Modelling Corporate Tax Liabilities Using Company Accounts

Saeed Ahmed

January 2004

CWPE 04012

Modelling corporate tax liabilities using company accounts: a new framework

Saeed Ahmed *
University of Cambridge

October 2003

1. Introduction

Economic theory suggests that firms seek to maximise their profits; however literature on profit maximisation has not distinguished between 'pre-tax profit' and 'after-tax profit'. This distinction is important for policy analysis. If it is taken that firms reduce their costs to maximise their pre-tax profits, then one would expect them to pay due share of taxes and tax revenues would be relatively predictable. However it is reasonable to suppose that in the pursuit of maximising after-tax profits, firms will deploy strategies to reduce their corporate tax liabilities. Tax avoidance (taking advantage of the provisions of tax laws), tunnelling (transferring resources from one firm to another), and transfer pricing, are pervasive, especially amongst large firms and tax authorities find is difficult to tackle these. Accordingly, profits of the firms are difficult to predict and, as a corollary, hard to forecast. Underestimation of revenues can lead to serious problems during the course of the budget year if governments are forced to bring down expenditures in line with revenues; overestimation can result in taxpayer cynicism about the entire budget process and in government employee anger over contract negotiations (Rogers and Joyce, 1996).

---

* Address: Faculty of Economics, University of Cambridge, Austin Robinson Building, Sidgwick Avenue, Cambridge CB3 9DE, UK. Email: sa358@cam.ac.uk Phone: +44 (0) 7879 050743 Fax: +44 (0)1223 335299

I am very grateful to John R. King (IMF), Richard Eason (UK Inland Revenue) and an anonymous referee for their helpful comments on an earlier draft of the paper. Special thanks are due to my research supervisor, Paul Kattuman (University of Cambridge) for his constant support and advice. Errors, if any, are the preserves of the author alone. Sponsorship for the doctoral research by the State Bank of Pakistan is gratefully acknowledged.

Within the context of a principle-agent framework, where the tax authority is principal and taxpaying firms are agents, this paper introduces a model of corporate taxes which shows that agent firms exploit complete information embodied in provisions of tax statutes and the tax policy. While the principal can observe some of the actions of the agents, it may be powerless in taking remedial actions because of legitimacy of the actions. The process of reducing tax liabilities by taxpayers taking advantage of loopholes in tax laws and special provisions is called 'tax sheltering' (Cowell, 1990). Certain actions of agents, such as tunnelling, are hidden from the principal or otherwise costly to investigate, and therefore the principal has less information as compared with the agents. Scholes and Wolfson (1992) provide a cogent discussion of the difficulties tax authorities face in identifying financial innovation and the dilemma of how to resolve them. Consequently, firms find ways to achieve their after-tax profit maximization objective.

Several approaches to corporate tax modelling co-exist, each with their own strengths, limitations, and potential role in policy analysis. Depending on the objectives of the policy analysis, tax modelling could follow either a micro or macro approach. The main use of tax models in the area of corporate taxation is for revenue estimating and forecasting. "Revenue estimating" is the process of assessing the impact of tax law changes proposed at the time of the budget or subsequently. In the UK, the same process is commonly referred to as "tax costing" (King, 1995). This is closely related to revenue forecasting but is different from it. Forecasts are needed even when no change of the tax law is envisaged, while revenue estimates must often be made for proposals that are not subsequently adopted (King, 1995). Since the late 1960s, the major OECD economies, and individual states within the USA, have developed microsimulation models for their major taxes, particularly on personal and corporate incomes[1]. These models are constructed from samples of tax return data. Their focus is on the detailed application of tax law to the structure of the tax base, at the level of individual taxpayer liabilities. In most cases the primary purpose of these models has been to assist in revenue estimating.

[1] Spahn and Pearson (1998) examine tax models in transition economies. For a review of models in the USA, see Rubin, Peters and Nantell (1999).

Revenue estimation is not without problems. King (1986, 1995) highlights problems that arise in summarising tax changes in a single number. First, a particular change to the tax law can generally be expected to have revenue effects that occur over time. Second, a change to one tax will often affect revenues from other taxes. Thirdly, behavioural effects may need to be captured.

Alongside revenue estimation, in many countries (for example, the UK and France) microsimulation models are also used for revenue forecasting. Forecasts of government revenues from different taxes are produced to serve a variety of purposes, most importantly, government budgeting. A forecast of total revenues is useful to estimate the deficit that will have to be financed. In the UK, at the heart of such forecasting process is the microsimulation model, developed internally by the Inland Revenue (IR), which exploits the macroeconomic forecasts supplied by the Treasury (see Eason (2000), Eason (1996), Eason and Elmore (1998) and Orme and Mellor (1999) for a detailed account of the model)[2]. However, despite its long history and steady improvement, the IR model cannot simulate some aspects of the future tax position of the companies accurately (Orme and Mellor, 1999). This is partly due to the heterogeneity (in terms of types, size, age, business activity, corporate financial policy, structures) of firms, volatility of annual profits or losses of companies, skewness of distribution of tax payments, and partly due to some limitations of the methods employed. Because forecasts are produced within a climate of uncertainty and changing economic conditions, the microsimulation models find it hard to cope with these factors and there is always the possibility of making an error. Moreover, with microsimulation models it is generally difficult to infer behavioural responses to changes in tax policy. Grizzle and Earle (1994) argue that combining forecasting methods could result in more accurate forecasts. A number of methodologies for revenue forecasting co-exist with structural microsimulation models; including those conditional on macroeconomic variables, such as GDP, and those that are made unconditionally. See appendix A for a brief discussion of such methodologies.

This paper finds its motivation from the UK experience of microsimulation

[2] In the UK non-government models include those of the Institute for Fiscal Studies which enable comparisons of forward looking marginal tax rates for the EU (Devereux and Griffith, 2002) and the Manchester Business School (MBS). The MBS tax models developed by Chittenden *et al*. (2001) measure the tax burden borne by SMEs and the impact on the growth of such businesses.

modeling of corporate taxes and aims to identify the significant determinants of tax liabilities that must be taken into account for more accurate tax estimation and forecasting. Considering the behavioural aspects of corporate tax modeling, this paper introduces a microeconometric approach that aims to provide an insight into the tax behaviour of firms and examine factors which impact on corporate tax liabilities.

Since microsimulation models of firms are constructed from samples of tax returns data, which are protected by privacy laws, the literature on corporate taxation has been limited to examining the impact of tax policies and effective tax rates (ETRs) in different countries on firms' investment decisions and their choices regarding ownership structure, debt/equity, and dividend payouts. The ETR approaches use hypothetical data to compute the cost of user capital for deciding on investments and are useful in multi-country analysis of tax burdens. Some portion of the literature has also examined the impact of taxation on income shifting/transfer pricing behaviour of companies.

For the most part, however, the existing literature does not examine the endogeneity of tax liabilities and the causation that runs from firms' economic decisions to their tax liabilities. Econometric analysis that establishes the link between the commercial factors at the level of the firm and the taxes paid is also non-existent in the literature. The micro level analytical framework introduced in this paper aims to fill this gap and is an important contribution in this area. The econometric approach used in the paper exposes the commercial factors and firms' rational decisions which potentially affect their tax liabilities. These factors cannot be captured by existing microsimulation models of corporate taxes. The econometric model of the determinants of corporate tax liabilities, using actual micro (firm level) data is a new framework. Tax behaviour of companies, especially the large ones, poses a great challenge to corporate tax modelling and no econometric study has previously examined the behavioural factors impacting on taxes paid by the firms.

Considering that trading profits and capital gains, which together make up taxable profits, are coarse determinants of corporation tax, the present study examines each component of accounting profits with respect to its impact in determining corporate tax liabilities of the firms. Besides the main variables (operating profits and capital gains), gross profit, cost of sales, management

expenses and even one-off transactions such as exceptional items and extraordinary items also affect corporation tax liabilities individually. These should be useful in understanding the tax behaviour of companies. Moreover, the variables reflecting a company's profile such as age, size, number of subsidiaries and holdings, asset structure, liabilities, dividend policy, working capital and investments in capital assets are also considered relevant to the determination of corporate tax liabilities. Additionally, the provisions in tax codes allowing tax reliefs, credits and deductions influence tax behaviour of a company. Therefore, the role of tax reliefs in the corporation tax payments also forms a part of the study. The explanatory model presented in the paper accentuates the potential loss of tax revenue due to firms' manipulations within subsidiaries and holdings by way of transfer pricing, income shifting, intra-group activities and artificial loans, which are labelled as 'tunnelling' in the recent literature (see, for instance, Bertrand, Mehta and Mullainathan, 2000). The model is estimated using firm level panel data of UK companies in three diverse sectors (hotels and restaurants, business services and transport). Given publicly available comparable dataset, the model provides a framework for international comparisons as well.

This paper is organised as follows. Section 2 presents an analysis of the UK corporate tax system to provide an overview of the tax environment in which the UK businesses operate. Section 3 presents a brief review of literature on studies that examine the effect of corporate taxation on factors, such as, investment, corporate financial decisions, and income shifting / tunnelling. Section 4 presents a new framework and develops an econometric model to investigate the determinants of tax liabilities. Section 5 describes the data on the variables used in the model and their relative significance. Section 6 reports the econometric results and their implication for tax modelling, while section 7 concludes.

2. The UK corporation tax system: an analysis

UK Corporation tax (CT) is charged on the trading profit and capital gains of a company earned in each accounting period (AP) - normally a twelve months period chosen by the company. There are a number of factors that render the calculation of tax liabilities a non-trivial exercise. Companies are allowed to deduct various costs. In addition, 'capital allowances' provide relief for the

consumption or depreciation of capital assets. Different types of assets attract different allowances. The trading loss or any capital loss can be adjusted in the same year and/or carried forward indefinitely or carried back to the previous accounting period. The dividends received from another company in the UK are exempt from corporate tax. A company that makes trading loss can surrender that loss as group relief to set against the profits of an equivalent accounting period of another group member. Small and Medium Enterprises (SMEs) are allowed Research and Development tax credits. Until April 1999 corporate income tax was paid in two parts. Advance Corporation Tax (ACT) was paid at the time of dividend payment with the tax amount determined by the size of dividend. Mainstream corporation tax (MCT) was paid nine months after the end of the accounting period. The MCT is calculated by deducting Advance Corporation Tax (ACT) already paid from the total tax liability. However, ACT was to be set off subject to certain rules limiting how much it could be carried back or forward to preceding or following years. In 1999 ACT was abolished and replaced by a new system of quarterly instalment payments for the larger companies. Under the new system, half of a company's tax liability would be paid in year and the remaining half paid within four months of the end of the accounting period. These changes were aimed at simplifying payment arrangements and removing the complexities of surplus ACT.

Corporation tax in the UK accounts for 10 percent of the total revenue and almost 4 per cent of the GDP. However, the annual yield is highly volatile and difficult to forecast accurately which is problematic since fiscal planning by the government requires somewhat accurate revenue forecasts. The forecast errors are attributable partly to the heterogeneity (in terms of types, size, age, business activity, corporate financial policy, structures) of firms, volatility of annual profits or losses of companies, skewness of the distribution of tax payments, and limitations of forecasting methodologies. The largest companies pay a major chunk of the corporate tax revenue. In 1998/99 just 12 companies paid 10 per cent of MCT receipts, some 10 per cent of all corporate tax payers accounted for 85% of the MCT receipts and 20 per cent of all CT paying companies accounted for 97 per cent of MCT revenue (Orme and Mellor, 1999). More recent trends are even more striking. According to Inland Revenue (Yeend, 2002), around a quarter of the largest corporations pay no tax at all. On the other hand, the top 10 CT payers

alone pay around 25% of all CT and the top 50 around 50% of the corporate tax revenue. This makes it crucial to fully understand a relatively small number of Business Groups to model the impact of tax policies (Yeend, 2002). During the year 2000/2001, out of total 502,101 companies actually paying some corporate tax, just 2982 companies paid £23,462 million, which is 74% of total CT payments of £31,729 million. Only 740 companies paid £18,765 million of corporation tax, which makes 59% of the total corporate tax revenue (Inland Revenue, 2002).

