.001)	(0.004)	(0.005)	(0.005)	(0.005)	(0.007)
Log (value added per employee)	0.265***	0.281***	0.264***	0.782***	0.643***	1.226***	0.625***	0.873***
	(0.005)	(0.007)	(0.005)	(0.035)	(0.063)	(0.035)	(0.038)	(0.093)
t-1	-0.161***	0.013***	0.092***	-0.145***	-0.161***	-0.491***	-0.192***	-0.163***
	(0.005)	(0.004)	(0.003)	(0.015)	(0.018)	(0.020)	(0.019)	(0.026)
t-2	-0.049***	0.023***	0.041***	-0.034***	-0.035***	-0.157***	-0.051***	-0.028***
	(0.003)	(0.003)	(0.002)	(0.006)	(0.005)	(0.009)	(0.008)	(0.010)
Hansen Over-identification test				314.55	105.72	755.54	450.18	19.23
(Degrees of freedom)				(72)	(16)	(96)	(20)	(12)
[p-value]				[0.000]	[0.000]	[0.000]	[0.000]	[0.083]
AR(1)	-13.17		-11.08	-18.01	-15.86	-23.27	-23.40	-11.86
[*p-value*]	[0.000]		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	-10.97		-5.42	-3.41	-3.32	-3.28	-2.87	-1.29
[*p-value*]	[0.000]		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.200]

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. In particular, the standard errors reported in columns [4]-[8] are robust two-step errors that allow for clustering at the company level. (iii) Additional instruments used in columns [4]-[8] were first-differences of EMTR, EATR and the statutory corporate tax rate; (iv) *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 6: Extensions to the Basic Specification (Column [8] from Table 5)
Difference GMM Estimates
Dependent variable: log (wage rate)

	[1] Basic specification	[2] Basic specification & Union density	[3] Basic specification & All bargaining variables
Log(wage rate per employee)			
t-1	0.133***	0.135***	0.147***
	(0.028)	(0.032)	(0.031)
t-2	0.034***	0.034**	0.039***
	(0.013)	(0.014)	(0.014)
Log (tax per employee)	-0.094**	-0.112**	-0.119**
	(0.047)	(0.050)	(0.052)
t-1	0.027*	0.023	0.022
	(0.014)	(0.016)	(0.016)
t-2	0.005	0.004	0.004
	(0.003)	(0.004)	(0.003)
Dummy: negative or zero tax bill	0.356**	0.221	0.127
	(0.152)	(0.222)	(0.199)
t-1	-0.078**	-0.042	-0.024
	(0.037)	(0.051)	(0.046)
t-2	-0.009	-0.003	-0.002
	(0.007)	(0.009)	(0.008)
Log (value added per employee)	0.873***	0.992***	1.038***
	(0.093)	(0.097)	(0.092)
t-1	-0.163***	-0.171***	-0.180***
	(0.026)	(0.029)	(0.031)
t-2	-0.028***	-0.026**	-0.026**
	(0.010)	(0.012)	(0.012)
Union Density		0.011	0.014*
		(0.008)	(0.008)
t-1		-0.009*	-0.002
		(0.005)	(0.007)
t-2		-0.012	-0.013
		(0.012)	(0.012)
Log(industry minimum wage)			0.002
			(0.002)
t-1			0.002
			(0.002)
t-2			0.004***
			(0.001)
Dummy: Company is min wage company			0.709
			(0.930)
t-1			0.389
			(0.307)
t-2			0.131
			(0.101)
Overidentification test (Hansen)	19.23	15.48	20.13
(Degrees of freedom)	(12)	(10)	(14)
[p-value]	[0.083]	[0.115]	[0.126]
AR(1)	-11.86	-10.80	-9.55
[p-value]	[0.000]	[0.000]	[0.000]
AR(2)	-1.29	-1.18	-1.18
[p-value]	[0.20]	[0.24]	[0.24]

Notes: See notes to Table 5.

Table 7: Estimated Incidence from Table 6, Column [3] results

	elasticity	incidence
SHORT RUN		
Tax bill	-0.119 (0.052)	-0.959
Value added	1.038 (0.092)	0.695
LONG RUN		
Tax bill	-0.114 (0.044)	-0.917
Value added	1.022 (0.101)	0.684

Note: Standard errors in parenthesis.

