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Corporate Tax Incidence in India

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ABSTRACT

The paper attempts to measure the incidence of corporate income tax in India under a general equilibrium setting. Using seemingly uncorrelated regression coefficients and dynamic panel estimates, we tried to analyze both the relative burden of corporate tax borne by capital and labor and the efficiency effects of corporate income tax. The data for the study is compiled from corporate firms listed on the Bombay Stock Exchange (BSE) and the National Stock Exchange of India (NSE) for the period 2000–15. Our empirical estimates suggest that in India capital bears more of the burden of corporate taxes than labor. Though it is contrary to the Harberger (1962) hypothesis that the burden of corporate tax is shifted to labor rather than capital, it confirms the existing empirical results in the context of India.

KEYWORDS: Corporate Tax; Tax Incidence; Capital; Labor

JEL CLASSIFICATIONS: C33; H22; H25

1. INTRODUCTION

An important question that remains largely unanswered in the Indian context is the incidence of corporate tax. Though corporate taxes are imposed on firms, a valid question is which factor of production actually bears the economic burden of such a tax. Various studies have attempted to test whether the burden falls on the owners of capital or on the labor employed by the firms. Theoretically, higher corporate taxes lead to lower capital formation, hence lower labor productivity and lower wages. In an open economy where capital flows across borders, the corporate tax has an impact on capital investments made by firms. Capital moves from high-tax to low-tax countries and higher capital formation in low-tax countries leads to higher capital-labor ratios, higher labor productivity, and hence higher wages. The burden in the high-tax country falls on both capital and labor, though in different proportions. Harberger (1962) asserts labor bears most of the burden of corporate taxes in an open economy. A recent study by Fuest, Peichl, and Siegloch (2017) found that more than half of the corporate tax burden is passed onto workers in Germany, implying a reduced overall progressivity of their tax system.

The paper is an attempt to test this theory using empirics in the context of India. We test the essential question of whether or not corporate taxation has a clear empirical impact on the labor market. The paper uses data from 5,666 corporate firms in India (listed on the Bombay Stock Exchange [BSE] and the National Stock Exchange of India [NSE]) from 2000–15 and analyzes the impact of corporate tax on the capital and labor employed by corporations. The framework used in this paper has been heavily derived from Desai, Foley, and Hines (2007) with several modifications. The framework used allows us to find the overall burden of the tax shared between labor and capital. In this general equilibrium framework, both relative burdens and the efficiency effects of corporate taxation have been deduced. Evidently, there is no direct effect of corporate tax on wages; most of the burden of corporate taxes falls on capital. This is in contrast to other studies being conducted in different countries. Clausing (2013) explains why such findings may result. Clausing’s paper explains that this could simply be that aggregate data are too coarse to pick up the true causal mechanisms at work, given the myriad factors that influence labor market outcomes. Second, it is possible that capital or shareholders bear the lion’s share of the corporate tax burden, and prior studies have picked up spurious relationships due to methodological or data constraints. In this paper, we looked into these issues and improved on the methodology.

The paper is organized into six sections. Section 2 reviews the current theoretical and empirical literature on corporate tax incidence. Section 3 explains the analytical framework used in estimating the equations. Section 4 describes the data used and the relation between the variables used. Section 5 provides for and interprets the results from econometric modeling. Section 6 concludes.

2. A THEORETICAL AND EMPIRICAL REVIEW OF THE LITERATURE

The analysis in Harberger (1962) concluded that corporate tax has a larger impact on capital in the corporate sector. The imposition of a corporate tax discourages the use of capital, also reducing the return on capital for the entire economy. His analysis assumes a closed economy with fixed labor and capital levels for a country as a whole. However, a consideration of the open economy reverses the results wherein the burden of a corporate tax is borne by labor. The corporate capital moves from high-tax countries to low-tax ones, reducing the capital-labor ratio in the former and leading to a lower marginal product of labor and lower wages. At the same time, low-tax countries experience higher capital-labor ratios, a higher marginal product of labor, and hence higher wages. Randolph (2006) conducts his study on the basis of Harberger's model. Assuming an open economy, he asserts that domestic owners shift much of the burden of the corporate tax onto capital owners abroad. He concludes that in the US, labor would bear 70 percent of the burden of the tax and capital would bear 30 percent of the burden.

Using data from 65 countries over 25 years, Hassett and Mathur (2006) focus on the long-term impact of higher corporate taxes on wages. The paper concludes that higher taxes depress wages. Moreover the findings suggest that not only domestic but international tax rates also affect domestic wages. This significant relation between corporate taxes and wages is tested using the fixed effects technique. Felix (2007) tests the relationship between taxes and the burden on capital and labor. Using data for 19 countries from 1979–2002, the paper finds that a 1 percent higher corporate tax leads to 0.7 percent lower wages after controlling for observable worker characteristics. The paper concludes that as the capital tax rate increases, the burden falls both on labor and capital, with labor bearing slightly more than half of this burden. Arulampalam, Devereux, and Maffini (2007) use company-level European data to estimate the wage effects of tax burdens that differ between firms. The results show that firms with greater tax obligations pay lower wages. Also the estimates imply that labor bears close to 100 percent of the corporate tax burden in the long run.

Desai, Foley, and Hines (2007) estimate wage and interest rate sensitivity to corporate tax rates for a four-year sample of US multinational firm affiliates in OECD countries in the years 1989, 1994, 1999, and 2004. Finding the relative burden of the corporate tax, they constrain the total burden shares to one using the seemingly unrelated regression technique. They find that labor bears between 45 percent and 75 percent of the total burden. Clausing (2012) compares OECD countries to find the effect of corporate taxes on wages. Contrary to the previous empirical literature, the paper finds no evidence of linkages between corporate taxes and wages. A thorough review of the theoretical literature, showing a probable link between the two, is in contrast with the empirics of the paper, which reveals no links between corporate taxes and wages. Carroll (2009) uses cross-sectional state-level data from 1970–2007 to investigate the relationship between corporate taxes and wages at the state level while controlling for both state and time effects. The paper finds a significant relationship between the two and concludes that a 1 percent increase in the average state and local corporate tax rate can lower real wages by 0.014 percent. One of the few papers in the Indian context is by Shome (1978), which explores the effect of a marginal change in the corporate tax on wages in the economy. In a general equilibrium setting, the incidence of corporate tax is tested for the period 1971–72. The findings suggest that a part of the burden of corporate taxes are shifted to laborers and that there is a need to alter the tax base, as the purpose of the corporate tax is in fact to tax capital income and not labor. We use Desai, Foley, and Hines's (2007) framework to estimate the corporate tax incidence in India.

3. ANALYTICAL FRAMEWORK

Drawing from the analytical framework used in Desai, Foley, and Hines (2007), our paper makes several modifications. This general equilibrium framework is the basis of the regressions run to analyze the impact of the corporate tax on capital and labor.

Consider a firm that produces output using capital (K) and labor (L) as inputs, assuming a production function Q (K, L) with the output price being normalized to unity. The capital investments of the firm 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 c, it follows that:

$$\rho E = [Q(K, L) - wL - rB]\,(1 - c) \qquad (1)$$

Differentiating this expression with respect to c gives,

$$\frac{d\rho}{dc}E + \frac{dw}{dc}L(1 - c) + \frac{dr}{dc}B(1 - c) = -[Q(K, L) - wL - rB] \qquad (2)$$

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 for by a reduction in wages or capital returns, or, equivalently, that some factor in the economy must bear the burden of corporate taxes.