Appendix 'B' shows the number, income, allowances, deductions and corporate tax liabilities by industrial sectors according to SIC 1992 classifications for the year 2000-2001. The highest income earning sectors is energy and water supply where just 2,371 cases yielded a gross profit of £24,648 million, and per case average trading profits were £10.396 million. However, the four biggest earning sectors (energy, water supply; overseas activities; banking and finance; extraction, metal manufacturing, chemical) also consumed the highest per case capital allowances and deductions reducing their tax liabilities considerably. It is interesting to see that the total capital allowances for the year stood at £67,382 million which were 36 per cent of the gross trading profits and 160 per cent of the total chargeable corporate income tax for the period. It must be recognized that these capital allowances give considerable relief to high-tech and capital-intensive industries for economic depreciation of their capital assets. Labour-intensive industries are less leveraged in such relief. It is no surprise that construction, business services, other services, hotels and catering, and distribution and repairs, which account for the largest number (498,771 or 71%) of UK corporate taxpayers earning some trading profit or other income during 2000-01 (698,183), only get 30% of total allowances and minimum average per case benefits on capital allowances. Likewise, deductions on account of interest expenses are restricted to those companies that finance their business through borrowed capital. Companies investing their retained earnings do not get a corresponding allowance for corporate equity (the opportunity cost of financing from retained profits i.e. forgone interest). Therefore, not surprisingly, the least leveraged groups of taxpayers in this regard (constructions, hotels and catering, business services, distribution, other services) are the groups who actually constitute the majority (71%) of corporate taxpayers in the UK.

3. Review of empirical studies

Much of the literature has studied the effects of tax policies and the effective tax rates in altering the behaviour of firms vis-à-vis investment, financial decisions, income shifting, and tunnelling. The earlier work on the impact of taxation on investment decisions by firms was provided by Hall and Jorgenson (1967), Summers (1981), Feldstein (1982), Chirinko and Eisner (1983), Poterba and Summers (1983), and Chirinko (1987). More recent studies using firm-level data give much better results due to better information. For example, Blundell, Bond, Devereux, and Schiantarelli (1992), Auerbach and Hessett (1992), Devereux, Keen and Schiantarelli (1994), Bernstein and Shah (1994) and Devereux, Lockwood, and Redoano (2002). Further surveys on the impact of corporate income taxes on the location of capital maybe found in Devereux and Griffith (2002). The overall conclusion that emerges from the above literature is that taxes do affect investment decisions, although the size of the effect is less clear. While the existing literature examines the impact of tax policy on investment decisions, this paper seeks to determine this causal relationship in opposite direction, from investments made by firms to their corporation taxes.

Auerbach (2001) reviews the portion of literature that has focussed on corporate financial policy, including choices about firm ownership structure. In its simplest terms, financial policy relates to two key choices that firms make: (1) how much of their capital structure to support by debt, rather than equity; and (2) how much of their earnings to retain for use as internal equity finance, rather than distributing dividends and raising new equity in the market. There are many influences on a firm's choice between debt and equity finance, so it is not surprising that retained profits remain the major source of finance for many firm despite the tax advantage of debt (Bond, Devereux, Gammie, 1996). Edwards (1987) provides a more detailed introduction to the literature on capital structure. Scholes and Wolfson (1992) discuss in detail the difficulties tax authorities face in identifying financial innovation and the dilemma of how to resolve them. For more discussion on the impact of taxes on the financial decisions of firms, see Mintz (1996), Graham (1999), Goolsbee (1998), Graham *et al*.(1998) MacKie-Mason (1990), MacKie-Mason *et al.* (1997), Miller (1977), and Stiglitz (1973).

Dividends represent the equity policy of organizations whose tax treatment

is non-neutral in the UK. Empirical evidence suggests that taxes do influence company dividends (Bond *et al.*, 1995). The share of profits paid out as dividends to shareholders increased sharply in the UK after 1985, and is exceptionally high by international standards (Bond *et al*., 1995). It is for this reason that the dividend policy of the firm is included as an explanatory variable to determine its impact on tax liabilities. Both survey and econometric evidence indicates that some company investment is constrained by a shortage of internally generated finance (Bond and Meghir, 1994). High dividend payments may therefore have an adverse effect on the level of investment.

The literature has also examined the issues of transfer pricing and income shifting vis-vis tax policies in different jurisdictions. Examples of such studies include Jenkins and Wright (1975), Bernard and Weiner (1990), Kopits (1976), Gubert and Mutti (1991), Hines and Rice (1994), Harris *et al*. (1993), Mutti (1993), Collins *et al*. (1996) Grubert (1996), Rousslang (1997) and Grubert (1997). Newlon (2000) evaluates the empirical evidence and concludes that cross-border incoming shifting by multinational companies is of some significance. Just how significant is still unclear, given the possible flaws and sometimes mixed results of the empirical estimates. The present study examines the influence of organizational structure, represented by the number of subsidiaries and holdings, on corporation tax payments with a view to estimate the reverse causality.

In many countries, controlling shareholders are accused of tunnelling, transferring resources from companies where they have few cash flow rights to ones where they have more cash flow rights (Bertrand, Mehta and Mullainathan, 2000). This diversion can take many forms (Johnson, La Porta, Lopez-de-Silanes and Shleifer 2000). High (or low) interest rate loans, selling of inputs or purchase of outputs at non-market prices, leasing of assets, and guarantees of other companies' borrowing are only a few of the readily available ways to tunnel. Johnson, Boone and Friedman (2000) showed that countries with better legal protection against tunnelling were less affected by the emerging markets financial crises of 1997-98. Bertrand, Mehta, and Mullainathan (2000) have noted that tunnelling can have large consequences. Because well-functioning capital markets require that outside shareholders benefit from their holdings, tunnelling may raise a serious barrier to financial development. The very process of transferring resources may also entail social costs. For example, it may reduce the transparency of the

entire economy, clouding accounting numbers and making it hard to infer the health of the firms. An equally important effect of tunnelling that has gone unnoticed in the literature is its negative impact on tax revenues. Firms also tend to reduce their tax liabilities through tunnelling.

It is in this backdrop that this study seeks to capture the effects of investments, corporate financial and dividend policy, and tunnelling on the corporate tax liabilities of firms- and not *vice versa*.

4. Econometric model

This section introduces an alternative approach to corporate tax modelling. The purpose is to provide an insight into the factors that determine corporate tax liabilities of firms.

4.1 The conceptual framework

Based on the analyses of the UK tax system and considering the limitations of microsimulation models of firms, this paper seeks to suggest an econometric approach to modelling the corporate tax liabilities of UK firms. The econometric model aims to identify the micro (firm level) factors that potentially affect firms' tax liabilities. The intuition behind this framework is as follows:

(1) Corporate taxation not only alters the investment behaviour of companies, their financial decisions relating to dividend policy and debt-equity ratios and choices regarding ownership structure and organizational forms, but also these factors are used by corporations to reduce their corporate tax payments. Thus the causation also runs from these variables to corporate tax liabilities of firms. Age, size, and number of subsidiaries and holdings provide ample opportunities for firms to tunnel their resources from one firm to another and practice such activities as concessional loans to their sister organizations, buying inputs at a higher prices from parent companies and selling outputs to other firms in the pyramid at lower than market rates. These advantages are not available to smaller and younger companies. Thus such factors are likely to have a significant impact on corporate tax liabilities.

Moreover, these variables also control for firms' heterogeneity, which poses a main problem in tax forecasting.

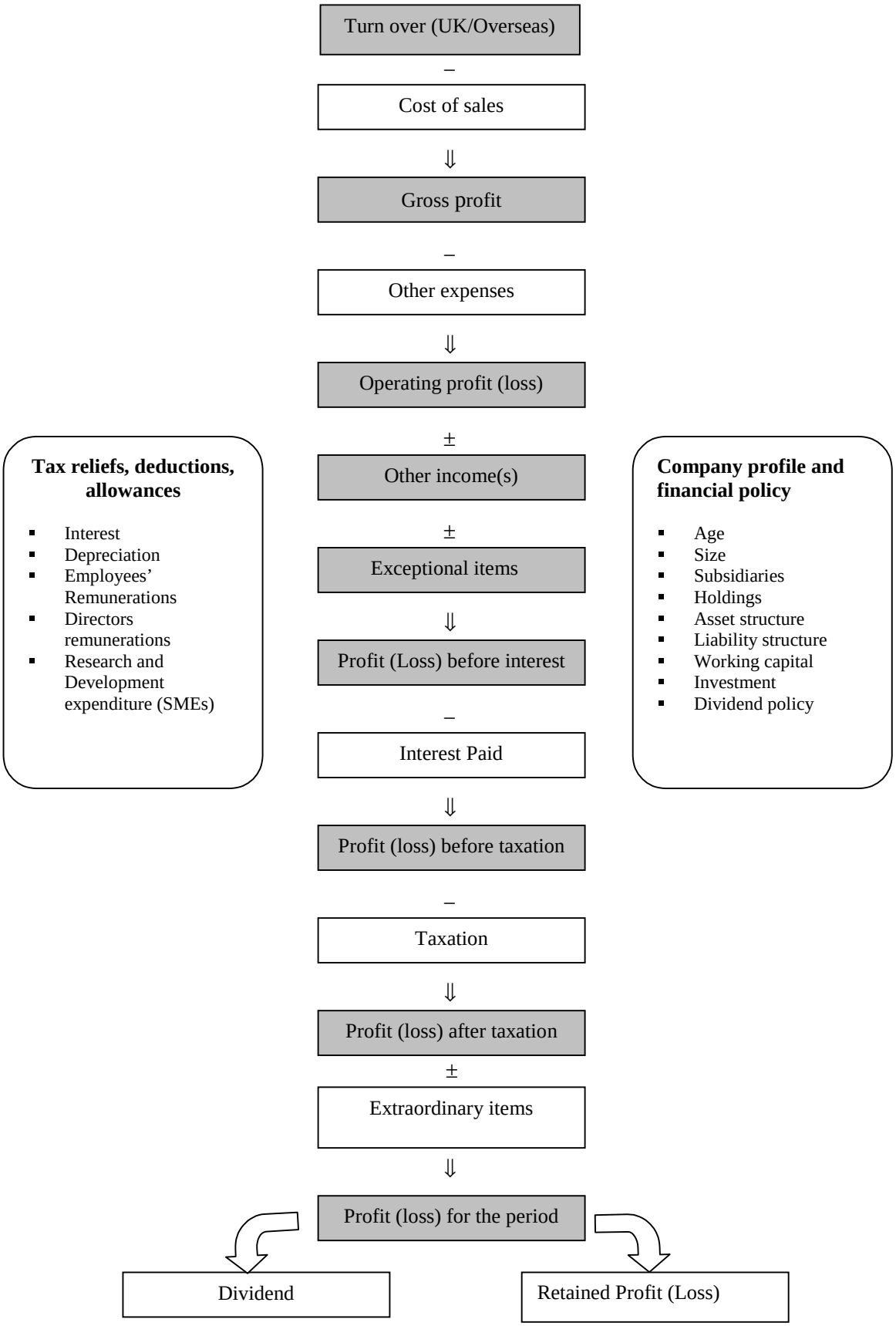
(2) Tax codes allowing companies to deduct various expenses, claim certain allowances and receive tax credits affect the behaviour of companies and they resort to tunnelling and tax sheltering to reduce their tax liabilities. As a legal activity, tax sheltering is rampant and is considered to significantly reduce corporate tax revenues. It has been shown in the previous section that tax revenue forgone on account of capital allowances and interest deductions is colossal.

(3) The errors in the forecast process using microsimulation models could be attributed to the inadequacies of the accounting variables used for forecasting process. It is not merely a gross measure of 'trading profits or losses' and 'capital gains' that determine the corporate tax liabilities. For an indication of the companies tax behaviour, it is equally important to look at the gross profit rates (the ratio of gross profit to turnover) and net profit rate (the ratio of net profit to turnover) of companies, which reflect the level of cost of sales and other expenses. These are usual channels through which corporations reduce tax liabilities. Even such one-off items as exceptional items and extraordinary items which are employed by companies for window dressing to present their accounting profits in an impressive manner, are equally important in determining tax liabilities. Each of these factors is included in the model as a separate explanatory variable.

