Labor and Capital Shares of the Corporate Tax Burden: International Evidence

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ABSTRACT

This paper develops and applies a simple framework for measuring the incidence of the corporate tax. This framework offers an empirical approach that jointly analyzes the degree to which owners of capital and workers share the burdens of corporate income taxes with the restriction that the overall burden is ultimately shared between them. Data on the foreign activities of American multinational firms provide wage rates and interest rates for a panel of more than 50 countries between 1989 and 2004. Evidence from applying this framework to these data indicates that between and 45 and 75 percent of the burden of corporate taxes is borne by labor with the balance borne by capital.

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1. Introduction

While there is universal agreement with the proposition that someone ultimately bears the burden of corporate taxes, there is considerable uncertainty, and indeed controversy, over exactly who this might be. The obvious candidates are owners of capital, whose after-tax returns may decline as tax rates rise, and workers, whose real wages may be adversely affected by corporate tax increases. Theoretical efforts to examine this question offer conflicting conclusions and demonstrate an unsettling sensitivity to underlying assumptions. These highly stylized models also leave open the question of whether actual economies, with their messy markets and no less messy tax systems, in fact react to corporate tax changes in the ways that the models predict.

The prevailing uncertainty over the incidence of the corporate tax is particularly unfortunate given that the distributional consequences of alternative tax policies are of fundamental importance to their desirability and political attractiveness. It has proven extremely difficult to evaluate corporate tax reforms on the basis of induced effects on the distribution of real income in the absence of reliable empirical evidence. Since there is no sense in which the burden of corporate taxes can fail ultimately to be borne, governments and policy analysts have been obliged to take stabs in the intellectual dark by attributing corporate tax burdens to different taxpaying groups. In practice, these attributions have an arbitrary feel: changes in corporate tax burdens are sometimes assigned to owners of corporate shares, sometimes to capital owners generally, and sometimes they simply are not attributed to anyone, despite the incoherence of such an approach.

This paper develops and tests a simple framework to analyze the incidence of the corporate tax. The theory of tax incidence offers guidance that is employed to sharpen estimates of the distribution of corporate tax burdens. The simple fact that corporate taxes must be paid by someone carries the implication that, if the economy consists of labor and capital, then any tax burden not borne by labor must be borne by capital. As a result, one can estimate the impact of corporate taxes on wages and returns to capital jointly, imposing a restriction that the effects sum to total tax burdens. Specifically, the theory points to the use of a seemingly unrelated system of regressions of wages and borrowing rates on measures of corporate taxes that includes a cross-equation restriction on the total tax effects. This method offers a more powerful, reliable, and

consistent method of identifying the distribution of tax burdens than does estimating the returns to labor or capital separately. This framework emphasizes the lessons of recent theoretical developments, particularly Randolph (2006), that factor shares are critical for understanding the incidence of the corporate tax.

This paper applies this framework to data collected from American multinational firms operating in a large number of countries between 1989 and 2004. One of the benefits of using these data is that they reflect the experiences of relatively comparable firms that report extensive information on their operations in a consistent manner between countries and over time. This sample excludes the United States, but includes evidence for more than 50 countries. Data on wage rates and returns to capital are related to corporate tax rates and measures of factor shares in several annual cross-sections and in a pooled analysis. The constraint on the coefficients allows capital or labor to bear more than 100 percent of the burden, as some theoretical variations suggest, but restricts the sum of the burden shares to equal one.

The results consistently indicate that corporate taxes depress both real wages and returns to capital, with most of the burden of corporate taxes borne by labor. The baseline estimate for the share of the burden borne by labor is 57 percent, and estimates vary between 45 and 75 percent, depending on the sample period and specification. These results are robust to the inclusion of control variables that might otherwise explain wages and returns to capital and to the inclusion of country fixed effects in a panel setting.

The method adopted in this paper moves part of the way toward reconciling empirical estimates with the underlying theory of corporate tax incidence. Recent empirical efforts to investigate corporate tax incidence focus largely on the extent to which high tax rates depress real wages. Such an approach does not capitalize on the theoretical insight that the overall tax burden must be shared between capital and labor. A second difference with earlier empirical studies is that this paper analyzes data that are collected and reported on a comparable basis by firms operating around the world. The use of these data has the potential to allay some of the concerns that would otherwise arise from using data obtained from disparate sources.

The approach employed in the paper also has several limitations. First, the empirical specifications rely heavily on the competitive market assumption that underlies the standard

theory of tax incidence. To the degree that the theory departs from reality, the estimating equations may be misspecified. On balance, however, the benefit of the empirical power obtained by constraining coefficients in accordance with standard economic theory seems to outweigh the disadvantage of relying on the theory. Second, the use of data from multinational firms may limit the applicability of the results obtained using these data. In particular, wage rates, returns to capital, factor shares and tax rates faced by multinational firms may be idiosyncratic and unrepresentative of the overall economy. Again, these potential limitations must be weighed against the benefits of employing highly comparable data for a significant fraction of global capital flows. These limitations and other matters of interpretation are discussed below.

Section 2 of the paper reviews some of the theoretical insights and empirical estimates from the literature on the incidence of the corporate tax. Section 3 provides a simple framework that leads to a set of estimating equations and describes the data employed in the paper. Section 4 presents empirical evidence on the degree to which labor and capital share the burden of the corporate tax. Sections 5 and 6 offer interpretations of these estimates, discuss their limitations, and conclude.