The output prices are normalized to one in the derivation of equation (2), which implies that output prices are assumed not to change as the corporate tax rates change. This is explained in Desai, Foley, and Hines (2007):

> 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 inter-sectoral reallocation of resources (as in Harberger [1962]) or changing terms of trade between countries. For a small open economy in which the corporate and non-corporate 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-α) of equity. Then,

$$\rho(1-\alpha)K = [Q(K,L) - wL - r\alpha K](1-c) \tag{3}$$

and differentiating with respect to c results in:

$$\frac{d\rho}{dc}(1-\alpha)K + \frac{dw}{dc}L(1-c) + \frac{dr}{dc}\alpha K(1-c) = -[Q(K,L) - wL - r\alpha K] \tag{4}$$

The paper by Desai, Foley, and Hines (2007) assumes that ρ=r and α=0, which means that the firms are entirely financed by equity. Our paper does away with these rather strong assumptions and works out the model under a more realistic set of assumptions. Hence the framework differs from the original paper from here onwards; however the results are eventually identical.

From equation (3), [Q(K,L)-wL-rαK] can be substituted for ρ(1-α)K/(1-c). Hence,

$$\frac{d\rho}{dc}(1-\alpha)K + \frac{dw}{dc}L(1-c) + \frac{dr}{dc}\alpha K(1-c) = \frac{-\rho(1-\alpha)K}{1-c} \tag{5}$$

$$\frac{d\rho}{dc}(1-\alpha)K + \frac{dr}{dc}\alpha K(1-c) + \frac{dw}{dc}L(1-c) = \frac{-\rho(1-\alpha)K}{1-c}$$

$$\frac{1-c}{\rho}\frac{d\rho}{dc}\,\frac{\rho(1-\alpha)K}{\rho(1-\alpha)K} + \frac{1}{r}\frac{dr}{dc}\frac{r\alpha K(1-c)^2}{\rho(1-\alpha)K} + \frac{1}{w}\frac{dw}{dc}\frac{wL(1-c)^2}{\rho(1-\alpha)K} = -1 \tag{6}$$

Applying $\frac{d\rho}{dc} = -\frac{d\rho}{d(1-c)}, \frac{dr}{dc} = -\frac{dr}{d(1-c)}$ and $\frac{dw}{dc} = -\frac{dw}{d(1-c)}$, we obtain the following:

$$\frac{1-c}{\rho}\frac{d\rho}{d(1-c)} + \frac{1-c}{r}\frac{dr}{d(1-c)}\left[\frac{r\alpha K(1-c)}{\rho(1-\alpha)K}\right] + \frac{1-c}{w}\frac{dw}{d(1-c)}\left[\frac{wL(1-c)}{\rho(1-\alpha)K}\right] = 1 \quad (7)$$

Now defining the labor share of output as s= wL/Q (as in Desai, Foley, and Hines [2007]) and d=rαK/Q, where αK is the debt of the firm and hence rαK is the interest expenses of the firm. (This d however is negligible in the case of Indian corporate firms and assumed to be zero in this model)[2]

To shorten the equation we use $\frac{wL(1-c)}{\rho(1-\alpha)K} = \frac{wL}{Q-wL-r\alpha K} = \frac{wL/Q}{(Q-wL-r\alpha K)/Q} = \frac{s}{1-s-r\alpha K/Q} = \frac{s}{1-s-d}$

Also $\frac{r\alpha K(1-c)}{\rho(1-\alpha)K} = \frac{r\alpha K}{Q-wL-r\alpha K} = \frac{r\alpha K/Q}{(Q-wL-r\alpha K)/Q} = \frac{d}{1-s-d}$

Equation (7) now becomes

$$\frac{1-c}{\rho}\frac{d\rho}{d(1-c)} + \frac{1-c}{r}\frac{dr}{d(1-c)}\left[\frac{d}{1-s-d}\right] + \frac{1-c}{w}\frac{dw}{d(1-c)}\left[\frac{s}{1-s-d}\right] = 1 \quad (8)$$

The assumption that d is nearly equal to one for most Indian firms is made, as supported by data. Hence, equation (8) reduces to:

$$\frac{1-c}{\rho}\frac{d\rho}{d(1-c)} + \frac{1-c}{w}\frac{dw}{d(1-c)}\left[\frac{s}{1-s}\right] = 1 \quad (9)$$

To estimate a framework in which we assess the impact of corporate taxes on wages and capital, we form the equations given below. Here s* is defined as $\frac{1-s}{s}$. Thus,

$$\ln w = \beta X + \gamma s^* \ln(1-c) + \varepsilon \quad (10)$$

[2] d was calculated using data from the mentioned sources in this paper. For the year 2015, the value of d was 0 for 1,093 firms; in the range of 0.00005 for 24 firms; 0.0001 to 0.0009 for 165 firms; 0.001 to 0.009 for 539 firms; 0.01 to 0.09 for 1,597 firms; 0.1–0.9 for 582 firms; and larger than 1 for 80 firms. The data for the remaining firms is missing. Hence we assume d to be negligible.

In the above equation, $\gamma = \frac{dw}{d(1-c)}\frac{1-c}{w}\frac{s}{1-s}$. This very clearly is the second half of the left-hand side of equation (9). Also, as Desai, Foley, and Hines (2007) mention, equation (10) requires that s* should not be a function of c. A parallel relationship for capital is drawn:

$$\ln \rho = \beta' X + \gamma' \ln(1-c) + \varepsilon' \qquad (11)$$

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

The relationship expressed in equation (9) carries implications for the estimated relationships (10) and (11). These two equations are not independent but must satisfy an adding-up constraint. The constraint being: $\gamma + \gamma' = 1$.

This cross-equation restriction is used to jointly estimate equations (10) and (11). As Desai, Foley, and Hines (2007) mention, the 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 (Desai, Foley, and Hines 2007). However, in our paper both the relative burdens and the efficiency effects of the corporate tax are calculated using different techniques.

The coefficients γ and γ' serve to identify the relative tax burdens on the two factors of production. We know that:

$\rho(1-\alpha)K=[Q(K,L)-wL-r\alpha K](1-c)$

hence:

$Q-wL=\frac{\rho(1-\alpha)K}{1-c} + rK.$

Also,

s=wL/Q

hence:

$$s\frac{1}{w}\frac{dw}{dln(1-c)}=\frac{wL}{Q}\frac{1}{w}\frac{dw}{dln(1-c)}=\frac{L}{Q}\frac{dw}{dln(1-c)}$$

and

$$1\text{-}s=\frac{Q-wL}{Q}\ and\ (1-s)\frac{d\rho}{d\ln(1-c)}\frac{1}{\rho}=\frac{Q-wL}{Q}\frac{d\rho}{d\ln(1-c)}\frac{1}{\rho}=(\frac{\rho(1-\alpha)K}{(1-c)Q}+\frac{rK}{Q})\frac{1}{\rho}\frac{d\rho}{d\ln(1-c)}$$

As d=rK/Q=0, we finally arrive at:

$$(1-s)\frac{d\rho}{d\ln(1-c)}\frac{1}{\rho}=\frac{\rho(1-\alpha)K}{(1-c)Q}\frac{d\rho}{d\ln(1-c)}$$

Now $\frac{\gamma}{\gamma'}=\frac{\frac{s}{1-s}\frac{1}{w}\frac{dw}{dln(1-c)}}{\frac{d\rho}{d\ln(1-c)}\frac{1}{\rho}}=\frac{\frac{L}{Q}\frac{dw}{dln(1-c)}}{\frac{(1-\alpha)K}{(1-c)Q}\frac{d\rho}{d\ln(1-c)}}=\frac{L\frac{dw}{dln(1-c)}}{\frac{K(1-\alpha)}{(1-c)}\frac{d\rho}{d\ln(1-c)}}=\frac{L\,[\frac{dw}{dln(1-c)}]}{K\,[\frac{1-\alpha}{1-c}\frac{d\rho}{d\ln(1-c)}]}$.

From the above equation, the effect of a tax change on returns to labor is given by $L\,[\frac{dw}{dln(1-c)}]$, and the effect of a tax change on returns to capital is given by $K\,[\frac{1-\alpha}{1-c}\frac{d\rho}{d\ln(1-c)}]$

Hence the above equations show 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'.