(4) Since the taxes paid in any year may not be related to the actual profits in that year due to carrying forward of previous credits and carrying back of current credits or losses, and the effects of various factors regarding firms' financial decisions may also be spread over the next periods, the study prescribes a panel data model covering a six year time period.

Figure 1 provides an intuitive framework for the model highlighting the various factors in tax accounting, statutory allowances and deductions, and corporate structures and financial policies that determine tax liabilities.

Figure 1: Determinants of corporate tax liabilities



Following Mintz (1996) the tax base of corporation tax (CT) in the UK maybe defined as follows:

CT = R – C – Dep – I

where

R = accrued revenues

C = current costs (salaries, advertisement and material expenditure)

Dep = economic depreciation of assets

I = Interests paid

4.2 Structural model

Corporation tax is modelled as a function of profits chargeable to tax, allowances, deductions and tax credits, and firm characteristics and financial policies which affect tax liabilities. The structural model representing the corporation tax system in the UK is as follows:

$$Corptax_{it} = f(\pi_{i\tau}, \alpha_{i\tau}, Z_{i\tau}) \quad \tau = 1, \cdots t, t = 1 \cdots T \tag{1}$$

where '*Corptax*' is Corporation tax chargeable on taxable profits earned by incorporated and unincorporated businesses and associations *(i)* during accounting period *(t)* . $\pi_{i\tau}$ is a vector of variables reflecting different sources of taxable profit such as gross profit, expenses, operating profit, other income and exceptional/extraordinary items) in the profit and loss account statement of firm *i* in period τ . Allowances and deductions (such as capital allowances, interest, and (other deductions) are represented by the vector $\alpha_{i\tau}$ and $Z_{i\tau}$ is a vector of variables representing company profile (including age, size and organizational form) and corporate financial policies which influence tax liabilities.

Identities:

pbt = pbi + intp

pbi = op + otinc ± excep ± extit

op = gp - otexp

gp = turn – cossal

where

pbt = profit before tax (chargeable to corporation tax)
pbi = profit before interest
intp = interest paid
op = operating/trading profit
otinc = incomes from other sources
excep = exceptional items (±)
extit = extraordinary item (±)
gp = gross profit
otexp = other expenses (charged to Profit and Loss account)
turn = turn over
cossal = cost of sales (manufacturing or trading expenses)

Table 1 shows the variables in each vector to be estimated in the model.

Table 1: Vectors of explanatory variables

π	a	Z	Dummy Variables
Turnover	Interest paid	Age	Years
Cost of sales	Depreciation	Number of Subsidiaries	Consolidated / unconsolidated accounts
Gross profit	Employees' remunerations	Number of Holdings	
Other expenses	Directors remunerations	Size (Turnover)	
Operating profit		Asset structure	
Other income		Liability Structure/ Long-term liability	
Exceptional Items		Investments	
Extraordinary items		Working capital	
		Dividend payout ratio	

Given the fact that all the above factors interact with each other, there will invariably be some degree of multicollinearity in the model, which makes it

somewhat difficult to disentangle the separate effects of each of the explanatory variables. However the model does clearly identify highly intercorrelated explanatory variables and the reduced form equations do not use combinations of variables which are highly correlated. For instance, the instrument interest paid is not estimated along with long-term liability or cost of sales and extraordinary items, which are highly correlated.

The econometric model is estimated in linear form using an unbalanced panel of companies in three diverse sectors over the period from 1995 to 2000. Variants of the reduced form of equation (1) are used in the estimation. To control for consolidated and unconsolidated accounts, which are not separated in FAME, a dummy variable has been included in the model. To reflect changes specific to certain years, a year dummy variable is also included.

A panel data structure was chosen for the following reasons:

(1) There are computational adjustments of income and losses, advance corporation tax payments relating to the previous/next year and other accounting practices that make it difficult to estimate corporate tax liabilities in the same year to which they relate. These adjustments spill over to the next years and therefore panel data are better able to incorporate the dynamics of adjustment and can give unbiased results.

(2) Panel data control for individual heterogeneity. Since individual firms are heterogeneous, cross section and time-series studies would not control for this heterogeneity and therefore run the risk of getting biased results.

(3) Panel data give more informative data, more variability, less collinearity among variables, more degrees of freedom and more efficiency. Time series studies are plagued with multicollinearity and cross section data adds a lot of variability (Baltagi, 1995).

4.3 Hypotheses and *a priori* expectations

In the light of the conceptual framework and the structural model, the study tests the following hypotheses:

1. Firms reduce their tax liabilities through choice of organisational form, ownership structure, and financial policies. Firms with large number of subsidiaries and holdings are in a better position to practice tunnelling and undertake transfer pricing/income shifting. Rational companies exploit provisions of tax laws to shelter from taxes. Organisational form, financial policies, and investments affect tax liabilities significantly. The effect, however, may differ across sectors.

2. Trading profits and capital gains are coarse determinants of corporation tax. Each component of taxable profit is a significant determinant of tax liabilities. The tax behaviour of companies can be studied by examining each source of their profits.

Table 2 suggests expectations *a priori* for each variable estimated in the model.

Table 2: Variables and expectations *a priori*

Variable	Expectation *a priori*
Age	Taxes are regressive in nature falling more heavily on younger companies. Older companies are leveraged in reducing tax liabilities and taking advantages of tax codes to get tax relief. Age is therefore expected to exhibit a negative relationship with tax burden.
Number of subsidiaries and holdings	Companies with a large number of subsidiaries and holdings are able to resort to tunnelling, deploy tax avoidance instruments, and undertake transfer pricing to lower their tax liabilities. The number of subsidiaries and holdings are therefore expected to have a negative impact on corporate tax payments by companies.
Turnover	Turnover is used as an instrument for the size of firms. This variable indicates volume of business and should ordinarily have a positive association with tax liabilities. It is therefore expected *a priori* that turnover will have a positive relationship with the dependent variable.

Asset structure	Companies with more fixed assets are likely to pay lower tax charges since they have the potential for deductions towards capital allowances that provide relief for economic depreciation of capital assets. Therefore, asset structure (defined as the ratio of fixed assets to total assets) is likely to exhibit a negative relationship with the total tax burden.
Liability structure	Companies are likely to be leveraged in tax liabilities owing to higher borrowings and subsequent interest deductions. Hence a negative relationship is expected between long-term liabilities, which is used as an instrument for liability structure, and total tax burden.
Working capital	Working capital is an indicator of the capital actually employed in the business and this is used to finance higher stocks in trade. This variable therefore also increases the cost of sales.
Investment	Investments by companies reduce the capital actually employed in the normal business activities of companies. However, yield on investments has a positive effect in future periods through enhanced other incomes . It is therefore likely to result in a positive relationship with corporate tax liabilities. Capital loss will be negatively associated with tax payments and gains will increase tax liabilities. In a dynamic structure, the variable may, however, show different correlations with the dependent variable in current and lagged periods.
Dividend payouts	A higher dividend payout ratio decreases the level of retained profits that can be ploughed back into the business. Hence, a negative relationship is expected between the dividend ratio (defined as the ratio of dividends paid to profit for the period) and corporation tax paid by companies.
Gross profit	Gross profit is calculated by subtracting the cost of sales from turnover. The higher the gross profit, the higher the operating profits. It is likely that gross profit will exhibit a positive relationship with the corporate tax liabilities of firms.
Cost of sales and expenses	Companies tend to inflate cost of sales and other expenses to reduce their tax liabilities. These costs lower operating profits. Therefore, cost of sales and other expenses are likely to exhibit a negative relationship with the tax liability of firms.
Sources of profits	Companies are likely to exhibit a strong positive relationship between different sources of profits (gross trading profit, operating profit, income from other sources and exceptional items) and the tax liability. However, extraordinary items (representing one-off costs) is expected to yield a negative sign.
Interest, depreciations, & remunerations	Interest, depreciations, and remunerations (employees/directors) are legally admissible expenses that allow relief to firms for borrowed capital and economic depreciation of their capital assets. Therefore a negative relationship between corporate taxes and these variables is expected. These variables may, however, behave differently in different sectors. Moreover, employees' remunerations also reflect the level of employment, which is an indicator of the size of the firm and may show a positive sign with corporation tax.

5. Data description

The data comprises unbalanced panels of 7,306 companies in the hotels and restaurants sector, 6,594 in business services and 1,484 in transport manufacturing sectors, for the accounting periods 1995 to 2000. The hotels and restaurants sector contributed an annual tax revenue of £430 million during 2000, business services had an annual contribution of £5,256 and the transport and communications sector contributed an annual corporation tax of £1,394 during the same period. The numbers of companies filing returns showing trading profits and other income for the year 2000 in the three sectors were 21,847, 271,398 and 22,116 respectively (see *Appendix B*). Data on all variables are taken from Fame, which is a computerised database on profit and loss accounts, balance sheets, financial ratios and company profiles of all UK companies reporting accounts to Companies House. All monetary variables are in £, age shows the number of years since incorporation, asset structure and dividend payouts are ratios and subsidiaries and holdings are in numbers. Since there was little change in the number of subsidiaries and holdings, these variables drop out in the fixed effects estimates and the dynamic panel regressions and therefore their effects on corporation tax liabilities are studied by normalizing them by turnover.

The main items in the accounts are a profit and loss account, cash flow statement and a balance sheet. The notes to the accounts contain a lot of important information on the breakdown of these items. A profit and loss account shows the results of the company's trading over the past financial period. The balance sheet gives a snapshot of the company's financial position on one particular date: the last day of its financial year. All assets and liabilities are shown in the balance sheet.

There is a difference between a balance sheet and a consolidated balance sheet or group balance sheet. Most companies listed on the stock exchange are not, in fact, single companies. A (parent) company may have subsidiary companies and may control them by owning all or a majority of their shares. The head company of a group is also sometimes called the holding company because it holds the shares of the subsidiaries. Companies are normally required to present both a balance sheet and a consolidated or group balance sheet, unless there are no subsidiaries. Companies are not required to publish a parent company profit and loss account, only a consolidated one that shows the aggregate of the profits and losses of all the

companies in the group. Since the companies in the data set are a mix of those with consolidated and unconsolidated accounts, a dummy variable is used to find out if the results are the same under the two parameters.

Fixed assets represent mainly the buildings and plants on which depreciation or amortization is charged to the profit and loss account. They are not necessarily fixed in a physical sense. They are fixed because they are not something the company is buying or selling or processing in the course of its normal trade. Capital allowances represent relief on depreciation of such assets. Asset structure is defined as the ratio of the fixed assets of the company to its total assets. Likewise, liability structure is defined as a ratio of total liabilities to total assets. Since both asset structure and liability structure are taken as ratios of total assets, in order to avoid collinearity between them, the level of long term liabilities is used as a proxy for the liability structure. Dividend policy is defined as the ratio of dividends paid to profits for the period. Turnover, gross profit, cost of sales and operating profit are self-explanatory. Turnover is used as an instrument for the size of firms. The relationship between accounting variables is shown in Figure 1.

As Brett (2000) has noted, there are some minor complexities that need to be addressed. If a company has an interest in associated companies or related companies (companies which are not subsidiaries, but in which it has a significant shareholding) it will show its proportionate share of profits from these companies as a separate item and include them in the pre-tax profit figure. There are some one-off items that distort profits in a particular way. These items appear under the heading either of exceptional items or extraordinary items. They could include items such as costs incurred in closing down a subsidiary business or windfall profits on the sale of a surplus factory. Neither item represents a normal feature of the company's trading. Exceptional items are added or subtracted in the published accounts above the line before reaching a pre-tax profit figure. Extraordinary items, however, do not affect the published pre-tax profits or published earnings but are deducted below the line after calculating net profits after tax. What is considered exceptional and what is extraordinary has been a matter for some debate. In practice, companies treat favourable items such as windfall profits as exceptional and therefore include them in published pre-tax profits. Unpleasant one-off items such as factory closure costs are more likely to be treated as extraordinary and deducted after tax where they are not so easily spotted. This

window-dressing has not escaped the accounting authorities and a new accounting standard FRS3 has come into force which obliges companies to treat virtually all one-off items as exceptional and add or subtract them before arriving at pre-tax profits and earnings per share. It is due to the significance of these one-off items for corporate tax liabilities that these have been included in the model.