2. Corporate Taxation and the Distribution of Its Burdens.

The simple intuition that owners of corporations bear the burden of corporate taxes appears to be surprisingly fragile. The pioneering work of Harberger (1962) identifies the source of the common perception that owners of corporations bear the burden of the corporate tax and also demonstrates its sensitivity to modeling assumptions by showing that returns to capital owners can *increase* with a corporate tax. The simple intuition relies on the insight that corporate tax obligations contribute to the cost of investment and thereby encourage substitution of other productive factors (such as labor) for capital used by corporations. Labor expenses are deductible against taxable income, so the corporate tax does not affect the marginal condition characterizing a firm's decision of whether or not to employ additional labor. This substitution of labor for capital depresses the demand for capital and thereby reduces its after-tax market return in a closed economy.

Even in a closed economy, however, induced intersectoral reallocations of resources can reverse this result. Corporate taxation increases the cost of producing corporate output, thereby raising output prices, depressing demand, and shifting output from the corporate sector of the economy to the noncorporate sector. This reallocation affects factor demands to the extent that factor input ratios differ between the corporate and noncorporate sectors of the economy. If the corporate sector of the economy has a lower capital/labor ratio than the noncorporate sector, then the introduction of a corporate tax shifts resources into the noncorporate sector and thereby raises the demand for capital. If this effect is large enough, then it has the potential to exceed in magnitude the countervailing impact of factor substitution, thereby implying that higher rates of corporate tax are associated with greater after-tax returns to capital – including capital invested in corporations. It would then follow that labor bears the burden of the corporate tax in the form of lower wages.

Open economy considerations further complicate the simple intuition that capital owners bear the full burden of the corporate tax. As noted by Diamond and Mirrlees (1971), and applied to open economies by Gordon (1986), Kotlikoff and Summers (1987a) and Gordon and Hines (2002), any source-based capital income tax falls entirely on fixed local factors – typically labor – in a setting with perfect capital mobility and product substitution. It follows from the assumption of perfect capital mobility that after-tax rates of return to capital cannot differ between countries, so higher corporate tax rates must discourage investment and thereby drive up pretax rates of return to the point that after-tax returns remain equal. Since after-tax rates of return to local capital do not change with corporate tax changes, it must be the case that local labor and any other local factor whose location is fixed, the archetypal example being land, bear the full burden of corporate taxes. Additionally, corporate taxes in large open economies may have spillover effects. With fixed world supplies of capital, higher tax rates in one country discourage local investment and drive investment to other countries, where it can reduce rates of return to capital and increase wages.

Harberger (1995, 2006) and Randolph (2006) explore the sensitivity of conclusions drawn from models of perfect capital mobility and fixed world capital supplies. They calibrate models that incorporate what they argue are realistic estimates of relative capital intensities, capital mobility, and product substitutability, finding that labor can be thought to bear a

significant fraction of the burden of the corporate tax. In the classes of simple models used in these papers, any imperfect substitutability between foreign and domestic traded goods effectively operates as a form of imperfect capital mobility. As the trade and capital accounts must balance, imperfect substitutability between traded goods implies that extensive net borrowing is expensive as it entails importing large volumes of foreign goods for which there is diminishing marginal substitution. Gravelle and Smetters (2006) use a computable general equilibrium model to allow for subtler variants of imperfect product competition, concluding that corporate capital owners may bear the lion's share of the corporate tax burden despite the availability of capital inflows and outflows.[1]

The extensive theoretical results on the incidence of the corporate tax have not been matched with as extensive an empirical investigation. The relative absence of empirical efforts may reflect one of the central insights of Harberger (1962) - corporate taxation must be understood in the context of the general equilibrium of an economy. In general equilibrium, all markets affect each other and, as a result, it is typically necessary to use national information to evaluate the impact of a country's system of taxing corporate income. From an estimation standpoint this greatly reduces the extent of tax variation that can be appropriately used to identify the distribution of tax burdens, since tax differences among firms and between industries may have broader effects that would be overlooked in standard partial equilibrium estimation. The need to identify tax effects at national levels severely restricts the available sample from which to draw inferences, and as a result, makes it particularly difficult to obtain reliable empirical estimates.

Despite these challenges, several recent studies attempt to measure tax incidence in open economies.[2] Arulampalam et al. (2007), Felix (2007) and Hasset and Mathur (2006) all employ international databases to explore the extent to which corporate taxes influence wages, thereby indirectly assessing the incidence of the corporate tax. Arulampalam et al. (2007) employ micro data from four countries over five years and conclude that between 60 to 100 percent of the

[1] For more on the importance of product substitutability, see Davidson and Martin (1985) and Gravelle and Kotlikoff (1989, 1993).

[2] There were several earlier efforts to empirically examine the incidence of the corporate tax, typically through time series analysis of domestic data. These include Krzyzaniak and Musgrave (1963), Gordon (1967), Dusansky (1972), Oakland (1972) and Sebold (1979). For excellent reviews of the existing empirical and theoretical literatures, see Auerbach (2006) and Gentry (2007).

corporate tax is passed on to labor. Given the limited number of countries in their estimating sample, Arulampalam et al. (2007) are unable to estimate the impact of national tax rate differences, instead considering differences in the tax situations of individual firms. They analyze the extent to which a firm facing a higher tax burden than other firms shares the cost of its disadvantaged tax situation with workers in the form of lower wages. Felix (2007) and Hassett and Mathur (2006) instead consider the effects of national tax rates on wage determination in competitive markets, employing measures of local wage rates in a much larger sample of countries, and finding large effects of corporate taxes on wages. These empirical studies offer specifications that investigate the relative importance of economic openness, the magnitude of capital flows, the global nature of firms and the skill composition of the workforce to the incidence of the corporate tax.