Thus, constraining the resulting estimates to sum to one, the equations provide direct estimates of the relative shares of the corporate tax burden borne by labor and by capital. The coefficients thus give the relative burdens borne by the factors of production rather than total burdens.

4. INTERPRETING DATA

Our data covers the period 2000–15 and includes 5,666 Indian corporate (BSE and NSE listed) firms. The main source of the data is the Prowess IQ database provided by the Centre for Monitoring Indian Economy (CMIE), one of the most reliable sources for data on Indian corporate firms. In the general equilibrium framework, capital is the dependent variable in the first equation and labor is the dependent variable in the second equation. The most important independent variable is the effective corporate tax of the firms. The natural log of all variables has been used in the regression models. Three proxies are used for the capital variable, namely return on equity (ROE), return on debt (ROD), and gross fixed assets (GFA). ROD is the interest rate paid to the debt holders by the firm and is calculated by dividing interest paid by the sum of the long-term and short-term borrowing of the firms, with all figures in millions (data for long-term and short-term borrowing was available only from 2011–15, therefore the analysis for this indicator is restricted). ROE is the rate of return received by the shareholders from the profits of the firm after taxes have been paid. It is computed as the ratio of profit after tax to the average net worth, with both values in millions. The GFA of the firm were directly available and are measured in millions. The variable used for calculating the impact of the corporate tax on labor is the wages paid to the laborers by the firms. "Compensation to employees" is used as a proxy for wages in this paper.

The effective corporate tax to which the firms are subjected is the measure "corporate tax/profit before tax," available directly from the database; labor share in total output (s) is calculated by dividing the compensation to employees by the total income of the firms (wL/Q). For the calculation of total factor productivity (TFP), the proxy for revenue is the "total income" of the firms, the power variable is the "power, fuel, and water charges" incurred by the firms, and the raw materials variable is the "raw material costs" to the firms. Moreover, we use all supply-side variables that affect a corporate firm rather than demand-side variables. For example, we do not include education as an explanatory variable in our analysis, though it is known to have a significant impact on the wages of labor. We wanted to analyze the influence of firm-specific variables on the corporate firms' behavior.

4.1 Total Factor Productivity (TFP)

Researchers have tried to test the positive correlation between input levels and the unobserved firm-specific productivity shocks in the estimation of a production function. Profit-maximizing firms respond to positive productivity shocks by expanding output, which requires additional inputs. Negative shocks lead firms to decrease output, which results in decreasing input usage. Moreover, TFP helps in evaluating the implications of the policy measures undertaken on the performance of the firm. In order to estimate productivity, ordinary least squares (OLS), fixed effects, or the recent semi-parametric method of Levinsohn and Petrin (2003) can be used. In the case of OLS, though it is difficult to obtain reliable measures, productivity can be measured as the residual of a production function.

Consider a Cobb–Douglas production function:

$$\mathrm{Y_{it}} = \mathrm{A_{it}K_{it}^{\beta k}L_{it}^{\beta l}\,M_{it}^{\beta m}} \tag{12}$$

Where Y_{it} is the physical output of firm i in period t; K_{it}, L_{it}, and M_{it} are inputs of capital, labor, and materials, respectively; and A_{it} is the Hicksian neutral efficiency level of firm i in period t. Taking natural logs of equation (1) results in a linear production function,

$$\mathrm{y_{it}} = \beta_0 + \beta_k \mathrm{k_{it}} + \beta_l \mathrm{l_{it}} + \beta_m \mathrm{m_{it}} + \varepsilon_{it}$$

where lower-case letters refer to natural logarithms and

$$\ln(\mathrm{A_{it}}) = \beta_0 + \varepsilon_{it}$$

where β_0 measures the mean efficiency level across firms and over time; and ε_{it} is the time- and producer-specific deviation from that mean, which can then be further decomposed into an observable and unobservable component. This results in the following equation:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + v_{it} + u_{it}^{q} \tag{13}$$

where $\omega_{it} = \beta_0 + v_{it}$ represents the firm-level productivity and u_{it}^q is the independent and identically distributed component representing unexpected deviations from the mean due to measurement error, unexpected delays, or other external circumstances. Estimating equation (2), we solve for ω_{it}. Estimated productivity can then be calculated as follows:

$$\widehat{\omega_{it}} = \widehat{v_{it}} + \widehat{\beta_0} = y_{it} - \widehat{\beta_k}\, k_{it} - \widehat{\beta_l}\, l_{it} - \widehat{\beta_m}\, m_{it}$$

Equation (2) can be estimated using OLS. However, under this method inputs of the firm in the production function should be exogenous or be independent of the efficiency level of the firm. Marschak and Andrews (1944) mention that inputs in the production function are not independently chosen, but rather determined by the characteristics of the firm, including its efficiency. This "endogeneity of inputs," or simultaneity bias, is defined as the correlation between the level of inputs chosen and unobserved productivity shocks (De Loecker 2007). Intuitively, simultaneity arises from the fact that the choice of inputs is not under the control of the econometrician, but determined by the individual firms' choices (Griliches and Mairesse 1995). If the firm has prior knowledge of ω_{it} at the time input decisions are made, endogeneity arises because input quantities will be (partly) determined by prior beliefs about labor productivity (Olley and Pakes 1996). Specifically, a positive productivity shock will likely lead to increased variable input usage leading to an upward bias in the input coefficients for labor and materials (De Loecker 2007). In the presence of many inputs and simultaneity issues, it is generally impossible to determine the direction of the bias in the capital coefficient. Hence, an OLS estimation that assumes no correlation between input demands and the unobserved productivity term will give inconsistent estimates of the input coefficients. However, the fact holds that firm productivity can be both contemporaneously and serially correlated with inputs. To this endogeneity problem, there exists a standard solution, which is to compute a fixed effects, or "within," estimator that uses deviations from firm-specific means in OLS estimation. This checks the simultaneity problem (as in OLS) provided the firm's productivity is time invariant. By assuming that ω_{it} (equation [2]) is plant specific, but time invariant, it is possible to estimate the equation using a fixed effects estimator (Pavcnik 2000; Levinsohn and Petrin 2003). The estimating equation is as follows:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + v_{it} + u_{it}^q$$

Equation (2) can be estimated in levels using a least-square dummy variable estimator (i.e., including firm-specific effects) or in first (or mean) differences. Provided unobserved productivity (ω_{it}) does not vary over time, estimation of the above equation will result in consistent coefficients for labor, capital, and materials. The fixed effects estimator overcomes the simultaneity bias that OLS can't correct for. Also given that exit decisions are determined by the time-invariant, firm-specific effects ω_i, the fixed effects estimator also eliminates the selection bias caused by endogenous exit in the sample.

In spite of these benefits, this approach has various drawbacks. Productivity is unlikely to remain constant over long periods of time, especially during periods of significant policy and structural changes. The constant flux in firm decisions regarding input use and firm entry and exit suggest a more general stochastic process for the unobserved productivity term than that specified by fixed effects. Hence, the fixed effects estimator will at best remove the effects of the time-invariant component of the productivity variable, but will still lead to inconsistent estimates. Also, Olley and Pakes (1996) constructed a fixed effects model on the balanced and unbalanced sample and found large differences between the two sets of coefficients, suggesting the assumptions underlying the model are invalid. Finally, the fixed effects estimator imposes restrictions on the exogeneity of the inputs, conditional on firm heterogeneity. In economic terms this means that inputs cannot be chosen in reaction to productivity shocks, an assumption that is not likely to hold in practice (Wooldridge 2009). Further work in this field comes from Olley and Pakes (1996) who developed an estimator that uses investment as a proxy for these unobservable shocks. However, an improvement over the Olley–Pakes method is that of Levinsohn and Petrin (2003), where instead of investment, intermediate inputs are used as a proxy. Levinsohn and Petrin (2003) illustrate that for a two-input production function where labor is the only freely variable input and capital is quasi-fixed, the capital coefficient will be biased downward if a positive correlation exists between labor and capital. Citing reasons for using intermediate inputs over investment (as used by Olley and Pakes), Levinsohn and Petrin (2003) suggest that firm-level datasets indicate investment is very lumpy (that is, there are substantial adjustment costs). If this is true, the investment proxy may not respond smoothly to the productivity shock, violating the consistency condition. Also, the investment proxy is only valid for plants reporting nonzero investment.