Data on research and development expenditure was not available and therefore is not included in the estimation.

The additional corporate tax liability determined by tax authorities by way of full and aspect enquiries (which add back inadmissible expenses and make other adjustments to arrive at the income chargeable to corporation tax) provide accurate tax liabilities of firms. However, for reasons of confidentiality access to Inland Revenue data was not possible. This problem does not, however, invalidate our results for two reasons:

(1) The additional liability of corporate tax generated by the Inland Revenue during the latest year (2000-01) as a consequence of 4,292 full enquiries and 67,222 aspect enquiries yielded £511.9 million. This is equivalent to 2.96 % of the mainstream corporation tax revenue (£17,303 million) from industrial and commercial businesses (including public corporations), but excluding financial, life assurance and North Sea oil and gas companies. This additional liability is 2.33% of the chargeable corporation tax revenue, which stands at £21,927 million from such companies. Thus, the additional tax liability determined in terms of the percentage of total tax constitutes a statistically insignificant figure.

(2) Since the study has used panel data over six years, any additional corporation tax paid by the companies is adjusted in the accounts of the companies, making the margin of error even more negligible.

6. Estimation Results

This section reports the estimation results of different reduced form equations for three unbalanced panels involving 7306 hotels and restaurants, 6594 computer consultancy firms, and 1484 transport (road, air, marine) manufacturing companies, over a period of 6 years from 1995 to 2000. The model has been estimated separately for different sectors to see how the coefficients on the

different variables behave for diverse sectors. For instance, the capital-intensive industries are likely to consume more capital allowances than firms in the service industry, which normally have lower capital requirements.

The *t*-statistics are in parenthesis. The diagnostics performed test specifications, fixed effects, serial correlations, Sargan's test of over-identifying restrictions and parametric restrictions tests. Equation 1 in the tables 3 & 4 below (and equations 2&3 in *appendices C&D*) represent variants of the reduced form of equation (1) and estimate alternative combinations of different instruments which do not correlate with the explanatory variables included in the same equation. For instance, turnover is used as instrument for the size of the firm. However, turnover is correlated with number of subsidiaries and holdings, which, though included in the model to represent organizational structure, also reflect the size of the firms. Therefore, where turnover is used, as in equation 3, subsidiaries and holdings are not included. Likewise, long-term liability is used as an instrument to represent the liability structure of firms, therefore, when it is included in the equation, its correlated variable interest paid is excluded. Similarly, cost of sales if used in conjunction with both turnover and gross profit, would be collinear. Also, asset structure and depreciation are correlated with each other.

First, a random effects model was estimated. The random effects model assumes that 'the unobserved effect' is uncorrelated with all the explanatory variables in each time period. In this model, it is assumed that the individual effects are randomly distributed across a cross-section of firms. Since the data represented highly heterogeneous firms with the unobservable firm differences correlated with the explanatory variables examined in the model, it was expected *a priori* that data would reject random effects. The Breusch and Pagan Lagrangian Multiplier test for random effects, which entails null hypothesis that variance (u) = 0, failed to reject the null and confirmed this *a priori* expectation.

The fixed effect or 'within' specification was estimated and the results are presented in table 3 (two more equations were estimated and their results are reported in appendix C). Like first differencing, fixed effects estimator uses a transformation to remove the unobserved effect prior to estimation. Any time-constant explanatory variables are removed along with unobserved effect. The resulting coefficients on the explanatory variables show their effects abstracting from the unobservable firm differences.

Table 3: Fixed Effects estimation

Dependent Variable: Corporation tax

Explanatory Variables	**Hotels and Restaurants**	**Business Services** (Computer consultancy)	**Transport Manufacturing**
Age	-77.856 (-0.50)	-181.33** (-2.05)	-59.8 (-0.44)
Subsidiaries	-21864.46 (-0.02)	-906398** (-1.87)	-168220.9 (-0.19)
Holdings	-45503.15 (-0.07)	237410.7 (0.12)	1729159 (0.31)
Dividends	-194.3** (-1.67)	27.57 (0.57)	715.19*** (5.02)
Investment	0.065*** (10.15)	-0.004 (-0.48)	-0.058*** (-3.68)
Working capital	-0.045*** (-2.86)	-0.130*** (-33.33)	0.019* (1.60)
Long-term liability	0.0006 (0.17)	0.030*** (6.12)	0.007** (2.26)
Asset structure	-2397.88 (-0.91)	1198.97 (1.00)	-5633.8*** (-2.37)
Gross profit	0.0188 (1.12)	0.073*** (9.89)	0.073*** (6.18)
Operating profit	0.185*** (8.27)	0.085*** (9.12)	0.027*** (4.95)
Other income	0.239*** (14.02)	0.062** (2.04)	0.137*** (2.68)
Exceptional items	0.0296*** (3.85)	0.047*** (6.12)	0.039*** (2.84)
Extraordinary items	-0.051** (-1.71)	-0.007 (-0.03)	-0.003 (0.32)
Remunerations	-0.033** (-1.96)	0.0258*** (3.91)	-0.093*** (-5.87)
Directors' remunerations	-0.632* (-1.33)	0.668** (1.85)	1.12** (2.11)
Accounts dummy	82.226 (0.05)	64.55 (0.10)	-2708.8^ (-1.23)
1996	76.477 (-0.12)	145.65 (0.42)	1.12** (2.11)
1997	-20.003 (-0.04)	270.27 (0.83)	376.24 (0.72)
1998	-317.98 (-0.61)	34.33 (0.11)	495.8 (1.19)
1999	343.310 (0.65)	8.13 (0.03)	230.22 (0.53)
2000	Dropped	Dropped	Dropped
Constant	5764.61 (0.94)	3275.54** (1.82)	8043.2** (1.64)
Observations	572	521	368

Explanatory Variables	**Hotels and Restaurants**	**Business Services** (Computer consultancy)	**Transport Manufacturing**
F-stat	(20,328)= 27.71	(20,231)= 138.87	(20,213)= 15.34
R. squared: within between overall	0.628 0.483 0.562	0.923 0.267 0.429	0.590 0.00 0.03
F test for fixed effects (All u_i= 0)	(223, 328) =10.44 Pr>F=0.00	(269, 231) =4.08 Pr>F=0.00	(134,213) =6.06 Pr>F=0.0
Parametric restriction test for year dummies	F(4, 328) = 0.33 Pr>F=0.85	F(4, 231) = 0.23 Pr>F=0.92	F(4,203) = 0.37 Pr>F=0.83
Parametric restriction test for accts. dummy	F(1, 328) = 0.00 Pr>F= 0.96	F(1, 231) = 0.01 Pr>F= 0.92	F(1,213) = 1.51 Pr>F= 0.22

*** statistically significant at 1 % level , **statistically significant at 5% level , *statistically significant at 10% level, ^marginally significant

The high R^2 indicates that corporate tax liabilities of the companies examined are explained reasonably well by the model. For instance, for the business services sector, the R^2 for the fixed effects (within) estimator ranges between 90.1 and 92.3 per cent suggesting variations in the corporate tax liabilities of firms are explained by the model satisfactorily. The F-test confirms the joint significance of the fixed effects and the explanatory variables in all equations reported.

Clearly the taxation system is dynamic and any business modelling would need to address issues of adjustment. The model in this paper is characterized by dynamic relationships between various explanatory variables and the dependent variable. In order to abstract from contemporaneity, a dynamic panel data model was estimated and the results of these estimations are reported in table 4 (two more equations were estimated and their results are reported in appendix D). The explanatory variables included the lagged dependent variable and all the explanatory variables and their two period lags. The lagged variables on age were dropped due to collinearity.

Arellano and Bond (1991) propose a test for the hypothesis that there is no second-order serial correlation for the disturbances of the first-differenced equation. This test is important as consistency of the GMM estimator depends on the hypothesis being true. There was no autocorrelation found in residuals of order 1 and/or 2 in all equations reported.

Table 4: Arellano-Bond Dynamic Panel Data regressions
Dependent Variable: Corporation tax

Explanatory variables	**Hotels and Restaurants**	**Business Services (Computer consultancy)**	**Transport (Manufacturing)**
Corporation tax	-0.366***	-1.506***	0.145**
L	(-3.40)	(-4.72)	(1.68)
L2	0.0244	-0.711*	0.446***
	(0.14)	(-1.41)	(4.07)
Age	-25142.1	15572.86	39861.46
	(-0.57)	(0.30)	(0.32)
Subsidiaries	126115.7	2761786***	-4109447**
	(0.45)	(4.18)	(-1.98)
L	1095652*	-3137842***	6402343**
	(1.62)	(-3.93)	(1.89)
L2	1186143*	114699.9	-7930831**
	(1.45)	(0.51)	(-2.24)
Holdings	8841001	-3241090	3694634
	(0.70)	(-0.92)	(0.36)
L	7007082	4510824	-1.35e+07
	(0.68)	(0.93)	(-0.74)
L2	3440321	1768026	1.09e+07
	(0.44)	(0.63)	(0.87)
Dividends	-21.423	50.978	-86.397
	(-0.96)	(0.86)	(-0.70)
L	-50.102	65.020	735.02**
	(-0.91)	(0.78)	(1.64)
L2	97.803	29.561	968.16***
	(1.18)	(0.27)	(2.62)
Investments	-0.025***	0.0128	0.138***
	(-2.68)	(0.44)	(7.03)
L	-0.081***	0.317***	0.196***
	(-2.64)	(3.45)	(6.02)
L2	0.0243*	0.039	-0.190***
	(1.34)	(0.47)	(-5.35)
Working capital	-0.062***	0.091^	0.163***
	(-3.21)	(1.21)	(7.25)
L	-0.053**	0.049	0.025^
	(-3.81)	(0.82)	(1.19)
L2	0.052*	-0.079^	-0.046*
	(1.41)	(-1.26)	(-1.36)
Long-term liability	0.011***	0.021	-0.032***
	(2.64)	(0.90)	(-4.94)
L	0.011***	0.008	-0.0055
	(2.53)	(0.41)	(-0.74)
L2	-0.094	0.202***	-0.053***
	(-0.87)	(4.83)	(-3.46)
Asset structure	-949.555	-795.71	829.64
	(-1.16)	(-1.16)	(0.42)

Explanatory variables	Hotels and Restaurants	Business Services (Computer consultancy)	Transport (Manufacturing)
L	2005.32** (2.17)	-663.66 (-0.89)	-2175.83 (-0.62)
L2	764.252 (0.90)	-169.55 (-0.27)	-1352.13 (-0.42)
Gross profit	0.033** (1.72)	-0.165*** (-2.69)	0.072 (0.93)
L	-0.130*** (-4.42)	0.129* (1.40)	0.042 (0.53)
L2	-0.126** (-3.24)	-0.23 (-0.27)	0.228*** (4.24)
Operating profit	0.103*** (2.92)	0.429*** (7.48)	-0.096 (-1.16)
L	0.048* (1.43)	0.346*** (2.78)	-0.176*** (-2.41)
L2	0.068 (0.96)	0.293** (2.02)	-0.307*** (-4.00)
Other income	0.426*** (4.41)	1.479*** (4.05)	-0.163** (-1.78)
L	0.007 (-0.15)	0.289 (0.25)	-0.081 (-0.78)
L2	0.141*** (2.48)	-1.86*** (-3.09)	-1.199*** (-7.55)
Exceptional items	-0.028 (-1.01)	0.1551^ (1.23)	0.111*** (2.62)
L	0.021 (0.73)	0.682*** (4.71)	0.088 (0.79)
L2	0.224*** (2.87)	0.648*** (5.06)	-0.0227* (-1.47)
Extraordinary items	0.147*** (5.000)	-	-0.0669** (-1.92)
L	0.172*** (4.74)	-	-0.044* (-1.33)
L2	0.234*** (6.16)	-	-0.0227* (-1.47)
Employees' Remunerations	-0.093*** (-2.88)	0.080* (1.61)	-0.176*** (-4.43)
L	0.124*** (2.86)	-0.585*** (-3.73)	0.009 (0.15)
L2	0.0015*** (0.06)	0.277* (1.61)	-0.011 (-0.27)
Directors' remunerations	-0.281* (-1.33)	0.153 (0.49)	2.23*** (3.35)
L	0.496* (1.37)	0.801* (1.52)	-0.422 (-0.57)
L2	1.616*** (4.73)	1.738*** (2.54)	-2.75*** (-2.66)
Constant	25229.97 (0.58)	-15660.85 (-0.31)	-39906.08 -0.32