As noted by Gravelle and Hungerford (2007) and Felix (2007), some of the reported wage equations indicate that labor bears an enormous cost of corporate taxation, the implied burdens in some specifications approaching twenty times the revenue raised by corporate taxes. Taken at face value, these estimates suggest that the distortions associated with the corporate tax are huge. Another possibility is that these results reflect the impact of data inconsistencies or correlated omitted variables. In order to assess the reliability of these estimates it is helpful to compare them to results obtained using a consistent data set and an estimating method that implicitly controls for some country-specific factors.

3. Estimation Method and Data.

This section sketches a framework that can be used to estimate corporate tax incidence. The first part of this section considers the implications of economic openness for the incidence of corporate income taxes, while the second part of the section describes the data used to estimate the impact of corporate taxation.

3.1 Accounting for tax changes.

Consider a firm that produces output with capital (K) and labor (L) inputs, using a production function denoted $Q(K, L)$, and with output price normalized to unity. The firm's capital investments are assumed not to depreciate, and are financed with a combination of debt

(*B*) and equity (*E*). Labor is paid a wage of *w*, and debt holders receive a return of *r*. Denoting by ρ the firm's after-corporate-tax rate of return to equity investments, and denoting the corporate tax rate by τ, it follows that:

$$\rho E \equiv \left[Q(K,L) - wL - rB\right](1-\tau). \tag{1}$$

Differentiating this expression with respect to τ, and applying the envelope theorem, produces:

$$\frac{d\rho}{d\tau}E + \frac{dw}{d\tau}L(1-\tau) + \frac{dr}{d\tau}B(1-\tau) = -\left[Q(K,L) - wL - rB\right]. \tag{2}$$

The left side of equation (2) consists of three terms, of which the first is the change in returns to equity holders, the second is the change in after-tax labor cost, and the third is the change in after-tax borrowing costs. The right side of equation (2) is simply the effect of a tax change on after-tax profits. Hence equation (2) reflects that higher tax costs must be compensated by a reduction of wages or capital returns, or equivalently, that some factor in the economy must bear the burden of corporate taxes.

It is noteworthy that output prices are normalized to one in the derivation of equation (2), which implies that output prices are assumed not to change as corporate tax rates change. In a single sector closed economy this assumption would simply represent a normalization of units, having no economic consequence, but in a multisector economy, or an open economy, the assumption that output prices are unaffected by corporate tax rates rules out effects that arise from intersectoral reallocation of resources (as in Harberger, 1962) or changing terms of trade between countries. For a small open economy in which the corporate and noncorporate sectors produce goods for a competitive world market, it follows (Gordon and Hines, 2002) that output prices cannot change in response to corporate tax changes, making the fixed price assumption a reasonable specification in this situation.

Suppose that capital investments are financed with a fraction α of debt and $(1-\alpha)$ of equity. Then equation (1) implies:

$$\rho(1-\alpha)K \equiv \left[Q(K,L) - wL - r\alpha K\right](1-\tau), \tag{3}$$

and differentiating with respect to τ produces:

(4) $$\frac{d\rho}{d\tau}(1-\alpha)K+\frac{dw}{d\tau}L(1-\tau)+\frac{dr}{d\tau}\alpha K(1-\tau)=-\left[Q(K,L)-wL-r\alpha K\right].$$

If investors are indifferent between receiving certainty-equivalent returns in the form of bond interest and equity returns, then $\rho = r$, and (4) implies:

(5) $$\frac{d\rho}{d\tau}(1-\alpha\tau)K+\frac{dw}{d\tau}L(1-\tau)=-\left[Q(K,L)-wL-r\alpha K\right].$$

In an extreme case, in which $\alpha \cong 0$, and investments are financed almost entirely with equity, (5) implies:

(6) $$\frac{dr}{d\tau}K+\frac{dw}{d\tau}L(1-\tau)=-\left[Q(K,L)-wL\right].$$

Equation (6) clarifies that the burdens of corporate tax increases are shared between labor and capital.

Under these conditions, the use of equation (1) allows equation (6) to be rewritten as:

(7) $$\frac{1}{r}\frac{dr}{d\tau}rK+\frac{1}{w}\frac{dw}{d\tau}Lw(1-\tau)=-\frac{rK}{(1-\tau)}.$$

This in turn implies:

(8) $$\frac{1}{r}\frac{dr}{d\tau}+\frac{1}{w}\frac{dw}{d\tau}\frac{Lw}{rK}(1-\tau)=-\frac{1}{(1-\tau)}.$$

Defining a labor share of output as $s \equiv \frac{wL}{Q}$, it follows that $\frac{Lw(1-\tau)}{rK}=\frac{Lw}{(Q-wL)}=\frac{s}{(1-s)}$. By also applying that $\frac{dr}{d\tau}=-\frac{dr}{d(1-\tau)}$ and $\frac{dw}{d\tau}=-\frac{dw}{d(1-\tau)}$, equation (8) becomes:

(9) $$\frac{dr}{d(1-\tau)}\frac{(1-\tau)}{r}+\frac{dw}{d(1-\tau)}\frac{(1-\tau)}{w}\frac{s}{(1-s)}=1.$$

3.2. Empirical implications.

In order to move to an estimating framework, it is useful to revisit an estimating equation that is employed to assess the effect of corporate taxes on wages. The corporate tax rate is not the only economic variable that affects wages and returns to capital. Letting X denote a vector of country attributes relevant to wage determination, and defining $s^* \equiv \frac{(1-s)}{s}$, it follows that the traditional framework for estimating wages can framed as:

$$\ln w = \beta X + \gamma s^* \ln(1-\tau) + \varepsilon \,. \tag{10}$$

In this setting, $\gamma = \frac{dw}{d(1-\tau)} \frac{(1-\tau)}{w} \frac{s}{(1-s)}$. Note that this corresponds to the second half of the left hand side of equation (9). Strictly speaking, equation (10) requires that s^* not be a function of τ.