Another benefit is that if it is less costly to adjust the intermediate input, it may respond more fully to the entire productivity term than it does to the investment term. Also an intermediate input provides a simple link between the estimation strategy and the economic theory, primarily because intermediate inputs are not typically state variables. Levinsohn and Petrin (2003) develop this link, showing the conditions that must hold if intermediate inputs are to be a valid proxy for the productivity shock. In addition, they derive the expected directions of bias on the OLS estimates relative to Levinsohn and Petrin's intermediate input approach when simultaneity exists. Using data from Chilean manufacturing industries, Levinshon and Petrin prove that significant differences exist between OLS and their approach that are exactly consistent with simultaneity.

The Levinsohn–Petrin approach assumes a Cobb–Douglas production function and it follows as:

$$y_t = \beta_0 + \beta_k k_t + \beta_l l_t + \beta_m m_t + \omega_t + \eta_t$$

where y_t is the logarithm of the firm's output, most often measured as gross revenue or value added; l_t and m_t are the logarithm of the freely variable inputs labor and the intermediate input; and k_t is the logarithm of the state variable capital.

The error term has two components: the transmitted productivity component (given as ω_t) and η_t (an error term that is uncorrelated with input choices). The key difference between ω_t and η_t is that the former is a state variable and, hence it impacts the firm's decision rules. It is not observed by the econometrician, and it can impact the choices of inputs, leading to the well-known simultaneity problem in production function estimation. Estimators ignoring the correlation between inputs and this unobservable factor (like OLS) will yield inconsistent results.

Demand for the intermediate input m_t is assumed to depend on the firm's state variables k_t and ω_t:

$$m_t = m_t(k_t, \omega_t)$$

Levinsohn and Petrin (2003) show that the demand function is monotonically increasing in ω_t, making assumptions about the firm's production technology. This allows inversion of the intermediate demand function, so ω_t can be written as a function of k_t and m_t,

$$\omega_t = \omega_t(k_t, m_t)$$

The unobservable productivity term is now expressed solely as a function of two observed inputs.

A final identification restriction follows Olley and Pakes (1996). Levinsohn and Petrin (2003) assume that productivity is governed by a first-order Markov process,

$$\omega_t = E[\omega_t \mathrm{I} \omega_{t-1}] + \xi_t$$

where ξ_t is an innovation to productivity that is uncorrelated with k_t, but not necessarily with l_t, which is part of the source of the simultaneity problem. Productivity in this method is calculated in two stages. In the gross revenue case (y_t is the gross revenue), let:

$$y_t = \beta_0 + \beta_k k_t + \beta_l l_t + \beta_m m_t + \omega_t + \eta_t$$
$$y_t = \beta_l l_t + \varphi(k_t, m_t) + \eta_t$$

where

$$\varphi(k_t, m_t) = \beta_0 + \beta_k k_t + \beta_m m_t + \omega_t(k_t, m_t)$$

Substituting a third-order polynomial approximation in k_t and m_t in place of $\varphi(k_t, m_t)$ makes it possible to consistently estimate parameters of the revenue equation using OLS as:

$$y_t = \delta_0 + \beta_l l_t + \sum_{i=0}^{3}\sum_{j=0}^{3-i} \delta_{ij}\, k_t^i m_t^j + \eta_t$$

where β_0 is not separately identified from the intercept of $\varphi(k_t, m_t)$. This completes the first stage of the estimation routine from Levinsohn and Petrin (2003), from which an estimate of β_l and an estimate of φ_t are available.

The second stage of the procedure identifies the coefficient β_k. It begins by computing the estimated value for φ_t using $\widehat{\varphi_t} = \widehat{y_t}$ - $\widehat{\beta_l}\, l_t$

$$\widehat{\varphi_t} = \widehat{\delta_0} + \sum_{i=0}^{3}\sum_{j=0}^{3-i} \widehat{\delta_{ij}}\, k_t^i m_t^j - \widehat{\beta_l}\, l_t$$

For any candidate values β_k^* and β_m^* (for β_k and β_m), we estimate $\widehat{\omega_t}$ using $\widehat{\omega_t} = \widehat{\varphi_t} - \beta_k^* k_t - \beta_m^* m_t$.

Using these values, a consistent (nonparametric) approximation to E[ωt|ωt−1] is given by the predicted values from the regression:

$$\widehat{\omega_t} = \gamma_0 + \gamma_1 \omega_{t-1} + \gamma_2 \omega_{t-1}^2 + \gamma_3 \omega_{t-1}^3 + \epsilon_t$$

which Levinsohn and Petrin (2003) call $E[\omega_t \mathrm{I} \omega_{t-1}]$.

Then the residual for (β_k^*, β_m^*) is computed as:

$$\widehat{\eta_t + \xi_t} = y_t - \widehat{\beta_l}\, l_t - \beta_k^* k_t - \beta_m^* m_t - E[\omega_t | \widehat{\omega_{t-1}}]$$

$$E[\eta_t + \xi_t I m_{t-1}]=0$$

Thus with $Z_t = (k_t, m_{t-1})$,

$$min_{(\beta_k^* \beta_m^*)} \sum_h \left\{ \sum_t \widehat{(\eta t + \xi t}) \, Z_{ht} \right\}^2$$

Here one redefines $Z_t = (k_t, m_{t-1}, l_{t-1}, k_{t-1}, m_{t-2})$. $\beta_k \; and \; \beta_m$ are then defined as the solution to:

$$min_{(\beta_k^* \beta_m^*)} \sum_h \left\{ \sum_t \widehat{(\eta t + \xi t}) \, Z_{ht} \right\}^2$$

The variables used for the calculation are log of total income (used to represent gross revenue), log of GFA, log of ROE for capital, log of compensation to the employees for labor, and log of expenses on power and fuel for the inputs.

We now compare the results from the OLS and Levinsohn–Petrin methods. According to Levinsohn and Petrin (2003), in case of the parameters for freely variable inputs (power and labor) the OLS estimates should be greater than the Levinsohn–Petrin estimates. However, regarding the GFA variable, it doesn't hold in the case of power but holds in the case of ROE well. We also find the labor coefficient from the OLS regression to be biased upwards due to the endogeneity of input choices, since OLS does not control for firm-specific differences in productivity, which has been corrected in the Levinsohn–Petrin method.

The bias of the capital coefficient depends on the degree of correlation among the inputs and the productivity shocks. In this particular application, the OLS estimate is less than the Levinsohn–Petrin estimate. The capital coefficient in OLS is biased downwards. If capital responds to the transmitted productivity shock, its coefficient would be biased upwards. However, if capital is not correlated with this period's transmitted shock (but variable inputs are), or capital is more strongly correlated with the productivity shock than the variable inputs are, the OLS estimate on capital is likely to be biased downward.

