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Behavioural Responses to Corporate Profit Taxation

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Behavioural Responses to Corporate Profit Taxation*

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Abstract

This paper examines behavioural responses by companies to changes in profit taxation in their home country. The elasticity of tax revenue with respect to changes in the corparation tax rate are decomposed into a variety of responses. As well as distinguishing real from profit-shifting responses, it is important to separate the responses of gross profits from those of deductions (such as claims for past or current losses) where these are endogenously related to gross profits declared at home. This endogenous response can be expected to differ over the business cycle, which can be important for empirical estimates of aggregate behavioural responses especially, but not exclusively, during cyclical downturns. It is suggested that the revenue elasticity can be expected to be asymmetrical between periods of above- and below-trend growth, arising from the asymmetric treatment of losses by the tax function.

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1 Introduction

This paper examines a number of different behavioural responses by companies to changes in the taxation of their profits in the home country. Such responses can take two forms. First, there are real responses, whereby activities are transferred to other tax jurisdictions. The second form of response involves income-shifting in which the location of economic activity is unchanged but the extent to which profits are declared in the home country changes.[1] It is argued here that it is also important to distinguish between the responsiveness of gross profits and that of deductions allowable as profit off-sets. Where these deductions are related to the size of companies' profits, it is found that allowing for an endogenous, or automatic, response may be important for empirical estimates of firms' overall behavioural responses.

In examining behavioural responses to taxes, much use has been made of the notion of the elasticity of taxable income with respect to the retention rate, introduced by Feldstein (1995, 1999), where the retention rate is one minus the tax rate. The closely related concept of the elasticity of taxable profit with respect to the tax rate is a central focus of the present paper. Though this concept was initially proposed as a means of capturing real behavioural responses to tax reforms, Slemrod and Yitzhaki (2002) showed that the concept can be applied to any responses, including evasion and avoidance, which cause the tax base to respond to exogenous changes in tax parameters.[2] This involves, for example, the shifting of declared income, profits or deductions to a different tax jurisdiction.[3] The present paper decomposes the revenue elasticity and considers its likely variation over the business cycle.

Income shifting, as mentioned above, arises where multinational companies can change the extent to which they declare their profits in different

[1] The role of transfer pricing in profit shifting is of course well known; for a review, see Gresik (2001, pp. 808-811).

[2] The terms evasion and avoidance are used here to denote responses that have no counterpart in real economic changes. Avoidance might be described as tax planning activities which allow some flexibility in accounting for the financial flows arising from real activities, such that these can be arranged in a tax-minimising manner in accordance with tax laws.

[3] This can also include changing the type of income declared by taxpayers, for example from self-employed to corporate.

countries in response to differences in international profits taxation, without changing their real activities. Empirical estimates suggest that these shifting responses could be substantial; see, for example, studies by Hines and Rice (1994), Hines (1999), Grubert and Slemrod (1998), Bartelsman and Beetsma (2003) and Huizinga and Laeven (2007). In addition, as Markusen (2002) and Devereux and Hubbard (2003) have demonstrated, multinational firms' decisions regarding whether to locate real production facilities at home or abroad, and trade between locations, can be influenced by profit taxation.[4] Real responses are not confined to multinational firms. They can also be expected for purely domestic firms because increases in tax rates reduce net-of-tax profits at the margin and so render some previously profitable production unprofitable. In some cases firms may change to non-corporate status where personal-corporate income tax regimes differ.

Section 2 begins by defining and decomposing firms' behavioural responses. Section 3 considers the orders of magnitude of elasticities of tax paid with respect to the tax rate, for individual firms, using possible orders of magnitude of important components suggested by previous empirical studies. The potential behaviour over the business cycle of the aggregate tax revenue elasticity with respect to the tax rate is then examined in section 4. Conclusions are in section 5.

2 Types of Behavioural Response

This section begins by defining alternative behavioural responses to corporate taxation, decomposing these into real responses, profit-shifting and deductions-shifting. The context is of a firm located in a home country, or tax jurisdiction, which may, at some cost, change its declared profits in that jurisdiction in response to a change in the home tax rate. This includes, but is not limited to, moving profits abroad which may or may not involve shifting some aspects of real economic activity. For comparative static purposes, tax rates abroad are assumed throughout to be independent of the tax rate

[4] See also, for example, Feldstein *et al.* (eds) (1995), in the context of multinational corporations.

in the home country, so that responses to a change in the home tax rate can be interpreted as responses to a change in the tax differential.