One can readily imagine also estimating the parallel relationship for interest rates:

$$\ln \rho = \beta' X + \gamma' \ln(1-\tau) + \varepsilon' \,, \tag{11}$$

for which $\gamma' = \frac{d\rho}{d(1-\tau)} \frac{(1-\tau)}{\rho}$.

The relationship expressed in equation (9) carries implications for the estimated relationships (10) and (11), since these equations are not independent, but instead must satisfy an adding-up constraint. In particular, equation (9) implies that:

$$\gamma + \gamma' = 1. \tag{12}$$

This cross-equation restriction, which does not constrain the values of γ and γ' between zero and one, can then be employed when jointly estimating equations (10) and (11). It is worth noting that coefficients derived from estimating these equations without imposing the cross-equation constraint do not have natural interpretations, as they would then capture efficiency effects of corporate taxation, and the influence of correlated omitted variables, instead of the determinants of relative burdens.

The coefficients γ and γ' from equations (10) and (11) serve to identify the relative tax burdens on the two factors of production. To see this, note that $(1-s)=\frac{Q-wL}{Q}=\frac{rK}{Q}$ and therefore:

(13) $$(1-s)\frac{dr}{d\ln(1-\tau)}\frac{1}{r}=\frac{K}{Q}\frac{dr}{d\ln(1-\tau)}.$$

Similarly, $s=\frac{wL}{Q}$, so

(14) $$s\frac{dw}{d\ln(1-\tau)}\frac{1}{w}=\frac{L}{Q}\frac{dw}{d\ln(1-\tau)}.$$

Equations (13) and (14) lead directly to:

(15) $$\frac{\gamma}{\gamma'}=\frac{\frac{s}{(1-s)}\frac{dw}{d\ln(1-\tau)}\frac{1}{w}}{\frac{dr}{d\ln(1-\tau)}\frac{1}{r}}=\frac{L[dw/d\ln(1-\tau)]}{K[dr/d\ln(1-\tau)]}.$$

From the envelope theorem, the effect of a tax change on returns to labor is given by $L[dw/d\ln(1-\tau)]$, and the effect of a tax change on returns to capital is given by $K[dr/d\ln(1-\tau)]$. Hence the right side of (15) is simply the ratio of the burdens borne by labor and capital, respectively, to a small tax change. This ratio equals the ratio of the two estimated coefficients, γ and γ'.

It follows from equation (15) that estimating γ and γ' from equations (10) and (11), constraining the resulting estimates to sum to one, provides direct estimates of the relative shares of the corporate tax burden borne by labor and by capital. These shares are independent of the deadweight loss of corporate taxation, reflecting tax burdens rather than total tax collections. For example, if $\gamma=0.67$, so that labor bears two thirds of the burden of corporate taxation, and the deadweight loss of the corporate tax equals 50 percent of revenue collected, then labor's total burden equals 100 percent of corporate tax revenue, with capital bearing a burden equal to an additional 50 percent of corporate tax revenue. An important way in which this estimating

method differs from its predecessors is that it identifies relative, but not total, burdens of the corporate tax.

3.3. Data

The empirical work presented in section 4 is based on the most comprehensive and reliable available data on the activities of U.S. multinational firms. The Bureau of Economic Analysis (BEA) Benchmark Surveys of U.S. Direct Investment Abroad in 1989, 1994, 1999, and 2004 provide a panel of data on the financial and operating characteristics of U.S. multinational affiliates.[3] As discussed above, the question of incidence recommends the use of data that are aggregated at the national level. Accordingly, an aggregation of the majority-owned activities of foreign affiliates at the country-year level is employed in the analysis below.

Table 1 presents means, medians, and standard deviations of variables used in the regressions that follow. The wage rate is defined as the ratio of total employee compensation (including benefits) paid by majority owned foreign affiliates to numbers of employees. Since the BEA data are measured in U.S. dollars, these can be interpreted as real wage rates to the extent that purchasing power parity holds and thereby automatically corrects for the effects of local inflation. As profit-type returns may reflect tax-motivated reallocation of pretax income, returns to capital are captured by measuring average interest rates paid on the liabilities of foreign affiliates. The interest rate is computed as the ratio of interest payments made by majority foreign owned affiliate to the aggregate level of current liabilities and long-term debt, with both variables again measured in U.S. dollars.[4] Tax rates are measured for each country-year combination as the ratio of aggregate foreign income tax payments to aggregate net income plus foreign income tax payments. Given that country-specific values of s also have the potential to reflect tax-motivated income reallocation, yearly aggregate values of s for the total foreign activities of U.S. multinational firms are used in their place. Specifically, s is calculated as the ratio of total employee compensation to the sum of total employment compensation, net income, foreign income taxes and depreciation in a given year.

[3] The International Investment and Trade in Services Survey Act governs the collection of the data and the Act ensures that "use of an individual company's data for tax, investigative, or regulatory purposes is prohibited." Willful noncompliance with the Act can result in penalties of up to $10,000 or a prison term of one year. As a result of these assurances and penalties, BEA believes that coverage is close to complete and levels of accuracy are high.
[4] See Desai, Foley and Hines (2004) for a discussion and analysis of this interest rate variable and its alternatives.