Table 1: GFA and Wages Model

Parameters	Model		
	OLS	FE	LP
log(power)	0.2051	0.2531	0.4303
	(0.0035)	(0.0048)	(0.0461)
log(GFA)	0.1658	0.0593	0.2238
	(0.0045)	(0.0052)	(0.0428)
log(wage)	0.6004	0.6219	0.5859
	(0.004)	(0.0056)	(0.0129)

Source: Author's computations

Table 2: ROE and Wages Model

Parameters	Model		
	OLS	FE	LP
log(power)	0.2438	0.2517	0.1987
	(0.0034)	(0.0047)	(0.1284)
log(ROE)	0.0239	0.0603	0.0944
	(0.0039)	(0.0024)	(0.0169)
log(wage)	0.6657	0.6486	0.6575
	(0.004)	(0.0051)	(0.0123)

Source: Author's computations

Table 3: ROD and Wages Model

Parameters	Model		
	OLS	FE	LP
log(power)	0.232	0.2323	0.7444
	(0.0059)	(0.0098)	(0.2185)
log(ROD)	0.0443	0.0307	0.0416
	(0.0057)	(0.0051)	(0.0225)
log(wage)	0.6588	0.6029	0.6561
	(0.0074)	(0.013)	(0.014)

Source: Author's computations

Levinsohn and Petrin (2003) pointed out a reason for this is that if capital positively covariates with labor but is uncorrelated with the productivity shock, or if this correlation is much weaker than that between the variable inputs and productivity, then the OLS estimate on capital is likely to be biased downwards. The fixed effects estimates differ quite substantially from both the OLS and Levinsohn–Petrin estimates (tables 1–3). One explanation is that the magnitude of each firm's productivity shock varies over time and is not a constant fixed effect.

4.2 Descriptive Statistics and Correlation Matrix

The descriptive statistics of the variables under consideration are given in table 4. The correlation coefficient between wage (log of wage) and the corporate tax, going by the general equilibrium framework (s*log(1-c)), is positive and significant, as expected (table 5). The value of the correlation coefficient stands at 0.0558.

Table 4: Descriptive Statistics

Variable	Mean	Standard Deviation
log(wage)	2.68	2.73
log(ROE)	-2.54	1.60
log(GFA)	4.98	2.76
log(1- tax rate)	-0.11	0.21
((1-s)/s)LN(1-tax rate)	-7.94	72.63
log(revenue)	5.18	3.13
log(raw materials)	5.47	2.57
log(power)	2.39	2.64

Source: Author's computations

Table 5: Correlation Matrix

	Ln (ROE)	Ln (GFA)	Ln (wage)	Ln (1-c)	s*ln(1-c)	Ln (revenue)	Ln (power)	Ln (raw material)
Ln(ROE)	1.0000							
Ln(GFA)	0.3150	1.0000						
	(0.0000)							
Ln (wage)	0.3303	0.8361	1.0000					
	(0.0000)	(0.0000)						
Ln (1-c)	0.0939	-0.0807	-0.1610	1.0000				
	(0.0000)	(0.0000)	(0.0000)					
s* ln(1-c)	0.0412	0.0411	0.0558	0.1486	1.0000			
	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
Ln (revenue)	0.3366	0.8122	0.8928	-0.1860	-0.0608	1.0000		
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)			
Ln (power)	0.2325	0.8308	0.7922	-0.0682	0.0342	0.8004	1.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
Ln (raw material)	0.1439	0.7131	0.7475	-0.1724	-0.0852	0.8753	0.7433	1.000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	

Note: "Ln" refers to log.
Source: Author's computations

Similarly the correlation coefficient between ROE (ln ROE) and the corporate tax going by the general equilibrium framework (ln(1-c)) is 0.0939, which is highly positive and significant, as expected. However the correlation coefficient between GFA (Ln(GFA)) and ln (1-c) is negative, which is perverse to our expectations. There is no possible explanation for such a finding. One can only guess if corporate taxes affect the lagged values (t-1 period) of fixed assets rather than the current fixed assets (t period).

4.3 Stylized Facts

Prima facie, the relationship between capital and labor with corporate tax should be negative. With the imposition of the corporate tax, the firms may shift their capital to low-tax countries, leading to a lower capital-to-labor ratio, which further affects the marginal product of labor and hence lower wages. Thus with an increase in the corporate tax, the burden on capital and labor increases, leading to lower amounts of capital and labor being employed by firms. However, in the general equilibrium framework we use here, the independent variables used are log forms of one minus corporate tax. Hence, the expected signs of the coefficients should be positive. We test for this in section five. All three proxies for capital (ROE, ROD, and GFA) and wages (the proxy for labor) should thus have a positive coefficient. Higher power and fuel charges must lead to more labor and capital being employed by the firm in order to produce efficiently. Similarly, higher raw material costs will simultaneously lead to more investment in capital and labor by the firms.

An increase in the TFP should also lead to lower usage of capital and labor by the firms. In the neoclassical model of growth, wherein production requires two main components—inputs (X), such as labor and capital, and knowledge (A), considering that knowledge has a direct effect on TFP—the more the firm has of A and X, the more output it can produce. Continuing in the neoclassical tradition, in the transition from one equilibrium to another, growth may stem from a change in both A and X. However, at some (marginal) point it no longer pays off to increase X and, in the long run, output growth depends entirely on knowledge creation or technological progress. Hence higher TFP is expected to decrease the capital and labor used by the firms.

5. ECONOMETRIC MODELING

We used the seemingly unrelated regression (SUR) technique, which is used to capture the efficiency due to a correlation of disturbances across equations. The correlation between equations maybe due to firm-specific attributes that affect the capital and labor in the regression equations used above. The regression coefficients are to be estimated efficiently, however classical least squares applied equation by equation may not yield efficient coefficient estimators. Hence, SUR is a procedure in which the regression coefficients in all equations are estimated simultaneously. Aitken's generalized least squares is applied to the whole system of equations and yields coefficient estimators at least asymptotically more efficient than single-equation least squares estimators. The results in table 6 summarize the effect of corporate taxes on both capital and labor using the SUR technique, wherein the sum of the corporate tax coefficients of both capital and labor are restricted to one, as suggested by our analytical framework. The labor and capital regressions aren't separate regressions and therefore are components of a single regression. The coefficients explain the relative burden borne by capital and labor due to the imposition of a corporate tax. Three proxies (namely GFA, ROE, and ROD) have been used for capital, along with wages as a proxy for the labor impact. The regression results are as reported below.

5.1 SUR for GFA and Wages

In the first regression, the estimated tax coefficient is 0.9988, which explains that 99 percent of the burden of corporate taxes falls on capital. The positive significant coefficient implies that higher tax rates lead to lower asset formation by firms. The tax coefficient in the labor equation is 0.0012, which implies that 0.12 percent of the burden falls on labor (table 6).

The second set of equations now adds TFP to the regressions. We use TFP obtained from both fixed effects and the Levinsohn–Petrin 2003 estimation methods. Controlling for TFP, the burden on capital reduces only marginally and is around 99 percent. The labor burden increases marginally from 0.0012 to 0.0071 in case of fixed effects TFP.

In the third set of regressions we control for power and fuel charges and raw material costs individually and then together. The results show that the relative burden on labor is now 0.86 percent when controlled for both power and raw material charges. The tax coefficient on capital is 0.9914, which means 99 percent of the burden of a corporate tax is on capital only (table 6), hence, the burden of a corporate tax is largely on capital in Indian firms.