Subsection 2.1 begins by specifying the composition of taxable profits. Subsection 2.2 then decomposes the overall change in a firm's tax, in response to a change in the tax rate, into its various components. Subsection 2.3 considers the likely signs attached to the components.

2.1 Taxable Profits

Consider a single company. Gross profits declared for tax are P^* and total deductions claimed against those profits are D^*, so that net taxable profits, P^T, are:

$$P^T = P^* - D^* \tag{1}$$

Deductions claimed are assumed to be related to gross declared profits, hence $D^* = D(P^*)$, but the short-hand D^* is used here. Suppose, for simplicity, that there is a single tax rate of t.[5] When $P^T > 0$, the tax liability, $T(P^*)$, is thus:

$$\begin{aligned} T(P^*) &= tP^T \\ &= t(P^* - D^*) \end{aligned} \tag{2}$$

There is an asymmetry in the tax treatment of profits arising from the fact that losses do not give rise to a tax rebate, but instead are deductible against current or future positive profits within the corporation or group defined for tax purposes.[6] Thus when $P^T \leq 0$, $T(P^*) = 0$. This reflects the UK system of corporation tax, though the same feature applies to the US, and numerous other countries', corporate tax structures.[7] The implications of this

[5] In some countries, such as the UK, there is more than one rate, but the vast majority of corporation tax is typically raised at the 'main' rate.

[6] For example, in the UK system, a current loss under one profit 'schedule' may be offset against a current profit under some, but not all, other 'schedules'. Thus a firm's ability to utilise its losses immediately can depend on the schedular characteristics of its profits and losses. Further conditions apply to firms which form part of a group.

[7] For a detailed analysis of the UK tax structure and its implications for tax revenue elasticities, see Creedy and Gemmell (2008).

kind of asymmetry for investment behaviour have been examined by Auerbach (1986), Devereux (1989), Altshuler and Auerbach (1990) and Edgerton (2007); see also Auerbach (2007). It will be seen below to have important implications in the present context.

This paper is concerned with revenue responses to a change in the tax rate. The notation used is of the form $\eta_{x,y} = (dx/dy)(y/x)$, which denotes the elasticity of x with respect to y. Taxable profit, P^T, varies as the tax rate varies so that:

$$\frac{dT}{dt} = P^T + t\frac{dP^T}{dt} \tag{3}$$

where dP^T/dt measures the extent of real changes plus 'profit shifting' in response to the tax rate change. Dividing both sides by P^T and using the fact that $\frac{dT}{P^T dt} = \frac{tdT}{Tdt}$ gives:

$$\eta_{T,t} = 1 + \eta_{P^T,t} \tag{4}$$

Thus the main elasticity of interest is the elasticity, $\eta_{P^T,t}$, of net taxable profit with respect to the tax rate. This elasticity is closely related to the Feldstein (1995) elasticity of taxable income with respect to the retention rate, $1 - t$, using:

$$\eta_{P^T,t} = -\left(\frac{t}{1-t}\right)\eta_{P^T,1-t} \tag{5}$$

The following discussion is in terms of the elasticity $\eta_{P^T,t}$.

2.2 Decomposing Behavioural Elasticities

Allowing for behavioural responses requires the extent to which profits and deductions are declared in the home tax jurisdiction to be specified. To simplify exposition, all other taxes are assumed to be constant. At this stage the use of different 'schedules' for different sources of income is ignored. In this section time subscripts are also omitted for convenience.

Define θ_p as the proportion of total gross profits, P, which are declared at home. Profits declared for tax at home, P^*, are thus:

$$P^* = \theta_p P \tag{6}$$

Similarly, let θ_d denote the proportion of total deductions which are declared at home, and let E denote qualifying expenditures which are eligible as offsets against declared profit. These include capital allowances arising from investment expenditures and accumulated losses. A proportion, s, of these qualifying expenditures can be deducted, so that declared deductions, D^*, are:

$$D^* = s\theta_d E \tag{7}$$

The deductions rate, s, is analogous to the term used by Devereux and Hubbard (2003, p. 473) to describe a 'factor which reflects the generosity of the provision for depreciation'. In the present paper, s represents the generosity of the tax code regarding all qualifying expenditures, not just those on capital. To the extent that a firm's total profits or qualifying expenditures change in response to changes in taxes, whilst keeping constant the extent to which they are declared for tax at home, these may be regarded as real. Alternatively, where total profits or qualifying expenditures remain unchanged but the proportion declared at home alters, some profit or deductions shifting can be considered to have occurred.