In addition to these variables constructed from the BEA data, some regressions include control variables used to explain wages and interest rates. For wages, the Barro-Lee measure of average workforce education, measured in years, and obtained from Barro and Lee (2000), is used as an explanatory variable. For interest rates, national measures of creditor rights, drawn from Djankov, McLiesh, and Shleifer (2005), and local inflation rates, drawn from the World Development Indicators, are included as explanatory variables. Desai, Foley and Hines (2004) note that stronger legal protections for lenders and higher inflation rates are associated with lower interest rates.[5]

4. The Distribution of Corporate Tax Burdens.

This section reports the results of estimating the distribution of corporate tax burdens using the data from American multinational firms described in section 3.

4.1. Annual cross-sections

Table 2 presents results of seemingly unrelated systems of equations that restrict the sum of the tax coefficients in the wage and interest rate specifications to equal one. The specification explaining wages and the specification explaining interest rates are not therefore separate regressions but instead components of a single regression. The estimated 0.6943 coefficient estimated in the first regression implies that higher tax rates are associated with lower wages, since 69 percent of the total tax burden is borne by labor. The corresponding 0.3057 coefficient carries the mirror image implication that 31 percent of the total burden is borne by capital. The estimated interest rate effect does not differ significantly from zero, but does differ significantly from one, which is consistent with (indeed, implied by) the statistical significance of the estimated wage effect reported in column one.

The second system of equations adds explanatory variables to the wage and interest rate specifications. Specifically, the wage specification now includes the Barro-Lee measure of workforce education, and the interest rate specification now includes measures of creditor rights and local inflation. Since the regression requires information on all of these variables for any

[5] Desai, Foley and Hines (2004) also report that higher corporate income tax rates are associated with lower interest rates in their affiliate-level specifications that control for various firm and affiliate attributes, a finding that is consistent with the results reported in section 4.

country included in the sample, the sample size falls from 52 observations for the regression reported in columns one and two to just 41 observations. Workforce schooling has a large and statistically significant effect on wages, the 0.2056 coefficient reported in column three implying that each additional year of education increases employment compensation by about 20%. The creditor rights and inflation variables appear to have only insignificant effects on reported interest rates.

The inclusion of additional explanatory variables and restriction of the sample size together reduces the magnitude of the estimated tax coefficient in the wage specification to 0.4839. There is a corresponding rise in the tax coefficient in the interest rate specification to 0.5161. Hence from these coefficients it appears that roughly half of the burden of corporate taxation is borne by labor in the form of reduced wages, and half by capital in the form of reduced returns.

In order to consider the dependence of these results to the use of 2004 data, Panels A, B, and C of Table 3 repeat these regressions for cross sections of data covering 1999, 1994, and 1989. The results are broadly consistent with those reported in Table 2, though the estimated burden on labor tends to be somewhat higher in these regressions than in the regressions reported in Table 2. For example, regression (4) in Panel B of Table 3 reports estimated coefficients from a regression explaining 1994 wages and interest rates as functions of local tax rates, worker education, creditor rights and inflation. The estimated 0.7456 coefficient implies that three quarters of the burden of corporate taxation is borne by labor, with the remaining 25 percent borne by capital. This estimated labor share is significantly different from zero, but not statistically different from one, implying that these results do not rule out the possibility that labor bears 100 percent of the burden of corporate taxation, whereas they are inconsistent with labor bearing none of the burden.

4.2. Panel evidence

Table 4 presents estimated coefficients from regressions using data from all four benchmark survey years, 1989, 1994, 1999, and 2004. The estimated 0.7118 coefficient obtained from the first seemingly unrelated regression implies that 71 percent of the burden of corporate taxation is borne by labor, with the remaining 29 percent borne by capital. The

relatively small standard error suggests that it is possible to reject that the labor share of the tax burden is either zero or 100 percent.

The second pair of specifications repeats this analysis but adds education, creditor rights, and inflation as controls. The need to incorporate this information reduces the sample size. The estimated labor share falls in these regressions, the 0.6152 coefficient in column three implying that 62 percent of the burden of corporate taxes is borne by labor, again with a small enough standard error that it is possible to reject that the labor share is either zero or 100 percent.

The third seemingly unrelated system of equations omits the control variables but introduces country fixed effects, thereby estimating tax effects from changes in corporate tax rates between benchmark survey years. This approach implicitly controls for country attributes that do not change over the 1989-2004 period. The 0.5665 coefficient in column five implies that labor bears 57 percent of the burden of corporate taxes. Together with the small associated standard error, this coefficient implies that it is possible to reject that labor's share of the total tax burden is outside the range of 40-74 percent.

Finally, the fourth pair of specifications presented in Table 4 adds country fixed effects to the second pair of specifications. The results of this regression suggest that labor bears a somewhat smaller share of the total corporate tax burden than does the third regression. The 0.4469 coefficient in column seven implies that labor bears 45 percent of the total tax burden, the remaining 55 percent falling on capital.

The regressions reported in Table 4 include specifications that interact local tax rates with measured values of s^*, a function of aggregate shares of labor compensation in total returns. Since the sample mean value of s is 0.4823, it does little injustice to the data simply to fix the value of s^* at unity, thereby effectively removing this interaction from the tax term on the right side of the wage specifications. Table 5 reports results from estimating the same regressions as those reported in Table 4, but imposing that $s^* = 1$.