Table 6: SUR Results for GFA and Wages

Dependent Variable/ Independent Variable	Constant	((1-s)/s)* LN(1-Tax Rate)	LN(1-Tax Rate)	LN(Power & Fuel)	LN(Raw Material)	LN(TFP_{fe})	LN(TFP_{levpet})	Obs.
LN(GFA)	5.3509 (0.0108)		0.9988* (0.0001)					62139
LN(wage)	2.9075 (0.0106)	0.0012 * (0.0001)						62139
LN(GFA)	0.3137 (0.0179)		0.9929* (0.0002)			0.9085* (0.0026)		38103
LN(wage)	-3.0952 (0.014)	0.0071* (0.0002)				1.0331* (0.002)		38103
LN(GFA)	6.000 (0.0098)		0.9968* (0.0002)				-0.0006* (0.000)	50225
LN(wage)	3.5225 (0.01)	0.0032* (0.0002)					-0.0003* (0.000)	50225
LN(GFA)	4.2773 (0.0075)		0.9974* (0.0001)	0.6993* (0.0021)				50226
LN(wage)	1.8622 (0.0084)	0.0026* (0.0002)		0.6742* (0.0023)				50226
LN(GFA)	3.1438 (0.017)		0.9932* (0.0002)		0.5789* (0.0028)			39631
LN(wage)	0.2045 (0.017)	0.0068* (0.0002)			0.6439* (0.0028)			39631
LN(GFA)	3.6163 (0.0139)		0.9914* (0.0002)	0.5508* (0.0035)	0.1896* (0.0033)			38103
LN(wage)	0.6249 (0.0158)	0.0086* (0.0002)		0.446* (0.004)	0.3247* (0.0038)			38103

Note: In all the tables * means significant at the 1 percent level, ** significant at the 5 percent level, and *** significant at the 10 percent level.
Source: Author's computations

5.2 SUR for ROE and Wages

Treating ROE as the proxy for capital, the first set of regressions show that 99.75 percent of the burden falls on capital, and labor bears 0.25 percent of the burden of a corporate tax. In the next set of regressions the tax coefficient on capital falls to 99.33 percent and the burden on labor increases to 0.67 percent. Controlling for power and raw material charges, we find that 99 percent of the burden still falls on capital while labor bears only 1 percent burden of the corporate taxes (table 7).

Table 7: SUR Results for ROE and Wages

Dependent Variable/ Independent Variable	Constant	((1-s)/s)*LN(1-Tax Rate)	LN (1-Tax Rate)	LN (power & fuel)	LN (raw material)	LN (TFP_{fe})	LN (TFP_{levpet})	Obs.
LN(ROE)	-2.3137 (0.0072)		0.9975* (0.0001)					46865
LN(wage)	3.2029 (0.0122)	0.0025* (0.0001)						46865
LN(ROE)	-3.091 (0.0306)		0.9933* (0.0001)			0.1546* (0.0042)		29350
LN(wage)	-3.3590 (0.0159)	0.0067* (0.0001)				1.0616* (0.0022)		29350
LN(ROE)	-2.1255 (0.0076)		0.9949* (0.0003)				-0.0001* (0.000)	38242
LN(wage)	3.7827 (0.0117)	0.0051* (0.0003)					-0.00003 (0.0117)	38242
LN(ROE)	-2.4819 (0.0102)		0.9971* (0.0002)	0.1311* (0.0027)				38242
LN(wage)	2.00 (0.0102)	0.0029* (0.0002)		0.6637* (0.0027)				38242
LN(ROE)	-2.588 (0.0204)		0.9876* (0.0003)		0.0939* (0.0032)			30385
LN(wage)	0.2584 (0.021)	0.0124* (0.0003)			0.6502* (0.0033)			30385
LN(ROE)	-2.5096 (0.0213)		0.99* (0.0003)	.0410* (0.005)	0.0616* (0.0048)			29350
LN(wage)	0.6652 (0.0193)	0.01* (0.0003)		0.4457* (0.0045)	0.3292* (0.0044)			29350

Source: Author's computations

5.3 SUR Results for ROD and Wages

The results for ROD reported below are for the time period 2011–15 only due to unavailability of data. The same results, as above, are obtained with ROD as the dependent variable. In the first set of regressions, 99.57 percent of the burden is borne by capital while only 0.43 percent of the burden is borne by labor. Controlling for power and raw material charges, the coefficient of corporate tax for labor increases to 0.97 percent, while the capital burden remains at 99 percent (table 8).

Table 8: SUR Results for ROD and Wages

Dependent Variable/ Independent Variable	Constant	((1-s)/s)* LN(1-tax rate)	LN(1-tax rate)	LN(power & fuel)	LN(raw material)	LN(TFP_{fe})	LN (TFP_{levpet})	Obs.
LN(interest rate paid on debt)	-2.2017 (0.0156)		0.9957* (0.0003)					13570
LN(wage)	4.2299 (0.02)	0.0043* (0.0003)						13570
LN(interest rate paid on debt)	-4.825 (0.113)		0.9998* (0.0001)			1.364* (0.0575)		12348
LN(wage)	-10.0847 (0.0399)	0.0002* (0.0001)				7.4690* (0.0202)		12348
LN(interest rate paid on debt)	-1.9675 (0.0241)		1.0018* (0.0003)				-0.101* (0.009)	12347
LN(wage)	5.9392 (0.023)	-0.0018* (0.0003)					-0.7549* (0.009)	12347
LN(interest rate paid on debt)	-2.4867 (0.025)		0.9975* (0.0002)	0.0969* (0.0059)				12348
LN(wage)	2.4552 (0.019)	0.0025* (0.0002)		0.6178* (0.0045)				12348
LN(Interest rate paid on debt)	-2.9198* (0.0493)		0.9893* (0.0004)		0.121* (0.0071)			9852
LN(wage)	0.8222 (.0396493)	0.0107* (0.0004)			0.6034* (0.0057)			9852
LN(interest rate paid on debt)	-2.8982 (0.0519)		0.9903* (0.0004)	0.0310* (0.0106)	0.0992* (.0105202)			9593
LN(wage)	1.151 (0.035)	0.0097* (0.0004)		0.4341* (0.0072)	0.2927* (0.0072)			9593

Source: Author's computations

5.4 Dynamic Estimates

To estimate the effect of corporate taxes on capital and labor, we use the one-step generalized method of moments (GMM) by Arellano and Bond (1991) for the estimation of dynamic panel datasets, as we have large cross-sectional and small time-series units. The two regression equations are now treated as separate equations and give the efficiency effects of corporate taxation. The dynamic relationship is characterized by the inclusion of a lagged dependent variable among the regressors.

Suppose we consider the equation:

$$y_{it} = \delta y_{i,t-1} + \beta x'_{it} + u_{it}$$

where i=1…N and t=1….T. Also suppose $u_{it} = \mu_{it} + \vartheta_{it}$, where $\mu_{it} \sim IID(0, \sigma_u^2)$ and $\vartheta_{it} \sim IID(0, \sigma_\vartheta^2)$ are independent of each other.

The inclusion of the lagged independent variable renders the OLS estimates biased and inconsistent, even if the ϑ_{it} are not serially correlated. This is due to the correlation between the lagged dependent variable and the error term. In case of the fixed effects estimator, the within transformation wipes out μ_{it} but $y_{i,t-1}$ is still correlated with $\overline{\vartheta_i}$ by construction. Hence the fixed effects estimator will be biased and consistent only when $\rightarrow \infty$. Therefore, when N is large and T fixed, the within estimator is biased and inconsistent. The random effects estimator will also be biased in a dynamic panel data model.

A first difference transformation of the model was suggested by Anderson and Hsiao (1981). This first differencing was used to get rid of μ_i and then the instrumental variable (IV) estimation procedure would be used; however, the above method leads to consistent but inefficient estimates of the parameters. Arellano and Bond (1991) proposed a GMM procedure that is more efficient than the Anderson and Hsiao (1982) estimator. The methodology used by Arellano and Bond (explained below) argued that additional instruments can be obtained if the orthogonality conditions between the lagged values of y_{it} and the disturbances ϑ_{it} are used. Their methodology can be illustrated with the help of a simple autoregressive model with no regressors:

$$y_{it} = \delta y_{i,t-1} + u_{it}$$

Where i=1…N, t=1….T, and $u_{it} = \mu_{it} + \vartheta_{it}$, with $\mu_{it} \sim IID(0, \sigma_u^2)$ and $\vartheta_{it} \sim IID(0, \sigma_\vartheta^2)$ independent of each other and among themselves.