Explanatory variables	Hotels and Restaurants	Business Services (Computer consultancy)	Transport (Manufacturing)
No. of observations	97	47	63
No. of groups	50	30	32
Wald test	Chi2 (45)= 43743.59	Chi2 (42)= 20517.87	Chi2 (45)= 3368.48
Sargan test of over-identifying restrictions	Chi2 (9)= 21.70 Pr>chi2= 0.01	Chi2 (8)= 2.89 Pr>chi2= 0.94	Chi2 (9)= 9.79 Pr>chi2= 0.37
Arellano-Bond test of no auto-correlation	z= -1.73 Pr>z= 0.08 No autocorrelation in residuals of order 1&2	z= -1.69 Pr>z= 0.09 No autocorrelation in residuals of order 1&2	z= 1.92 Pr>z= 0.055 No autocorrelation in residuals of order 2

*** statistically significant at 1 % level **significant at 5% level *significant at 10% level ^marginally significant. L denotes one-period lagged, and L2 denotes two-period lagged variable.

Testing overidentifying restrictions is very important in the context of Instrument Variables (IV) estimation. It is a requirement of the IV estimation that each instrument variable must be uncorrelated with the error. Sargan's test of overidentifying restrictions entails a null hypothesis that all IVs are uncorrelated with the error. The results reported in table 4 show that, except for one single equation in the hotels and restaurants sector, all equations estimated failed to reject the null hypothesis, suggesting that the choice of all the instruments in the model is satisfactory and none of the explanatory variables is correlated with the disturbance.

The above results mostly confirm the hypotheses and *a priori* expectations.

Corporate profile, structure and financial policy

The coefficient on age is invariably negative in all the equations in the fixed effects estimations and statistically significant for firms engaged in business services. However, age shows mostly positive signs in the dynamic panel results and is statistically insignificant in all but one equation. Therefore, it would appear that the size of the age effect on corporate tax payments is small and its relationship is a non-linear one. New entrants into business pay more taxes as their main financial source of running the business is equity finance and their ability to

manipulate and reduce tax liabilities is limited. However, as they grow older they are able to reduce their tax liabilities by taking advantage of tax provisions and using transfer pricing instruments between their affiliated companies. This is also evident from variables forming the vector α and the number of subsidiaries and holdings being negatively associated with corporate tax liabilities. The negative relationship between age and the tax liability seems to be available for the initial few years only when firms are in the process of settling in the market.

The coefficients on number of subsidiaries and holdings normalized by turnover are negative but generally insignificant in the fixed effects model. For the firms carrying on business of computer consultancy, the coefficient on subsidiaries is statistically significant in one of the two fixed effects estimations reported. However, for the dynamic specification of the model, the coefficients on the number of subsidiaries in the current and lagged periods are significant and negatively associated with corporation tax payments for two major sectors studied, business services and transport manufacturing. The latter include all major corporations engaged in the manufacturing of cars, aircrafts, and marine ships. This suggests that, normalizing turnover, firms with a large number of subsidiaries manage to reduce their future tax liabilities by transfer pricing and tunnelling. Similarly, in the dynamic panel regressions, the coefficients on the number of holdings one period lagged is negative and significant in one equation in the hotels and restaurants and has insignificant and mixed signs elsewhere. The dynamic panel results (table 4) suggest that companies with affiliated concerns resort to tunnelling and other tax avoidance measures to reduce their tax liabilities. The fact that the variables cost of sales (in equations 3 - *appendices C&D*) and interest payments and directors' remunerations are negative and statistically significant in the fixed effects models as well as the dynamic panel regressions shows that organizations with a large number of subsidiaries and holding companies reduce their corporation tax payments by transfer pricing. This can take the form of inflating costs of business, creating fictitious intra-company loans, getting tax relief for interest payments and paying exorbitant remunerations to their directors. This finding is in line with the existing empirical evidence (for instance, Kopits (1976)) on transfer pricing which suggests multinational companies transfer their incomes to different jurisdictions by royalty payments. The results are also in line with the existing literature on tunnelling. As argued in section 3, in many countries

controlling shareholders are accused of tunnelling, transferring resources from companies where they have few cash flow rights to ones where they have more cash flow rights. This diversion can take many forms. High (or low) interest rate loans, selling of inputs or purchase of outputs at non-market prices, leasing of assets, and guarantees of other companies' borrowing are only a few of the readily available ways to tunnel. As noted by Bertrand, Mehta, and Mullainathan (2000), tunnelling can have large consequences. Because well-functioning capital markets require that outside shareholders benefit from their holdings, tunnelling may raise a serious barrier to financial development. The very process of transferring resources may also entail social costs. For example, it may reduce the transparency of the entire economy, clouding accounting numbers and making it hard to infer the health of firms. It is in this backdrop that the results of present study make an important contribution, showing that tunnelling, if prevalent, can reduce tax liabilities thereby causing a drain on public revenues. This also indicates the channels through which firms transfer their incomes and reduce tax liabilities. This has repercussions for corporate governance in an international context.

Equation 3 (reported in the *appendices C&D*) disentangles the effects of the organizational form from size, proxied by turnover, and includes turnover as an explanatory variable exclusive of subsidiaries and holdings. The coefficient on turnover is positive and significant at the 1% level. This confirms that the bulk of the tax revenue comes from large companies and the contribution by the younger and smaller firms is relatively very small. This is as per the UK Inland Revenue data of tax payments by size.

The fixed effects results show a very significant, positive sign on the investment coefficient in the two sectors, hotels and restaurants and business services. This is in line with the hypothesis and *a priori* expectations that investments made by companies yield more capital gains and this increases their corporate tax liabilities. However, investment behaviour vis-à-vis corporation tax is best explained in the dynamic setting. As the dynamic panel results (table 4) indicate, investments made in the current period will have positive effect on earnings in the following periods. In the shorter run, investments in portfolios mean that less capital is available to be invested in the main trading activities. The transport sector, which is the largest sector in terms of the size of individual companies examined, shows the opposite sign on investment. The fixed effects

results indicate that innovative investments have a negative association with corporate tax liabilities and the dynamic specification shows a significant, positive impact on tax liability in the short run and a statistically significant negative effect in the longer run (after two accounting periods). Therefore, we can say that investment is strongly related with corporation tax payments; however, the nature of its relationship will depend on the conditions in the capital markets and how prudently corporations manage their funds.

Working capital is found to have a statistically significant negative relationship with tax liabilities. This is consistent with the hypothesis that working capital adversely affects corporation tax through enhanced cost of sales which has the effect of reducing operating profit. The results are further confirmed by the variable cost of sales itself being negative and significant in equations 3. Here again, transport sector has shown a different trend. In the current period, the inflow of additional capital enhances business profits and the consequential tax liabilities. However, working capital in the current period reduces future tax liabilities in this sector, which is predominately characterised by large business groups. This indicates the possibility of an intra-group set off of losses in future periods to reduce tax payments.

The dividend ratio, which reflects the dividend policy of firms, is significant and negatively related with corporate tax payments in the fixed effects estimations for the hotels and restaurants and transport sectors. It is insignificant for firms in the business services sector. In the dynamic panel regressions, the hotels and restaurants, which is relatively a smaller sector, shows a negative association between dividends and corporation tax payments. In the larger sectors, namely transport manufacturing and business services, dividend payout ratios are positively associated with corporation tax liabilities in the lagged periods. However, the dynamic panel data results confirm that the current year's dividend payouts do not affect corporate tax liabilities in the same year. This result conforms to the UK tax system. The existing literature finds that, in the UK, companies have higher payout dividend ratios and that share of profits paid out as dividends to shareholders increased sharply in the UK after 1985, and is exceptionally high by international standards (Bond *et al*., 1995). This would suggest that for the giant companies, the high dividend ratios increase the volume of their stocks traded in the markets, which enhances their financial position, resulting in higher capital

gains and tax payments. However, for the relatively smaller companies the relationship between dividend payouts and the corporate tax liabilities is negative. The dynamic panel regressions further confirm that the effects of dividend payments spread over future periods.

Liability structure, proxied by long-term liabilities, is found to have positive, significant association with tax liabilities. In the dynamic panel, the coefficient on liability structure shows different signs for different sectors. For the hotels and restaurant sectors, and transport sectors, the coefficients show a negative association with corporation tax in the long run. Business services firms show a positive effect of borrowed capital on their earnings and tax liabilities. This is also evident from the coefficient on interest payments being positive and statistically significant for this sector in the fixed effects model.

Asset structure mostly shows an insignificant association with tax liabilities. It produces a statistically significant negative sign in the transport sector in the fixed effects model only. However, for the dynamic specification, only the lagged variable is significantly (but positively) correlated with current tax liabilities in the hotels sector. This shows that the asset structure does not have a linear relationship with the corporation tax liabilities.

Components of accounting profits

Different sources of profits, namely gross trading profit, net operating profit, other incomes (capital gains) are all, as expected, statistically significant and yield positive signs in the fixed effects model, showing that each of these items is individually significant in determining corporate tax payments. Interestingly, the dynamic panel regressions show that for the business services and transport sectors (the two large sectors), the lagged period operating profits (losses) and other incomes (capital losses) reduce current tax liabilities. This demonstrates the existence of huge losses in the larger groups. This may possibly be due to the effect of tunnelling through subsidiaries and holdings, which, as shown already, have a significant impact in reducing the corporation tax payments in these sectors. The regressions, however, produce very strong and consistent results vis-à-vis one-off items, that is exceptional items and extraordinary items, which often get neglected by researchers and microsimulation modellers. The results show that both

exceptional items (windfall profits from one particular venture) as well as extraordinary items (generally relating to one-time incurred costs) significantly affect corporation taxes asymmetrically. Exceptional items are positively related and extraordinary items have negative association with corporation tax. It may be mentioned that for tax purposes extraordinary items are included in the cost of sales, which also has a negative and significant sign in eq.3 (*Appendices C&D*).

Tax allowances, deductions and reliefs

The results confirm that interest payments, depreciation, employees' remuneration, and directors' remuneration have a significant impact on corporation tax liabilities individually. However, these cost variables behave differently in different sectors as expected *a priori*. Employees' remuneration has a positive, significant sign in the two labour-oriented sectors, namely hotels and restaurants and computer consultancy, and a negative sign in the transport manufacturing sector. This suggests that for labour-intensive industries, remuneration is an instrument for the size of firms and the higher the number of employees in such sectors the higher the profits and taxes. However, for transport manufacturing companies, the remuneration simply indicates an expenditure, which has the effect of enhancing costs thereby reducing corporation tax payments. In the dynamic setting, remuneration reduces tax liabilities significantly in the same year of payments but in the longer run it has a positive effect on taxation. It is no surprise that for the computer consultancy sector, which requires highly skilled labour, the variable on depreciation has shown an insignificant association for the dynamic specification of the model.

Capital allowances, proxied by depreciation, provide relief from tax for the consumption of capital assets in the business. It was used in the model to represent reliefs from corporation tax and as such expected to be negatively associated with CT. However, the existence of large fixed assets, attracting depreciation, also indicate the volume of the business and confounds with the size of the firm. Therefore, the higher the depreciation allowance, higher the profits and corresponding corporation tax. The results reported have accordingly confirmed a positive and significant relationship between depreciation allowances and corporate taxes.