The estimated coefficients reported in Table 5 are similar to those reported in Table 4, the primary difference being that the estimated labor share of the total tax burden is somewhat higher in the specifications in Table 5. For example, the 0.7521 coefficient estimated from the

first regression implies that labor bears three quarters of the total burden of corporate taxes, which compares to the 0.7118 coefficient reported for the analogous regression in Table 4. The differences between the results in these two tables are the greatest for the third and fourth regressions, reported in columns 5-8, that include country fixed effects. Thus, the 0.7326 coefficient estimated from the third regression presented in Table 5 implies that labor bears 73 percent of the corporate tax burden, whereas the corresponding 0.5665 coefficient in Table 4 implies that labor bears only 57 percent of the burden. Similarly, the 0.5889 coefficient estimated from the fourth regression presented in column 8 of Table 5 suggests a notably larger labor share of total burdens than does the corresponding 0.4469 coefficient in Table 4. It is clear, therefore, that time-varying labor shares of total output are not responsible for the significant labor shares of total tax burdens implied by the results reported in Table 4. It is also the case that, at least in these specifications, treating labor shares in an arbitrary manner by imposing a value that removes the labor share variable from the estimation has the effect of increasing the estimated fraction of the tax burden borne by labor.

5. Interpretation

This section considers two issues that arise in interpreting the empirical results. The first of these issues is the consistency of the empirical estimates with the theoretical literature that emphasizes perfect international capital mobility. The second issue is the extent to which it is appropriate to draw broad economic conclusions from an analysis based on data drawn from American multinational firms.

5.1. Local effects and spillover effects

Do the regression estimates presented above capture the entire distributional consequences of corporate tax changes? These cross sectional and panel regressions provide estimates of the average effect of tax differences on after-tax returns to local factors. As emphasized in the Randolph (2006) application of the Kotlikoff and Summers (1987a) framework, a corporate tax change in one country typically affects wages and rates of return to capital in all other countries. As such, the statistical evidence presented in section four does not identify all of the distributional effects of a country's corporate tax rate. The evidence instead isolates any effect of international differences in corporate tax rates on differences in factor

returns, not incorporating any distributional impact that average corporate tax rate levels may have.

If the assumption of perfect capital mobility embodied in the Randolph (2006) and Kotlikoff and Summers (1987a) approach were correct, then regressions such as those presented in section four would show that borrowing rates are unrelated to corporate income tax rates. Nonetheless, Randolph's model implies that roughly 30 percent of the burden of U.S. corporate income taxes is borne by U.S. capital. This burden arises because, with a fixed worldwide capital stock, worldwide capital bears 100 percent of the burden of U.S. corporate taxation and the U.S. comprises 30 percent of the worldwide capital stock. Consequently, these models imply that the worldwide rate of return to capital varies year by year according to how heavily the whole world taxes corporate income. Regressions, however, do not pick up this effect as they are based on comparing rates of return between countries in the same year.

How should one interpret the findings in section four in light of the effects of average world tax rates identified in the work of Kotlikoff and Summers (1987a), and applied in the Randolph (2006) model? From the standpoint of a small open economy, the cross sectional results likely identify the full burden of the corporate tax, given that spillover effects from a small open economy to the rest of the world, and thereby back to the small country, are apt to be tiny. For a large open economy such as the United States, corporate tax changes have the potential to have sizable spillover effects on world interest rates and wages that are not captured in the empirical estimates provided in this paper.

It is difficult to combine the effects of average world tax rates with cross-sectional estimates to project the distributional impact of corporate tax changes in large countries. Simply adding empirical estimates of within-country effects of corporate tax changes and the numerical simulations from Randolph's model for spillover effects would be incorrect. Indeed, the evidence that interest rates vary with corporate income tax rates, for example, is inconsistent with assumptions underlying the Randolph model, instead being consistent with a framework in which there is imperfect international capital mobility, at least in the short run. Furthermore, the strong and untested assumption of Randolph's model that the total world capital supply is unaffected by after-tax returns is responsible for at least some of the model's stark conclusions.

While some of the implications of average world corporate tax rates highlighted by Randolph's calculations certainly should be incorporated in a complete assessment of the effects of a U.S. corporate tax reform, in the absence of empirical evidence it is difficult to know exactly to what extent it is necessary to modify conclusions that can be drawn from cross-sectional evidence.

5.2. Multinational firms and national economies

If the activities of American multinational firms operating abroad were perfectly representative of their host economies, then estimating the relationship between taxes, wages and returns to capital in the manner employed in section four would constitute a straightforward application of the framework sketched in section three. In reality, available evidence on the activities of multinational firms suggests that multinational firms differ in important dimensions from local firms. For example, there is a consensus that wages paid by multinational firms exceed those paid by local firms.[6] Such differences, while well-established, need not influence the interpretation of the empirical results if multinational firms pay wages that exceed prevailing local wages by percentages that are not influenced by corporate tax rates. Similarly, while foreign investors may confront borrowing costs that differ from those facing local firms, the use of interest rates paid by multinational firms as indicators of local capital returns produces valid inferences as long as the ratio of these two borrowing costs is not itself influenced by corporate tax rates.

These considerations and others suggest that it would be worthwhile to estimate the extent to which corporate taxes affect wages and capital returns in a simultaneous system using data that cover more than the foreign operations of American multinational firms. One formidable challenge facing such an estimation is the compilation of consistent data for a large enough number of countries to provide statistical reliability for the results. While there is good reasons to expect that conclusions drawn from the environment facing American firms are likely to apply to entire economies, this is a proposition that might well benefit from further empirical exploration.

[6] The wage premium paid by the foreign affiliates of multinational firms reflects the greater than average skills of the labor force they employ, rather than a tendency to assign some home country workers to foreign locations. U.S. citizens represented less than 0.3 percent of the employees of foreign affiliates of American multinational firms in 1999, far too small a fraction to influence average wages significantly.