In order to get consistent estimates, the individual effects are first eliminated by first differencing the equation to obtain:

$$y_{it} - y_{i,t-1} = \delta(y_{i,t-1} - y_{i,t-2}) + (\vartheta_{it} - \vartheta_{i,t-1})$$

When t=3, we have:

$$y_{i3} - y_{i2} = \delta(y_{i2} - y_{i1}) + (\vartheta_{i3} - \vartheta_{i2})$$

In this case, y_{i1} is a valid instrument, since it is highly correlated with $(y_{i2} - y_{i1})$ and not correlated with $(\vartheta_{i3} - \vartheta_{i2})$ as long as ϑ_{it} are not serially correlated.

For t=4,

$$y_{i4} - y_{i3} = \delta(y_{i3} - y_{i2}) + (\vartheta_{i4} - \vartheta_{i3})$$

In this case, y_{i2} as well as y_{i1} are valid instruments for $(y_{i3} - y_{i2})$, since both y_{i2} and y_{i1} are not correlated with $(\vartheta_{i4} - \vartheta_{i3})$. Adding valid instruments in this fashion for period T, the set of valid instruments becomes $(y_{i1}, y_{i2} \dots \dots . y_{i,T-2})$.

Let w be the matrix of all instruments of individual i, so pre-multiplying the difference equation in the vector form with the matrix of all instruments gives:

$$W'\Delta y = W'(\Delta y_{-1})\delta + W'\Delta\vartheta$$

Now, if we perform generalized least squares on this model, we will get the Arellano and Bond (1991) one-step consistent GMM estimator.

The Arellano–Bond estimation is done for both capital and labor as dependent variables. The two regressions are now treated as two different equations and hence give the efficiency effects of the corporate tax. The coefficients now explain the effects of an increase in the corporate tax on capital and labor.

In the first set of regressions, the coefficient of one minus corporate tax is insignificant and hence it is inferred that in this bivariate model, GFA are not affected by corporate taxes. However, the coefficient turns significant as we control for wages, power and fuel charges, raw material charges, and TFP. The coefficients for corporate tax are positive and significant, as expected. In the last set of regressions, an increase in the corporate tax by 1 percent will lead to a fall in the GFA by 0.0534 percent (table 9).

Table 9: Dynamic Estimates for Capital, with GFA as Proxy for Capital

Dependent Variable/ Independent Variable	Constant	Lagged GFA	LN(1-tax Rate)	LN (wage)	LN (power & fuel)	LN(raw material)	LN(TFP_{fe})	LN (TFP_{levpet})	Obs.
LN(GFA)	0.6956	0.876*	0.0118						54076
	(0.0423)	(0.0084)	(0.0142)						
LN(GFA)	1.0941	0.7334*	0.0285**	0.1269*					50580
	(0.0418)	(0.0101)	(0.0127)	(0.0056)					
LN(GFA)	1.059	0.8042*	0.04*		0.0718*				40626
	(0.0336)	(0.0068)	(0.0121)		(0.0046)				
LN(GFA)	0.97	0.815*	0.0556*			0.0489*			31968
	(0.0317)	(0.0059)	(0.0127)			(0.0032)			
LN(GFA)	1.028	0.7918*	0.0513*		0.0568*	0.0343*			30699
	(0.0331)	(0.0066)	(0.0121)		(0.0054)	(0.0037)			
LN(GFA)	0.2503	0.8021*	0.0522*				0.5836*		30665
	(0.0439)	(0.006)	(0.0120)				(0.0285)		
LN(GFA)	1.2925	0.8242*	0.0301**					-0.0924*	40358
	(0.0354)	(0.0056)	(0.0121)					(0.0043)	
LN(GFA)	1.1201	0.7591*	0.0534*	0.0421*	0.0484*	0.0301*			30665
	(0.0393)	(0.0095)	(0.0117)	(0.0082)	(0.0054)	(0.0038)			

Note: In all the tables * means significant at the 1 percent level, ** significant at the 5 percent level, and *** significant at the 10 percent level.
Source: Author's computations

In the first regression of the dynamic panel, with the log of one minus corporate tax as the independent variable, as the corporate tax rate increases by 1 percent, the ROE falls by 0.784 percent (table 10). The coefficient is positive and highly significant in the bivariate model itself. As we control for other variables, the coefficient of corporate taxes falls. In the next regression, with power, raw material, and wages as the independent variables, an increase in the corporate tax rate by 1 percent leads to a fall in the ROE by 0.62 percent. The coefficient is highly significant: considering other explanatory variables, an increase in wages by 1 percent leads to a fall in equity returns by 0.2192 percent. Though the coefficient for power is negative, it is insignificant. The raw material charges are seen to have a positive impact on equity returns. This may occur because as investment in raw materials increases, output and profitability also increase. Increasing profits lead to increasing returns to equity holders.

Table 10: Dynamic Estimates for Capital, with ROE as Capital Proxy

Dependent Variable/ Independent Variable	Constant	Lagged ROE	LN(1-tax rate)	LN (wage)	LN(power & fuel)	LN(raw material)	LN(TFP_{fe})	LN (TFP_{levpet})	Obs.
LN(ROE)	-1.669 (0.0325)	0.2925* (0.0128)	0.784* (0.0346)						31589
LN(ROE)	-1.717 (0.0542)	0.3007* (0.0129)	0.7961* (0.0346)	0.0286* (0.0113)					30251
LN(ROE)	-1.495 (0.0486)	0.3073* (0.0133)	0.7357* (0.0373)		-0.0056 (0.0119)				25242
LN(ROE)	-2.016 (0.0759)	0.2667* (0.0143)	0.6602* (0.0416)			0.0789* (0.0106)			20113
LN(ROE)	-1.895 (0.0816)	0.2655* (0.0146)	0.6545 (0.0424)		-0.116* (0.0176)	0.1258* (0.0142)			19483
LN(ROE)	-3.652 (0.1972)	0.2409* (0.0143)	0.6764* (0.0418)				1.0706* (0.0978)		19471
LN(ROE)	-1.0018 (0.0832)	0.3127* (0.0133)	0.7291* (0.0374)					-0.1280* (0.0188)	25143
LN(ROE)	-1.683 (0.0864)	0.2696* (0.0146)	0.6207* (0.0427)	-0.2192* (0.0235)	-0.0043 (0.0209)	0.1787* (0.0152)			19471

Note: In all the tables * means significant at the 1 percent level, ** significant at the 5 percent level, and *** significant at the 10 percent level.
Source: Author's computations

In the ROD and corporate taxes scenario, the analysis for the relationship between the interest rate paid to debt holders by the firm and the corporate taxes is limited to the period 2011–15 due to the unavailability of data for the remaining years. In the bivariate model (with the log of one minus corporate tax as the independent variable) the coefficient of the corporate tax rate is negative but insignificant. Controlling for other factors, the coefficient of corporate taxes turns positive but continues to remain insignificant (table 11). Hence we conclude that the corporate taxes do not affect the interest rate paid on the debt incurred by the firm. Wages and power and fuel charges may lead to a higher return to debt holders due to higher profitability by the employment of these factors.