Using the proportions described above, (1) can be rewritten as:

$$P^T = \theta_p P - s\theta_d E \tag{8}$$

Let $\alpha = \theta_p P / P^T \geqslant 1$ denote the ratio of declared profits to the tax base, P^T; this is strictly greater than one as long as there are some declared deductions. Then, differentiating $T = t\left(\theta_p P - s\theta_d E\right)$ with respect to t, it can be shown that:

$$\eta_{P^T,t} = \alpha \left\{\eta_{\theta_p,t} + \eta_{P,t}\right\} - (\alpha - 1)\left\{\eta_{\theta_d,t} + \eta_{E,t}\right\} \tag{9}$$

In view of the fact that both weights α and $(\alpha - 1)$ can exceed unity, it is not appropriate to think of $\eta_{P^T,t}$ as a weighted average of the two terms in curly brackets in (9).

Equation (9) provides the basic decomposition of the elasticity of taxable profit with respect to the tax rate for a single firm. The first term in curly brackets, $\eta_{\theta_p,t} + \eta_{P,t}$, measures profit responses while the second term, $\eta_{\theta_d,t} + \eta_{E,t}$, measures deductions responses. The four component elasticities capture the four basic behavioural responses and are summarised in Table 1.

Table 1: Responses to a Tax Change

Income shifting		
Profit shifting:	$\theta_p = \theta_p(t)$	$d\theta_p/dt < 0$
Deductions shifting:	$\theta_d = \theta_d(t, s)$	$d\theta_d/dt > 0$
Real responses		
Real profit response:	$P = P(t)$	$dP/dt < 0$
Real deductions response:	$E = E(t, s)$	$dE/dt \lesseqgtr 0$

The willingness of firms to shift profits or deductions out of the tax net is likely to depend on the relative costs of each. For example, it may be easier to hide profits than to inflate deductions, depending on the specification of the tax code, the extent and form of enforcement activity, and the available evasion and avoidance facilities.[8] However, consider the special case where, to the extent that such factors permit, a firm seeks to be indifferent at the margin between a reduction in tax liability obtained via a reduction in declared profits, $P^* = \theta_p P$, and an increase in declared deductions, $D^* = s\theta_d E$. That is, firms would seek to set $dP^*/dt = -dD^*/dt$, implying that $\eta_{P^*,t} = -(D^*/P^*)\eta_{D^*,t}$. In this special case, the expression in (9) simplifies to:

$$\eta_{P^T,t} = 2\alpha \left\{ \eta_{\theta_p,t} + \eta_{P,t} \right\} \tag{10}$$

and knowledge of only the real profit and profit-shifting responses is required.

2.3 Expected Signs

The definitions above treat θ_p and θ_d as propensities to shift profits and deductions. In general the expected directions of change are indicated in the final column of Table 1. Total profits and the proportion declared for tax at home respond negatively to increases in t. Conversely total deductions

[8] Profit- or deductions-shifting is expected to be easier for large firms, especially multinationals, both because of their pre-existing foreign presence, and because they can more readily absorb any fixed costs of setting up avoidance schemes. Grubert and Slemrod (1998) suggested that firms which create opportunities for real profit responses, for example by setting up foreign subsidiaries, are likely to find it easier to enagage in profit-shifting; indeed the two may be joint decisions. As a result it might be expected that firms with larger values of $\eta_{P,t}$ are more likely to have larger values of $\eta_{\theta_p,t}$.

and the proportion claimed at home respond positively to changes in t and s: increased tax or deductions rates increase the corporate tax deductions value of qualifying expenditures. These sign expectations assume that substitution effects dominate any income effects: this accords with Gruber and Saez's (2002) finding that compensated and uncompensated taxable income elasticities are similar. Furthermore, the overwhelming majority of taxable income elasticity studies since Feldstein (1995, 1999) find the overall elasticity with respect to the retention rate to be positive.