Table 8: Difference GMM Estimates
Dependent variable: log (wage rate)

	[1] All companies	[2] Stand alone companies	[3] Multinational companies	[4] Multinational companies
Lagged log(wage rate)	0.147***	0.040	0.169***	0.145***
	(0.031)	(0.076)	(0.029)	(0.034)
t-2	0.039***	-0.027	0.056***	0.035**
	(0.014)	(0.027)	(0.013)	(0.015)
Log (tax bill per employee)	-0.119**	-0.155***	-0.118**	-0.066*
	(0.052)	(0.048)	(0.052)	(0.035)
t-1	0.022	0.052***	0.030*	0.023*
	(0.016)	(0.016)	(0.015)	(0.014)
t-2	0.004	0.007*	0.004	0.004
	(0.003)	(0.004)	(0.004)	(0.003)
Dummy: negative or zero tax bill	0.127	0.611***	0.443***	0.373
	(0.199)	(0.172)	(0.152)	(0.381)
t-1	-0.024	-0.168***	-0.052	0.111
	(0.046)	(0.041)	(0.036)	(0.202)
t-2	-0.002	-0.026***	0.004	0.056
	(0.008)	(0.009)	(0.010)	(0.081)
Log (value added per employee)	1.038***	0.882***	0.861***	0.527***
	(0.092)	(0.075)	(0.143)	(0.109)
t-1	-0.180***	-0.086*	-0.125***	-0.129**
	(0.031)	(0.049)	(0.039)	(0.050)
t-2	-0.026**	0.007	-0.014	-0.017
	(0.012)	(0.020)	(0.014)	(0.17)
Union density	0.014*	-0.008	0.019**	0.024***
	(0.008)	(0.008)	(0.009)	(0.007)
t-1	-0.002	-0.014*	0.004	0.007
	(0.007)	(0.008)	(0.011)	(0.010)
t-2	-0.013	0.017*	-0.016	-0.035***
	(0.012)	(0.010)	(0.015)	(0.014)
Log(industry minimum wage)	0.002	-0.003	-0.000	-0.004
	(0.002)	(0.002)	(0.004)	(0.004)
t-1	0.002	-0.001	0.005*	-0.001
	(0.002)	(0.002)	(0.003)	(0.002)
t-2	0.004***	-0.001	0.006***	0.001
	(0.001)	(0.002)	(0.002)	(0.002)
Dummy: Co. is min wage company	0.709	-1.209	-0.822	-0.322
	(0.930)	(1.244)	(1.180)	(0.529)
t-1	0.389	-0.112	-0.271	-0.187
	(0.307)	(0.364)	(0.547)	(0.305)
t-2	0.131	-0.057	-0.091	-0.074
				(0.102)
Log (group tax bill per employee)				0.024
				(0.025)
t-1				-0.012
				(0.014)
t-2				-0.002
				(0.005)

Table 8: Continued

	[1] **All companies**	[2] **Stand alone companies**	[3] **Multinational companies**	[4] **Multinational companies**
Dummy: negative or zero group tax bill				-0.017
				(0.093)
t-1				-0.022
				(0.044)
t-2				0.002
				(0.022)
Log (group value added per employee)				0.073
				(0.060)
t-1				-0.040
				(0.029)
t-2				0.002
				(0.010)
Overid. restrictions test (Hansen)	20.13	17.92	17.85	33.34
(Degrees of freedom)	(14)	(14)	(14)	(20)
[p-value]	[0.126]	[0.211]	[0.214]	[0.031]
AR(1) test	-9.55	-7.87	-5.33	-6.62
[p-value]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2) test	-1.18	-1.84	-1.05	-1.75
[p-value]	[0.24]	[0.066]	[0.081]	[0.079]
Observations	55,082	62,955	56,883	35,315
Number of companies	166,749	19,399	19,348	13,526

Note: (i) See notes to Table 5. (ii) The group variables are calculated 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 1A – Persistency 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) The standard errors are in parenthesis unless otherwise stated. (iv) *** significant at 1% level; ** significant at 5% level; * significant at 10% level.