Table 11: Dynamic Estimation for Capital, ROD as Capital Proxy

Dependent Variable/ Independent Variable	Constant	Lagged ROD	LN(1-tax rate)	Ln (wage)	LN(power & fuel)	LN(raw material)	LN (TFP_{fe})	LN (TFP_{levpet})	Obs.
LN(interest rate paid on debt)	-1.711 (0.0816)	0.2702* (0.0336)	-0.0718 (0.0491)						7047
LN(interest rate paid on debt)	-2.836 (0.1592)	0.2387* (0.0338)	-0.064 (0.0482)	0.2424* (0.0279)					7000
LN(interest rate paid on debt)	-2.3271 (0.1176)	0.2736* (0.0353)	-0.0557 (0.0503)		0.188* (0.0233)				6484
LN(interest rate paid on debt)	-2.114 (0.1607)	0.3416* (0.0426)	0.016 (0.0577)			0.0947* (0.0193)			5250
LN(interest rate paid on debt)	-2.437 (0.1743)	0.3386* (0.0427)	0.0103 (0.0584)	0.1541* (0.0323)	0.0486** (0.0236)				5123
LN(interest rate paid on debt)	-6.1491 (0.529)	0.3318* (0.0426)	0.0156 (0.0581)				2.2985 * (0.2542)		5121
LN(interest rate paid on debt)	-1.504 (0.0898)	0.2849* (0.0363)	-0.0604 (0.0508)					-0.0814* (0.0238)	6469
LN(interest rate paid on debt)	-3.1747 (0.2391)	0.2942* (0.0435)	0.0129 (0.0572)	0.2075* (0.0488)	0.1005* (0.0346)	0.0266 (0.024)			5121

Note: In all the tables * means significant at the 1 percent level, ** significant at the 5 percent level, and *** significant at the 10 percent level.
Source: Author's computations

In the wages and corporate taxes scenario (table 12), we present the results of the impact of corporate taxes on wages. In the bivariate model, the coefficient of one minus corporate taxes to wages is positive and significant. A 1 percent decrease in one minus corporate taxes (effectively an increase in the corporate tax rate) will lead to a 0.0004 percent decrease in wages. We control for all the capital proxies individually. In the seventh regression in table 12 (when we control for ROE, power and fuel charges, and raw material charges), the coefficient of one minus corporate tax increases to 0.0017. Hence, a 1 percent decrease in one minus corporate taxes (effectively an increase in the corporate tax rate) will lead to a 0.0017 percent decrease in wages. Similarly, controlling for GFA, power and fuel charges, and raw material charges, the coefficient of one minus corporate tax becomes 0.0015.

Table 12a: Panel Estimation Using GFA

Dependent Variable/ Independent Variable	Constant	Lagged Wage	((1-s)/s)* LN(1-Tax Rate)	LN (GFA)	LN (ROE)	LN(Power & Fuel)	LN(Raw Material)	LN (TFP_{fe})	LN (TFP_{levpet})	Obs.
LN(Wage)	0.4278	0.8823*	0.0004*							51032
	(0.0254)	(0.0089)	(0.0001)							
LN(Wage)	-0.0792	0.6952*	0.0005*	0.2020*						49577
	(0.0243)	(0.0106)	(0.0001)	(0.0063)						
LN(Wage)	0.2703	1.0123*	0.000		0.07*					34300
	(0.0348)	(0.0115)	*(0.0001)		(0.0034)					
LN(Wage)	0.4635	0.6872*	0.0007*			0.2938*				40352
	(0.0183)	(0.0065)	(0.0001)			(0.0045)				
LN(Wage)	-0.1803	0.7857*	0.0015*				0.1941*			31774
	(0.0223)	(0.0061)	(0.0001)				(0.0035)			
LN(Wage)	-0.0609	0.6821*	0.0016*			0.2265*	0.1142*			30612
	(0.0202)	(0.006)	(0.0001)			(0.0051)	(0.0037)			
LN(Wage)	-0.0141	0.7566*	0.0017*		0.0305*	0.1869*	0.0926*			21897
	(0.0270)	(0.0094)	(0.0001)		(0.0026)	(0.0063)	(0.0046)			
LN(Wage)	-0.2237	0.6376*	0.0015*	0.0573*		0.2186*	0.1130*			30585
	(0.028)	(0.0085)	(0.0001)	(0.0075)		(0.0051)	(0.0036)			

Table 12b: Panel Estimation Using ROE

	Constant	Lagged wage	((1-s)/s)* LN(1-tax rate)	LN(TFP_{fe}) when ROE is capital proxy	LN (TFP_{levpet}) when ROE is capital proxy	LN(TFP_{fe}) when GFA is capital proxy	LN (TFP_{levpet}) when GFA is capital proxy	Obs.
LN(wage)	-4.331	0.6723*	0.0016*	3.011*				21897
	(0.0541)	(0.0070)	(0.0001)	(0.0348)				
LN(wage)	1.030	0.9692*	0.0005*		-0.2027*			28418
	(0.0379)	(0.0081)	(0.0001)		(0.0078)			
LN(wage)	-3.917	0.6877*	0.0015*			2.7858*		30585
	(0.0422)	(0.0051)	(0.0001)			(0.0261)		
LN(wage)	0.776	0.8622*	0.0006*				-0.0996*	40259
	(0.0258)	(0.0063)	(0.0001)				(0.005)	

Note: In all the tables * means significant at the 1 percent level, ** significant at the 5 percent level, and *** means significant at the 10 percent level.
Source: Author's computations

The results in table 12 are controlled only for ROE and GFA. We run separate regressions controlling for ROD, as this is only a four-year period regression. Table 13 presents the results for the same regression. Controlling for ROD, the coefficient of one minus corporate taxes to wages is 0.0005. The effects of corporate taxes remain the same in all the other regressions as well.

Table 13: Dynamic Estimation for Labor Variable (Four-year Analysis)

	Constant	Lagged wage	((1-s)/s)* LN(1-tax rate)	LN(ROD)	LN(power & fuel)	LN(raw material)	LN(TFP_{fe}) when ROD is capital proxy	LN (TFP_{levpet}) when ROD is capital proxy	Obs.
LN (wage)	1.4213 (0.2293)	0.5949* (0.0696)	0.0005* (0.0001)						11355
LN (wage)	1.8688 (0.1897)	0.5975* (0.0448)	0.0005* (0.0001)	0.0419* (0.006)					7340
LN (wage)	1.2414 (0.1359)	0.5189* (0.0355)	0.0012* (0.0002)		0.2905* (0.0087)				8786
LN (wage)	0.2012 (0.1477)	0.7352* (0.0337)	0.0004** (0.0002)			0.1713* (0.0068)			6623
LN (wage)	0.309 (0.1258)	0.6610* (0.0295)	0.0005*** (0.0002)		0.1966* (0.0107)	0.0924* (0.0073)			6375
LN (wage)	0.4591 (0.1296)	0.621* (0.0283)	0.0005** (0.0002)	0.0053 (0.0052)	0.1945* (0.0109)	0.0986* (0.0076)			5291
LN (wage)	-7.8598 (0.0853)	0.3573* (0.0186)	0.0001*** (0.0001)				5.5257* (0.0505)		6752
LN (wage)	2.626 (0.1537)	0.5049* (0.0334)	0.0005* (0.0002)					-0.1755* (0.0088)	6750

Note: In all the tables * means significant at the 1 percent level, ** significant at the 5 percent level, and *** means significant at the 10 percent level.
Source: Author's computations

Analyzing the dynamic panel results of the impact of corporate taxes on capital and labor, we infer several things. The impact of corporate taxes falls more on capital than labor in the case of GFA and ROE; however, when the interest paid on debt is taken as a proxy for capital, the coefficients of corporate taxes are insignificant in the capital equation, while in the labor equation the impact of corporate taxes is significant. Hence, the burden of corporate taxes falls more on labor than capital, as proposed by Harberger (1962).

6. CONCLUSION

Using the improvised analytical framework of Desai, Foley, and Hines (2007), this paper estimated the corporate income tax incidence in a general equilibrium framework. Further, using SUR and dynamic panel estimates, we tried to empirically capture the relative impact of corporate tax on capital and labor. Using data for 5,666 Indian firms for the period from 2000–15, the econometric coefficients of SUR and dynamic panel estimates suggest that capital bears most of the burden of a corporate tax while the effect on labor is almost negligible. The results, however, vary with different proxies for capital. The result is contrary to the Harberger (1962) hypothesis that the incidence of corporate taxes is shifted to labor. However, earlier studies on corporate tax incidence in the context of India also suggest that the incidence is on capital, and not shifted to labor.

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