As discussed above, firms in business services sector show a positive effect of borrowed capital on their earnings and tax liabilities. Therefore, the coefficient on interest payments is also positive and statistically significant for this sector in the fixed effects model. In the other sectors interest payments show a negative and significant relation with corporation tax. Even in the business services sector, interest paid in the two period lags is negative and statistically significant with current tax liabilities. This is in agreement with the expectations *a priori* that interest payments by the firms are a deductible expense when arriving at profits chargeable to tax.

Directors' remuneration shows different behaviour vis-à-vis taxation across sectors. For the hotels and restaurants sector, this shows a significant, negative effect on tax liabilities while for the consultancy and transport sectors, it is positively and significantly associated with dependent variable. As such, the instruments representing allowances and deductions, and tax reliefs, (interest, depreciations, remuneration, directors' remuneration) all have significant association with corporations' tax payments asymmetrically.

Lagged dependent variable and dummies

Table 4 shows that corporate tax payments in the previous period significantly reduce the corporate tax liabilities of the current year in all sectors. This is consistent with the tax system. Until April 1999, companies were required to pay advance corporation tax (ACT) at the time of making dividend payments to their shareholders. This payment was adjusted against the total tax due for the year after filing returns in the next period, so essentially the corporation tax was paid in two periods. The advance corporation tax was replaced by a system of quarterly instalments of anticipated tax liabilities of the next year of large companies. This was in order to offset the revenue effect of the abolition of ACT. The marginal tax rate was also employed as an explanatory variable to check whether the negative sign on lagged dependent variable was possibly due to tax rates (higher tax rate in period t-1 will influence tax paid in period t), but that was found to be insignificant. This would suggest that negative relationship between the last year's tax payments and current tax liability is on account of the advanced corporation tax paid by firms.

The coefficients on the year dummies show little significance in the model. Dummy variable for year 2000 dropped out for fewer observations. Likewise, the results show that for the model there was no statistically significant difference between the two types of accounts. For the transport sector, the dummy variable on consolidated/unconsolidated accounts is significant and negatively associated with tax liabilities. The parametric restriction test again fails to reject the null hypotheses that the parametric variation between firms is zero.

The dynamic panel regressions show some unexpected signs on certain coefficients, such as lagged gross profits, lagged directors' remuneration, and extraordinary items in the hotels and restaurants sector. The instability of the signs could be either due to some element of collinearity or possibly the result of some inherent shortcomings of the Arellano-Bond estimation technique.

In summary, the results highlight the need to consider variables on firms' size, structure and financial policy and the system of allowances and deductions, and each element of the profits chargeable to tax, not just information on the main profit items, to study the tax behaviour of companies. These factors affect companies' tax behaviour in a different way in different sectors. With a large number of highly significant coefficients, often with expected signs, and high explanatory power, the model provides deep insight into the UK corporate income tax system and spells out important determinants of corporate tax liabilities which have not been previously analysed. The model also provides ingredients for any future microsimulation modelling ventures.

7. Conclusion

This paper has presented estimates of a reduced form model of determinants of corporate tax liabilities for three important sectors in the UK. Several results stand out. Firstly, microsimulation models would be prone to forecasting errors if they only take into account trading profit (loss), capital gains, and profit/loss patterns of the companies. The econometric model presented here highlights the need to consider and include additional variables in the forecast process to which little attention is seemingly paid. Secondly, corporate tax liabilities do not simply depend on the accounting profits. There are a number of factors that interplay in the process. We find that size, organizational form, various sources of profitability

and tax allowances and deductions all affect tax liabilities considerably. Even one-off transactions, which are reported and classified separately in the account books, such as exceptional items and extraordinary items significantly increase or decrease tax liabilities. Thirdly, our findings suggest that firms in pyramids appear to practice tunnelling not just to transfer resources from one company to the other to improve financial gains for the controlling shareholders as the existing literature suggests, but also they do so in order to reduce their tax liabilities and maximise '*after-tax*' profits. Though tax authorities are powerless to do anything about corporations' legitimate involvement in tax sheltering, they ought to look into the methods of tunnelling by firms in order to detect possible tax evasion, which in contrast to tax sheltering is illegal. Fourthly, more information on companies' activities within groups is required to explore the exact nature of relationships between some variables and corporation tax liabilities. Finally, it is suggested that econometric methods should be applied in conjunction with microsimulation models to identify the significant factors affecting corporation tax payments. The findings have implications for understanding diversity in corporate governance systems and for systematic analysis of the interaction between financial regulations, tax codes and social institutions.

Bibliography

Arellano, M. and S. Bond (1991), "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *Review of Economic Studies* 58, 2777-297.

Auerbach, Alan (2001), "Taxation and Corporate Financial Policy", *NBER Working Paper* No.8203.

Auerbach, Alan and K. Hassett (1992) " Tax policy and business fixed environment in the United States", *Journal of Public Economics*, vol.47, 141-70.

Baltagi, Badi H. (1995), *Econometric Analysis of Panel Data*, Chichester, John Wiley.

Bernard, J-T., and R.J. Weiner (1990), "Multinational Corporations, transfer pricing, and taxes: evidence from the US petroleum industry", in A. Razin and J.Slemrod (eds.), *Taxation in the Global Economy*, Chicago: University

of Chicago press.

Bernstein, J. and A. Shah (1994),"Taxes and Production: the case of Pakistan", *International Tax and Public Finance*, Vol.1, 227-43.

Bertrand, M., P. Mehta and S. Mullainathan, (2000) "Ferreting Out Tunnelling: An Application to Indian Business Groups", *NBER Working Paper* No.7952.

Blundell, R. S.R. Bond, M.P.Devereux, and F.Schiantarelli, (1992), "Investment and Tobin's Q: evidence from company panel data", *Journal of Econometrics*, vol.51, 233-58.

Bond, S.R. and C. Meghir (1994), "Financial Constraint and Company Investment", *Fiscal Studies*, 15(2), 1-18.

Bond, Stephen R., Michael P. Devereux, Malcolm J. Gammie (1996), " Tax Reform to Promote Investment", *Oxford Review of Economic Policy*, Vol.12, NO.2.

Brett, Michael (2000), *How to Read the Financial Pages*, London: Random House Business Books.

Chirinko, R.(1987), "The ineffectiveness of effective tax rates on business investment: a critique of Feldstein's Fisher-Schultz Lecture", *Journal of Public Economics*, vol.32, 369-87.

Chittenden, F., Poutziouris P. and Michaelas N. (2001) Modelling the Tax Burden (Direct and Compliance Costs) on the UK Small Business Economy. in *Tax Compliance Costs - a Festschrift for Cedric Sandford*; Evans C., Hasseldine J. and Pope J. (eds.); Sidney*:* Prospect Media Pvt Ltd.

Chriniko, R. and R. Eisner (1983), "Tax Policy and investment in major US macro-econometric model models", *Journal of Public Economics*, vol.20, 139-66.

Collins, J.H., D.Kemsley, and M.Lang (1996), "Cross-jurisdictional income shifting and earnings valuations", *University of North Carolina*, unpublished paper.

Cowell, Frank. A.(1990), Tax sheltering and the cost of evasion", *Oxford Economic Papers*, 42, 231-243.

Creedy, John (2001), "Tax Modelling" in John Creedy (ed) '*Taxation and Economic Behaviour'*, Cheltenham: Edward Elgar.

Devereux, Michael P., Ben Lockwood, Michela Redoano, (2002) "Do Countries Compete over Corporate Tax Rates?", Draft Paper.

Devereux, Michael P., M. Keen, and F. Schiantarelli (1994), "Corporation tax

asymmetries and investment: evidence from UK panel data", Journal of Public Economics, 53, 395-418.

Devereux, Michael P., Rachel Griffith (2002), "The Impact of Corporate Taxation on the Location of Capital : A Review", Unpublished.

Eason, Richard J. (2000), "Modelling Corporation Tax in the United Kingdom", in A. Gupta and V. Kapur (eds), *Contributions to Economic Analysis: Microsimulation in Government Policy and Forecasting*, Elsevier: North-Holland.

Eason, Richard (1996), Microsimulation for direct taxes and fiscal policy in the United Kingdom" in A. Harding (ed), *Microsimulation and Public Policy*, North-Holland.

Eason, Richard J. and Bill Elmore (1998), " The Inland Revenue Model for Forecasting Corporation Tax in the United Kingdom", in Spahn, Paul Bernd and Mark Pearson (eds) (1998), *Tax Modelling for Economies in Transition*, Hampshire: Macmillan.

Edwards, J.S.S. (1987) "Recent developments in the Theory of Corporate Finance", *Oxford Review of Economic Policy*, 3(4), 1-12.

Feldstein, M (1982), " Inflation, tax rules and investment: some econometric evidence", *Econometrica*, vol.50, 825-62.

Fullerton, D. (1984), "Which effective tax rate?", *National Tax Journal*, Vol. XXXVII, 23-41

Fullerton, Don, John. B. Shoven, and John Whalley (1983), "Replacing the US Income Tax with a Progressive Consumption Tax: A Sequenced General Equilibrium Approach, " *Journal of Public Economics*, 20 February, 3-23.

Graham, john R. (1999), "Do personal taxes affect corporate financing decisions? *Journal of Public Economics*, 73, 147-185

Grizzle, G.A. and W.E. Kley (1994), "Forecasting state sales tax revenue: Comparing the accuracy of different models", *State and Local Government Review*, 3, 142-152.

Grubert, H (1997), Another look at the low taxable income of foreign-controlled companies in the United States", *US Department of the Treasury*, Unpublished paper, January.

Grubert, H. (1996), "Taxes and the division of foreign operating income among royalties, interest, dividends, and retained earnings", *US Department of the*

Treasury, unpublished paper, November.

Grubert, H. and J.Mutti (1991), "Taxes, tariffs and transfer pricing in multinational corporate decision making", *Review of Economics and Statistics*,73, 28-93.

Hall, Robert E. and Dale W. Jorgenson (1967), "Tax Policy and Investment Behvaiour", *The American Economic Review* 57, June, 391-414.

Harris, D.G., R.Morck, J.Slemrod, and B.Young (1993), " Income shifting in US multinational corporations", in A. Giovannini, R.G.hubbard, and J.Slemrod (eds.), *Studies in International Taxation*, Chicago: University of Chicago Press.

Hines, J.R. Jr. and E.M. Rice (1994), "Fiscal paradise: foreign tax havens and American business", *Quarterly Journal of Economics*, 109, 149-82.

Hines, J.R., Jr. (1996), Tax Policy and the activities of multinational corporations", *NBER, Working paper* 5589.

Inland Revenue (2002), *Annual Report (2000/2001)*, United Kingdom, London.

Jenkins, G.P. and B.D Wright (1975), "Taxation of multinational corporations: the case of the United States petroleum industry", *Review of Economics and Statistics*, 57, 1-11.

Johnson, S., P. Boon, A. Breach and E. Friedman (2000), "Corporate Governance in the Asian Financial Crisis," *Journal of Financial Economics*, forthcoming.

Johnson, S., R. La Porta, F. Lopez-de-Silanes and A. Sleifer (2000), "Tunnelling," *American Economic Review Papers and Proceedings*, XC, 22-27

Jorgenson, Dale W. (1963), Capital Theory and Investment Behaviour", The *American Economic Review*, May, 53, 247-59

King, J.R., (1986), "On the Revenue Effects of Tax Changes", *Fiscal Studies*, 7, February 51-60.

King, John R. (1995), "Alternative Methods of Revenue Forecasting and Estimating", in Shome, P. (ed.) *Tax Policy Handbook*, IMF, Fiscal Affairs Department, Washington.

Kopits, G.F. (1976), "Intra-firm royalties crossing frontiers and transfer pricing behaviour," *Economic Journal*, 86, 791-805.

MacKie-Mason, Jeffery K. (1990), "Do taxes affect corporate financing decisions?" Journal of Finance 45, 1471-93.