6. Conclusion

Who bears the burden of corporate taxes in modern open economies? Economic theory points to a range of possibilities. While the available theory does not identify specific answers, it does suggest a worthwhile empirical framework that can be used to estimate the distribution of corporate tax burdens. Applying this framework to data on American multinational firms that operate around the world produces estimates that imply that the burden of corporate taxation is borne by labor to a significant degree. These estimates evaluate the extent to which differences in corporate tax rates are associated with differences in after-tax returns to capital and labor, likely capturing the full burden of corporate taxes in small economies and most if not close to all of the distributional effects of corporate taxes in large economies.

It is possible to bring both more evidence and sharper theory to bear on the question of the distributional impact of corporate taxation. The use of aggregate national data collected on a consistent basis for a large number of countries has the potential to enlighten our understanding of the workings of corporate taxation on parts of economies that are less influenced by foreign direct investment. Tax incidence theory might usefully distinguish the effects of tax rates and tax bases, the treatment of individual industries and sectors, and other realistic features of corporate taxation that could be incorporated in future empirical work. For all that remains to be done, however, it is a mistake to overlook the evidence before us, in which it appears that the burden of corporate taxation is not, as some have thought, entirely borne by owners of corporations or owners of capital, but instead shared between labor and capital.

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Table 1

Descriptive Statistics

	Mean	Median	Standard Deviation
LN (Wage)	3.0984	3.2091	0.7365
LN (Interest Rate)	-3.6777	-3.6379	0.7374
s	0.4823	0.4931	0.0584
LN (1-Tax Rate)	-0.3744	-0.2971	0.3793
((1-*s*)/*s*) * LN (1-Tax Rate)	-0.3989	-0.3118	0.3893
Workforce Schooling	7.6838	7.8930	2.2323
Creditor Rights	2.0695	2.0000	1.1362
LN (Inflation)	-2.9234	-2.8895	1.3894

Notes: LN (Wage) is the natural log of employment compensation per employee as measured in the BEA data. LN (Interest Rate) is the natural log of the ratio of interest payment to current liabilities and long term debt, computed using BEA data. Tax Rates are imputed from the BEA data by taking the ratio of foreign income taxes paid to the sum of foreign income taxes paid and net income. S is the ratio of employment compensation to the sum of employment compensation, net income, foreign income taxes, and depreciation and it is calculated at the annual level using aggregate worldwide BEA data. Workforce Schooling is the average schooling years in the population over 25 years old provided in Barro and Lee (2000). Creditor Rights is an index of the strength of creditor rights developed in Djankov, McLiesh, and Shleifer (2005); higher levels of the measure indicate stronger legal protections. LN (Inflation) is the natural log of the rate of inflation as measured using GDP deflator data drawn from the World Development Indicators.

Table 2

2004 Cross-Sectional Constrained Seemingly Unrelated Regressions

Dependent Variable:	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)
	(1)		(2)	
Constant	3.6416	-3.8137	1.8783	-3.7709
	(0.1271)	(0.1053)	(0.3108)	(0.3406)
((1-*s*)/*s*) * LN (1-Tax Rate)	0.6943		0.4839	
	(0.2047)		(0.1847)	
LN (1-Tax Rate)		0.3057		0.5161
		(0.2047)		(0.1847)
Workforce Schooling			0.2056	
			(0.0363)	
Creditor Rights				0.0442
				(0.0725)
LN (Inflation)				-0.0154
				(0.0914)
No. of Obs.	52		41	
Log Likelihood	-103		-61	

Notes: This table presents the results of constrained, seemingly unrelated regressions using 2004 data. LN (Wage) is the natural log of employment compensation per employee as measured in the BEA data. LN (Interest Rate) is the natural log of the ratio of interest payment to current liabilities and long term debt, computed using BEA data. Tax Rates are imputed from the BEA data by taxing the ratio of foreign income taxes paid to the sum of foreign income taxes paid and net income. *s* is the ratio of employment compensation to the sum of employment compensation, net income, foreign income taxes, and depreciation and it is calculated at the annual level using aggregate worldwide BEA data. Workforce Schooling is the average schooling years in the population over 25 years old provided in Barro and Lee (2000). Creditor Rights is an index of the strength of creditor rights developed in Djankov, McLiesh, and Shleifer (2005); higher levels of the measure indicate stronger legal protections. LN (Inflation) is the natural log of the rate of inflation as measured, using GDP deflator data drawn from the World Development Indicators.

Table 3
Alternative Annual Cross-Sectional Results

	Panel A: 1999				*Panel B: 1994*				*Panel C: 1989*			
Dependent Variable:	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)
	(1)		(2)		(3)		(4)		(5)		(6)	
Constant	3.3461	-3.7290	2.2437	-3.3396	3.3214	-3.5696	1.8132	-2.9711	3.0581	-3.0228	1.8119	-2.1200
	(0.1488)	(0.1530)	(0.3814)	(0.2661)	(0.1185)	(0.1061)	(0.3406)	(0.1815)	(0.1287)	(0.1323)	(0.3286)	(0.2613)
((1-*s*)/*s*) * LN (1-Tax Rate)	0.4547		0.7241		0.7263		0.7456		0.5695		0.5538	
	(0.3426)		(0.3222)		(0.1802)		(0.2190)		(0.1328)		(0.1229)	
LN (1-Tax Rate)		0.5453		0.2759		0.2737		0.2544		0.4306		0.4462
		(0.3426)		(0.3222)		(0.1802)		(0.2190)		(0.1328)		(0.1229)
Workforce Schooling			0.1429				0.1860				0.1717	
			(0.0434)				(0.0409)				(0.0421)	
Creditor Rights				0.0623				-0.0327				-0.0525
				(0.0826)				(0.0536)				(0.0960)
LN (Inflation)				0.1036				0.1570				0.3125
				(0.0630)				(0.0454)				(0.0707)
No. of Obs.	50		31		50		39		52		42	
Log Likelihood	-107		-44		-97		-54		-125		-81	