MacKie-Mason, Jeffery K., and Roger H. Gordon (1997), "How much do taxes

discourage incorporation*?" Journal of Finance*, 52, 477-505.
Miller, Merton H., 1977, Debt and taxes, *Journal of Finance*, 32, 261-75.
Mintz, Jack (1996), "The Corporation Tax", in M.P. Devereux (ed.), *The Economics of Tax Policy*, Oxford University Press.
Mutti, J. (1993), "Comment", in A. Giovannini, R.G.hubbard, and J.Slemrod (eds.), *Studies in International Taxation*, Chicago: University of Chicago Press.
Newlon, T.Scott (2000), " Transfer Pricing and income shifting in integrating economies" in Sijbren Cnossen (ed) *Taxing Capital Income in the European Union,* Oxford: OUP.
Orme, Jacqueline and Elizabeth Mellor, (1999) "The Role of Micro-simulation in the reform of corporation tax in the United Kingdom, 1997-99", *UK Inland Revenue, Analytical Services Division*, Review Paper.
Poterba, J and L. Summers (1983), "Dividend taxes, corporate investment and Q", *Journal of Public Economics,* vol.22, 729-52.
Rogers, R. and P. Joyce (1996), "The effect of under forecasting on the accuracy of revenue forecasts by state governments", *Public Administration Review*, 56, 48-56.
Rousslang, D. J. (1997), "International income shifting by US multinational corporations", *Applied Economics*, 29, 925-34.
Rubin, Marilyn Marks, J.L.Peters, and Nancy Mantell (1999), "Revenue forecasting and Estimation", in W.Bartley Hildreth and James A. Richardson (eds), *Handbook on Taxation,* New York: Marcel Dekker, Inc.
Scholes, Myron S. and Mark A. Wolfson (1992), "*Taxes and Business Strategy*", New Jersey: Prentice-Hall, Englewood Cliffs.
Spahn, Paul Bernd and Mark Pearson (eds) (1998), "*Tax Modelling for Economies in Transition"*, Hampshire: Macmillan.
Stiglitz, Joseph E. (1973), " Taxation, corporate financial policy and the cost of capital*"*, *Journal of Public Economics*, 2, 1-34.
Summers, L (1981), "Taxation and corporate investment: a Q-theory approach", *Brookings Papers on Economic Activity*, vol.1, 67-127.
Yeend, Colin. (2002), "Issues surrounding developments in business sector modelling and policy advice and construction of a multi-source database in the Inland Revenue, UK", *Diecofis WP4 Prelimanry Report*, Analysis and

Research, Inland Revenue.

Appendix A

Methods of revenue forecasting

- **Extrapolation**

Extrapolating an established linear trend in receipts is the straightforward method of making an unconditional forecast of revenues from a particular tax. More sophisticated procedures include the Box-Jenkins ARIMA procedure. In such univariate procedures, the revenue forecast τ_t^i from a particular tax i, in a particular time t, depends only on revenues observed in the past:

$$\tau_t^i = f(\tau_{t-1}^i, \tau_{t-2}^i, \ldots\ldots\ldots\ldots)$$

This does not involve any knowledge of the tax system, or the relationships between the revenues and other economic variables, and these techniques are not widely used for revenue forecasts. Box-Jenkins also requires long time series data.

- **Forecasting using elasticities**

The conditional approach to revenues forecasting for a particular tax is to use an elasticity of revenue from the tax with respect to GDP. This is defined as:

$$\varepsilon^i = (dT^i / dY).(Y / T^i)$$

where ε^i is the elasticity of a particular tax T^i with respect to GDP denoted by Y. If ε is assumed to be constant, a forecast of ε^i in the forecast period may be derived in a straightforward way for a forecast of Y in the same period, together with actual figures for both ε^i and Y in some previous periods. In practice, this is the most widely used approach.

- **Macroeconomic (regression) models**

The assumption that relevant elasticities are constant is questionable. A more general approach is to use regression methods to estimate functional relationships between revenues from particular taxes and a variety of macroeconomic variables. An important advantage of econometrically estimated tax revenue function is that revenue forecasts are integrated with the corresponding macroeconomic forecasts, ensuring consistency between the two. The limitation of this approach is that it constrains the revenue forecasts to depend on only a small number of macroeconomic variables.

Appendix B

Corporation Tax 2000-01: Number, income, allowances, deductions and tax by Industry Numbers: actual ; Amounts:£ million

	1	2	3	4	5	6	7	8	9	10
#	Industry (1)	No. of cases with trading profits and other income	Gross trading profits	Average per industry sector	Capital Allowances (less balancing charges)	Average per industry sector	Net trading profits	Average per industry sector	Other income & gains	Average per industry sector
1	Agriculture,forestry,fishing	10,080	599	0.059	364	0.0361	362	0.036	201	0.020
2	Energy, water supply	2,371	24,648	10.396	9,780	4.125	16,526	6.970	4,327	1.825
3	Extraction, metal mfg,chemical	10,668	8,499	0.797	3,698	0.347	5,725	0.537	4,738	0.444
4	Metal goods and engineering	45,940	14,210	0.309	6,168	0.134	9,722	0.212	2,999	0.065
5	Other manufacturing	39,237	15,582	0.397	5,513	0.141	11,056	0.282	4,959	0.126
6	Construction	61,685	6,146	0.100	1,584	0.026	4,940	0.080	1,219	0.020
7	Distribution and repairs	90,508	21,626	0.239	7,973	0.088	15,105	0.167	3,708	0.041
8	Hotels and catering	21,847	3,007	0.138	1,555	0.071	1,925	0.088	1,139	0.052
9	Transport and communication	22,116	12,244	0.554	8,978	0.406	6,169	0.279	2,887	0.131
10	Banking, finance, insurance	41,252	46,402	1.125	11,419	0.277	38,404	0.931	51,459	1.247
11	Business services	271,398	23,341	0.086	7,246	0.027	18,031	0.066	13,148	0.048
12	Other services	53,333	5,946	0.111	1,848	0.035	4,624	0.087	1,771	0.033
13	Overseas activities	735	2,859	3.890	321	0.437	2,639	3.590	2,460	3.347
14	Not classified	27,013	2,211	0.082	935	0.035	1,717	0.064	6,504	0.241
15	**All industries**	**698,183**	**187,320**	0.268	**67,382**	0.097	**136,945**	0.196	**101,519**	0.145
	Number of cases	698183 (2)	545,881		529,229		490,509		392,038	

Notes:

Continued

(1) See TD for SIC industry classification

(2) Companies with trading losses and no other income are excluded here. The total number of these excluded companies in 1999-2000 was about 400,000.

Numbers: actual ; Amounts:£ million

11	12	13	14	15	16	17	18	19	20	21	22	23
#	Industry (1)	Deductions allowed	Average per industry sector	Income chatgeable to tax	Average per industry sector	ACT set off	Other reliefs set against tax	Average per industry sector	Tax payable	Average per industry sector	Chargeable Corporate tax	Average per industry sector
1	Agriculture,forestry,fishing	208	0.021	355	0.035	1	3	0.000298	84	0.008333	88	0.008730
2	Energy, water supply	6,147	2.593	14,706	6.202	179	336	0.141712	3,823	1.612400	4,338	1.829608
3	Extraction, metal mfg, chemical	3,802	0.356	6,661	0.624	55	898	0.084177	1,022	0.095801	1,975	0.185133
4	Metal goods and engineering	6,026	0.131	6,695	0.146	62	189	0.004114	1,644	0.035786	1,895	0.041249
5	Other manufacturing	5,649	0.144	10,366	0.264	104	648	0.016515	2,248	0.057293	3,000	0.076458
6	Construction	1,724	0.028	4,435	0.072	4	80	0.001297	1,077	0.017460	1,161	0.018821
7	Distribution and repairs	6,008	0.066	12,805	0.141	28	211	0.002331	3,383	0.037378	3,622	0.040019
8	Hotels and catering	1,509	0.069	1,555	0.071	1	59	0.002701	370	0.016936	430	0.019682
9	Transport and communication	4,236	0.192	4,820	0.218	5	223	0.010083	1,166	0.052722	1,394	0.063031
10	Banking, finance, insurance	34,180	0.829	55,683	1.350	115	3,758	0.091099	11,383	0.275938	15,256	0.369824
11	Business services	11,499	0.042	19,680	0.073	75	879	0.003239	4,302	0.015851	5,256	0.019366
12	Other services	3,414	0.064	2,981	0.056	2	79	0.001481	718	0.013463	799	0.014981
13	Overseas activities	1,029	1.400	4,070	5.537	0	1,124	1.529252	96	0.130612	1,220	1.659864
14	Not classified	2,027	0.075	6,194	0.229	15	1,382	0.051161	413	0.015289	1,810	0.067005
15	**All industries**	**87,458**	0.125	**151,006**	0.216	**646**	**9,869**	0.014135	**31,729**	0.045445	**42,244**	0.060506
	Number of cases	261,365		522,186		8,436	219,591		502,101		522,186	

Constructed from T11.5 and T11.3 Inland Revenue Statistics

Appendix C

Fixed Effects estimation (Eq.2&3)
Dependent Variable: Corporation tax

Sectors ⇒	**Hotels and Restaurants**		**Business Services (Computer consultancy)**		**Transport Manufacturing**	
Explanatory variables	**Eq. 2**	**Eq. 3**	**Eq. 2**	**Eq. 3**	**Eq. 2**	**Eq. 3**
Age	-69.580 (-0.49)	-119.35 (-0.89)	-203.47** (-2.10)	-160.84** (-1.70)	-176.2* (-1.56)	-99.389 (-0.88)
Number of subsidiaries	-47185.76 (-0.05)		-656882.7 (-1.19)		-111537.2 (-0.15)	
Number of holdings	-36210.85 (-0.06)		-16983.14 (-0.01)		1628305 (0.38)	
Dividend ratio	-166.30* (-1.56)	-133.43* (-1.31)	36.04 (0.61)	42.20 (0.71)	-236.956* (-1.37)	-224.74* (-1.30)
Investment	0.044*** (7.04)	0.045*** (7.54)	0.011 (1.00)	0.018** (1.76)	-0.039*** (-2.83)	-0.0434*** (-3.11)
Working capital	-0.026** (-1.88)	-0.006 (-0.41)	-0.127*** (-30.09)	-0.128*** (-30.33)	0.009 (0.92)	0.014* (1.24)
Turnover		0.073*** (4.71)		0.071*** (8.62)		0.024*** (2.44)
Cost of sales		-0.086*** (-5.20)		-0.068*** (-8.32)		-0.017* (-1.47)
Gross profit	0.073*** (4.45)		0.073*** (9.11)		0.026*** (2.52)	
Operating profit	0.124*** (5.58)	0.127*** (6.30)	0.100*** (9.46)	0.094*** (9.17)	0.032*** (6.62)	0.028*** (5.91)
Other income	0.221*** (14.07)	0.231*** (15.59)	0.119*** (2.33)	0.08** (1.69)	0.242*** (4.65)	0.190*** (3.69)
Exceptional items	0.052 *** (7.03)	0.052*** (7.41)	0.072*** (8.31)	0.068*** (7.68)	0.048*** (3.95)	0.039*** (3.28)
Interest paid	-0.536*** (-9.76)	-0.538*** (-10.07)	0.749*** (5.15)	0.773*** (5.06)	-0.086^ (-1.26)	-0.0227 (-0.34)
Depreciation	-0.0150 (-1.20)		0.024** (1.84)		0.058 (1.04)	
Remunerat-ion	0.047 *** (3.00)	0.067*** (4.00)	0.027*** (3.90)	0.024** (2.24)	-0.008 (-0.49)	-0.041** (-1.83)
Directors' remuneration	- 0.805** (-1.86)	-0.654* (-1.57)	0.350 (0.82)	0.646* (1.41)	0.980** (2.13)	1.175*** (2.60)
Accounts dummy	-128.17 (-0.08)	-166.75 (-0.10)	38.65 (0.05)	98.97 (0.14)	-3211.2** (-1.81)	-3188.97** (-1.83)
1996	-366.95 (-0.64)	-348.236 (-0.63)	-299.47 (-0.80)	-296.53 (-0.79)	144.22 (0.32)	345.78 (0.77)
1997	-515.56 (-0.99)	-437.23 (-0.87)	204.67 (0.59)	322.43 (0.92)	-97.04 (-0.25)	87.04 (0.23)
1998	-525.11 (-1.12)	-312.73 (-0.68)	-167.48 (-0.51)	-160.74 (-0.49)	129.88 (0.36)	289.9 (0.81)
1999	-300.267 (-0.64)	-233.783 (-0.51)	-235.68 (-0.72)	-259.34 (-0.78)	-265.6 (-0.71)	-147.73 (-0.40)
2000	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped

Cons	3150.95 (0.62)	5254.99 (1.09)	2966.12** (1.66)	1607.926 (1.01)	9149.6** (2.20)	6761.45* (1.62)
No. of obs	559	563	575	578	358	360
F-stat	(19,318)= 41.18	(17, 323) = 48.13	(19,246)= 122.37	(17,250) = 133.47	(19,203)= 7.42	(917,207) = 7.95
R: within between overall	0.711 0.617 0.620	0.717 0.405 0.372	0.904 0.407 0.555	0.901 0.563 0.657	0.410 0.235 0.264	0.39 0.17 0.25
F test for fixed effects (All u_i= 0)	(221,323) =13.66 Pr>F=0.00	(222, 323)= 3.62 Pr>F=0.0	(309,246 =3.12 Pr>F=0.00	(310,250)= 2.96 Pr>F=0.0	(135,203) =7.39 Pr>F=0.0	(135,207)= 6.50 Pr>F=0.0
Parametric restriction test for year dummies	F(4,318) =0.39 Pr>F=0.81	F(2,323)=0. 23 Pr>F=0.92	F(4,246) =0.90 Pr>F=0.46	F(4,250)=1. 38 Pr>F=0.24	F(4,203) =0.36 Pr>F=0.84	F(4,207)=0. 45 Pr>F=0.77
Parametric restriction test for accts. dummy	F(1,318) =0.01 Pr>F= 0.94	F(1,323)=0. 01 Pr>F= 0.92	F(1,246) =0.00 Pr>F= 0.95	F(1,250)=0. 02 Pr>F= 0.89	F(1,203) =3.29 Pr>F= 0.07	F(1,203)=3. 36 Pr>F= 0.07

*** statistically significant at 1 % level , **statistically significant at 5% level, *statistically significant at 10% level, ^ statistically significant at 10% level.

Appendix D

Arellano-Bond Dynamic Panel Data regressions (Eq. 2&3)
Dependent Variable: Corporation tax

Sectors ⇒	**Hotels and Restaurants**		**Business Services (computer consultancy)**		**Transport (Manufacturing)**	
Explanatory variables	**Eq. (2)**	**Eq. (3)**	**Eq. (2)**	**Eq. (3)**	**Eq. (2)**	**Eq. (3)**
Corporation tax L	-0.176 (-1.00)	-0.617*** (-3.38)	-0.411 (-0.40)	-0.4925 (-0.62)	-0.384** (-1.79)	-0.755*** (-4.72)
L2	0.381* (1.40)	0.059 (0.20)	-1.06 (-0.67)	-2.875*** (-2.56)	0.027 (0.12)	0.162* (1.47)
Age	41448.02 (0.57)	1186.717 (0.02)	-78390.62 (-0.65)	146544.9* (1.46)	63346.9 (1.07)	59182.3 (0.96)
Subsidiaries	662820.8 (0.35)		2608204 (1.16)		-1145519 (-0.70)	
L	303003.4 (0.17)		-3846240 (-1.16)		1617276 (0.62)	
L2	-2337439** (-2.10)				-1836251 (-0.70)	
Holdings	1.59e+07 (1.12)		-4367633 (-0.17)		4383424 (0.60)	
L	-1.26e+07* (-1.32)		-471366.8 (-0.04)		-1.10e+07 (-0.85)	
L2	1671615 (0.24)				6965682 (0.87)	
Dividends	-0.654 (-0.02)	0.789 (0.02)	-167.501 (-0.57)	-138.101 (-0.60)	75.32* (1.39)	8.897 (0.16)
L	100.300 (-1.06)	-137.9** (-1.88)	129.779 (0.41)	461.73* (1.44)	-14.895 (-0.06)	-0.105 (-0.00)
L2	-118.386 (-0.92)	-172.92* (-1.26)	196.80 (0.58)	424.898* (1.42)	226.345 (0.83)	143.453 (0.64)
Investments	-0.0025 (-0.16)	-0.04*** (-3.24)	-0.349** (-2.15)	-0.369*** (-2.97)	0.037*** (2.68)	0.084*** (5.05)
L	0.050 (1.10)	0.0113 (0.28)	-0.0046 (-0.01)	-0.186 (-0.62)	-0.029 (-0.79)	-0.035 (-0.64)
L2	0.016 (0.45)	0.095*** (3.10)	-0.877** (-1.62)	0.119 (0.66)	-0.153*** (-5.78)	-0.102*** (-5.01)
Working capital	0.0356 (0.81)	-0.0218 (-0.86)	0.248 (1.11)	0.278*** (2.45)	-0.003 (-0.16)	0.0337** (1.63)
L	-0.154*** (-3.53)	-0.10*** (-5.50)	-0.113 (-0.52)	-0.413*** (-2.81)	-0.0226 (-1.23)	-0.012 (-0.65)
L2	-0.197** (-2.20)	-0.0201 (-0.41)	0.297 (1.26)	0.525*** (3.90)	-0.052* (-1.47)	-0.118*** (-4.14)
Turnover		0.143*** (4.31)		-0.070 (-0.81)		0.050 (1.05)
L		-0.18*** (-3.74)		0.278** (1.74)		-0.181** (-2.05)
L2		-0.024 (-0.52)		-0.066 (-0.62)		-0.025 (-0.35)
Cost of sales		-0.13*** (-3.58)		0.206** (2.33)		-0.040 (-0.83)

Sectors ⇒	**Hotels and Restaurants**		**Business Services (computer consultancy)**		**Transport (Manufacturing)**	
Explanatory variables	**Eq. (2)**	**Eq. (3)**	**Eq. (2)**	**Eq. (3)**	**Eq. (2)**	**Eq. (3)**
L		0.210*** (4.80)		-0.262 (-1.25)		0.205** (2.30)
L2		0.049 (0.96)		0.047 (0.40)		0.031 (0.41)
Gross profit	0.092** (1.82)		-0.005 (-0.03)		0.022 (0.43)	
L	-0.152** (-2.18)		-0.194 (-0.97)		-0.105 (-0.68)	
L2	-0.076 (-1.06)		-0.121 (-0.59)		-0.046 (-0.61)	
Operating profit	0.059 (0.88)	-0.021 (-0.50)	0.518*** (4.44)	-0.043 (-0.21)	0.0097 (0.14)	0.161*** (2.30)
L	0.003 (0.04)	0.042 (0.92)	0.467*** (2.42)	0.395** (1.93)	0.180* (1.33)	0.285*** (3.56)
L2	-0.113 (-0.91)	.0392 (0.38)	0.621 (1.06)	1.097*** (3.55)	0.159* (1.59)	0.043 (0.49)
Other income	0.439*** (3.25)	0.0326 (0.31)	2.393*** (2.30)	3.55*** (4.25)	-0.066 (-0.54)	0.153** (1.89)
L	-0.054*** (-0.51)	-0.098* (-1.32)	-0.311 (-0.15)	2.31** (1.95)	-0.081 (-0.55)	0.019 (0.19)
L2	0.053 (0.65)	0.1483** (2.05)	0.230 (0.25)	-2.29** (-2.25)	-0.883*** (-2.97)	-0.576*** (-2.72)
Exceptional items	-0.072*** (-2.52)	0.0105 (0.44)	-0.032 (-0.17)	0.136 (0.60)	0.025 (0.92)	0.073*** (3.06)
L	-0.075** (2.06)	0.0177 (0.61)	0.372* (1.28)	0.093 (0.33)	-0.054 (-0.88)	-0.117** (2.19)
L2	0.181** (1.70)	0.114* (1.36)	0.633** (2.02)	0.850*** (2.75)	-0.06** (-2.19)	-0.012 (-0.55)
Interest paid	-0.118 (0.76)	-0.110 (-1.02)	-1.328 (-0.77)	-0.746 (-0.67)	-0.268* (-1.38)	-0.415*** (-3.89)
L	0.235 (1.15)	0.262 (1.07)	0.795 (0.31)	1.05 (0.81)	0.077 (0.36)	0.125 (0.70)
L2	-0.332* (-1.57)	-0.199 (-1.11)	1.772 (1.01)	-2.51* (-1.31)	-0.163 (-0.61)	0.253 (1.14)
Depreciation	0.363*** (3.24)		1.388 (1.22)		0.345*** (3.29)	
L	0.241*** (2.76)		0.972 (0.78)		0.242** (2.41)	
L2	-0.014 (-0.10)		0.956 (0.80)		0.103 (0.45)	
Employees remuneration	-0.051 (-0.93)	0.0007 (0.01)	-0.111 (-0.63)	-0.257* (-1.58)	-0.0228 (-0.44)	-0.094** (-2.27)
L	0.303 (0.51)	.0589 (1.06)	0.026 (0.07)	-0.495** (-2.01)	0.057 (0.48)	0.0425 (0.49)
L2	0.008 (0.23)	-0.14*** (-3.24)	-0.049 (-0.11)	0.476** (1.98)	0.039 (0.56)	0.125*** (3.30)
Directors' remuneration	-0.407 (-1.12)	-0.621** (-2.29)	-0.676* (-1.26)	-0.520 (-0.85)	0.480 (0.72)	0.7301** (1.76)

Sectors ⇒	**Hotels and Restaurants**		**Business Services (computer consultancy)**		**Transport (Manufacturing)**	
Explanatory variables	**Eq. (2)**	**Eq. (3)**	**Eq. (2)**	**Eq. (3)**	**Eq. (2)**	**Eq. (3)**
L	-0.516 (-0.91)	-0.823* (-1.39)	1.074* (1.61)	1.410* (1.60)	-0.893 (-1.03)	-2.73*** (5.17)
L2	1.311** (2.12)	1.076*** (2.40)	0.254 (0.32)	0.357 (0.64)	-0.299 (-0.36)	-0.952* (-1.30)
Constant	-41501.42 (-0.57)	-1195.19 (-0.02)	78294.4 (0.65)	-146729.5* (-1.46)	-63399.53 (-1.07)	-59256.63 (-0.96)
Observations	84	88	43	43	54	55
No. of groups	46	47	28	28	30	30
Wald test	Chi2 (42)= 18315.93	Chi2(36) =17129.1	Chi2 (40)= 10676.71	Chi2 (36)= 9125.33	Chi2 (42)= 4738.71	Chi2 (36)= 4485.44
Sargan test of over-identifying restrictions	Chi2 (9)= 16.37 Pr>chi2 = 0.04	Chi2 (9)= 9.60 Pr>chi2= 0.38	Chi2 (8)= 1.96 Pr>chi2= 0.99	Chi2 (8)= 5.62 Pr>chi2= 0.78	Chi2 (9)= 9.40 Pr>chi2= 0.40	Chi2 (9)= 11.71 Pr>chi2= 0.23
Arellano-Bond test of no auto-correlation	z=-1.33 Pr>z= 0.184 No autocorr. in residuals of order 1&2	z= -0.76 Pr>z= 0.44 No autocorr. in residuals of order 1	z=-1.17 Pr>z= 0.24 No autocorr. in residuals of order 1&2	z= -1.97 Pr>z= 0.05 No autocorr. in residuals of order 1&2	z=-1.59 Pr>z= 0.1123 No autocorr. in residuals of order 1&2	Z= -1.05 Pr>z= 0.29 No autocorr. in residuals of order 1&2

*** statistically significant at 1 % level , **statistically significant at 5% level, *statistically significant at 10% level, ^ statistically significant at 10% level. L denotes one-period lag and L2 two-period lags.