Notes: This table presents the results of constrained seemingly unrelated regressions using data from 1999, 1994, and 1989 in Panels A, B, and C, respectively. LN (Wage) is the natural log of employment compensation per employee as measured in the BEA data. LN (Interest Rate) is the natural log of the ratio of interest payment to current liabilities and long term debt, computed using BEA data. Tax Rates are imputed from the BEA data by taxing the ratio of foreign income taxes paid to the sum of foreign income taxes paid and net income. *s* is the ratio of employment compensation to the sum of employment compensation, net income, foreign income taxes, and depreciation, calculated at the annual level using aggregate worldwide BEA data. Workforce Schooling is the average schooling years in the population over 25 years old provided in Barro and Lee (2000). Creditor Rights is an index of the strength of creditor rights developed in Djankov, McLiesh, and Shleifer (2005); higher levels of the measure indicate stronger legal protections. LN (Inflation) is the natural log of the rate of inflation as measured using GDP deflator data drawn from the World Development Indicators.

Table 4

Panel Analysis: 1989, 1994, 1999, and 2004

Dependent Variable:	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)
	(1)		(2)		(3)		(4)	
Constant	3.3823	-3.5698	1.8567	-2.8089	2.3000	-3.0667	1.3252	-2.8009
	(0.0661)	(0.0648)	(0.1762)	(0.1341)	(0.3282)	(0.5003)	(0.3080)	(0.2974)
((1-*s*)/*s*) * LN (1-Tax Rate)	0.7118		0.6152		0.5665		0.4469	
	(0.1002)		(0.0909)		(0.0843)		(0.0734)	
LN (1-Tax Rate)		0.2882		0.3848		0.4335		0.5531
		(0.1002)		(0.0909)		(0.0843)		(0.0734)
Workforce Schooling			0.1878				0.3182	
			(0.0212)				(0.0499)	
Creditor Rights				0.0274				0.1407
				(0.0416)				(0.1438)
LN (Inflation)				0.2206				0.2340
				(0.0338)				(0.0369)
Country Fixed Effects?	N		N		Y		Y	
No. of Obs.	204		153		204		153	
Log Likelihood	-463		-272		-178		-85	

Notes: This table presents the results of constrained seemingly unrelated regressions using pooled data from 2004, 1999, 1994, and 1989. LN (Wage) is the natural log of employment compensation per employee as measured in the BEA data. LN (Interest Rate) is the natural log of the ratio of interest payment to current liabilities and long term debt, computed using BEA data. Tax Rates are imputed from the BEA data by taxing the ratio of foreign income taxes paid to the sum of foreign income taxes paid and net income. s is the ratio of employment compensation to the sum of employment compensation, net income, foreign income taxes, and depreciation, calculated at the annual level using aggregate worldwide BEA data. Workforce Schooling is the average schooling years in the population over 25 years old provided in Barro and Lee (2000). Creditor Rights is an index of the strength of creditor rights developed in Djankov, McLiesh, and Shleifer (2005); higher levels of the measure indicate stronger legal protections. LN (Inflation) is the natural log of the rate of inflation as measured using GDP deflator data drawn from the World Development Indicators.

Table 5

Panel Analysis with Fixed Values for the Labor Share

Dependent Variable:	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)	LN (Wage)	LN (Interest Rate)
	(1)		(2)		(3)		(4)	
Constant	3.3800	-3.5849	1.9249	-2.8496	2.3131	-3.6142	1.5434	-2.8682
	(0.0644)	(0.0647)	(0.1760)	(0.1320)	(0.3088)	(0.4615)	(0.3006)	(0.2879)
((1-*s*)/*s*) * LN (1-Tax Rate)	0.7521		0.6989		0.7326		0.5889	
	(0.1006)		(0.0924)		(0.0825)		(0.0748)	
LN (1-Tax Rate)		0.2479		0.3011		0.2674		0.4111
		(0.1006)		(0.0924)		(0.0825)		(0.0748)
Workforce Schooling			0.1805				0.2660	
			(0.0212)				(0.0494)	
Creditor Rights				0.0277				0.1220
				(0.0407)				(0.1392)
LN (Inflation)				0.2179				0.2330
				(0.0332)				(0.0358)
Country Fixed Effects?	N		N		Y		Y	
No. of Obs.	204		153		204		153	
Log Likelihood	-461		-268		-167		-76	

Notes: This table presents the results of constrained seemingly unrelated regressions using pooled data from 2004, 1999, 1994, and 1989. In these regressions, the value of the labor share, *s* , is fixed at 0.5. LN (Wage) is the natural log of employment compensation per employee as measured in the BEA data. LN (Interest Rate) is the natural log of the ratio of interest payment to current liabilities and long term debt, computed using BEA data. Tax Rates are imputed from the BEA data by taxing the ratio of foreign income taxes paid to the sum of foreign income taxes paid and net income. Workforce Schooling is the average schooling years in the population over 25 years old provided in Barro and Lee (2000). Creditor Rights is an index of the strength of creditor rights developed in Djankov, McLiesh, and Shleifer (2005); higher levels of the measure indicate stronger legal protections. LN (Inflation) is the natural log of the rate of inflation as measured using GDP deflator data drawn from the World Development Indicators.