Therefore the two profit responses, $\eta_{\theta_p,t}$ and $\eta_{P,t}$, encourage a negative value of $\eta_{P^T,t}$ and, to the extent that tax rate increases attract additional declared deductions, when multiplied by $\alpha - 1 > 0$, $\eta_{\theta_d,t}$ generates further negative effects on $\eta_{P^T,t}$ which compound the negative effect from profit responses. This negative deductions effect is stronger, the larger is a firm's initial deductions claim.

Even if the elasticity terms on the right hand side of (9) were to take similar values across firms, differences in α would ensure that $\eta_{P^T,t}$ varies. In particular, firms with a larger deductions base have a higher α, *ceteris paribus*, and hence a larger absolute $\eta_{P^T,t}$.[9] As a result, profit-making firms with a recent history of losses (or profit-making members of a group with large losses elsewhere) and firms with large capital allowances can be expected, *ceteris paribus*, to have stronger negative responses to a tax change. For firms declaring a current loss or zero profit, $\eta_{P^T,t}$ is of course zero.

The sign of $\eta_{E,t}$ in (9) is complicated by the fact that, to the extent that some qualifying expenditures are related to profits, there may be some automatic response of deductions to tax-induced changes in profits declared at home. For example, consider the case where a firm transfers production abroad in response to a tax change. Some profits previously obtained at home are now earned abroad. The associated investment which shifts abroad, previously deductible from profits declared at home, are no longer deductible. The elasticity $\eta_{E,t}$ can therefore be decomposed as:

$$\eta_{E,t} = \eta_{E,t}\big|_{dP^*=0} + \left(\eta_{E,P^*}\right)\left(\eta_{P^*,t}\right) \tag{11}$$

[9] The term 'larger absolute' is preferred here to 'smaller (more negative)'. Similarly, the term 'smaller absolute' is preferred to 'larger (less negative)'.

where η_{E,P^*} represents this automatic response. To make this expression less cumbersome, write $\eta_{E,t}\big|_{dP^*=0} = \eta'_{E,t}$; this 'autonomous' elasticity captures any tendency for firms to generate additional qualifying expenditures independently of declared profits. Hence:

$$\eta_{E,t} = \eta'_{E,t} + \left(\eta_{E,P^*}\right)\left(\eta_{P^*,t}\right) \tag{12}$$

For example, where enforcement of tax rules make it easier for firms to generate additional deductions via 'real' changes to qualifying expenditures, rather than shift profits or deductions abroad, $\eta'_{E,t}$ could be high relative to $\eta_{\theta_p,t}$ or $\eta_{\theta_d,t}$.

In general the sign of $\eta_{E,t}$ is ambiguous. Consider the components on the right hand side of (12). Qualifying expenditures, E, are likely to rise while profits declared at home, P^*, are expected to fall in response to an increase in the tax rate: thus $\eta'_{E,t} > 0$, $\eta_{P^*,t} < 0$. The sign of the automatic response, η_{E,P^*}, is likely to depend on the type of qualifying expenditure and whether changes in P^* arise from changes in total profits, P, or changes in profit-shifting, θ_p. It might also be expected that where the tax code causes a greater automatic response, that is, a larger absolute value of $(\eta_{E,P^*})(\eta_{P^*,t})$, firms may adopt a larger shifting response, $\eta'_{E,t}$, to compensate. Where, for example, a tax rise leads to more investment overseas, firms may attempt to compensate for the loss of capital allowances at home by shifting other deductions into the home tax jurisdiction where they have a greater tax offsetting value.

The elasticity η_{E,P^*} captures the extent to which, for given s and θ_d, claimed deductions change as declared profits change. This is affected both by changes in firms' economic circumstances and by tax rules. In a situation of steady-state or trend growth, a value of η_{E,P^*} equal or close to unity might be expected, otherwise deductions would become a persistently increasing or declining fraction of declared profits over the long-run. However, away from the steady-state, η_{E,P^*} may be greater than unity, for example when, following a recession, deductions claimed rise faster than profits. Alternatively it may be less than unity during booms when past losses are exhausted and profits grow faster than deductions. In this latter case, η_{E,P^*} could even be negative.[10]

Substituting the expression for $\eta_{E,t}$ in (12) into (9) gives:

$$\eta_{P^T,t} = \alpha \left\{ \eta_{\theta_p,t} + \eta_{P,t} \right\} - (\alpha - 1) \left\{ \eta_{\theta_d,t} + \eta'_{E,t} + \left(\eta_{E,P^*} \right) \left(\eta_{P^*,t} \right) \right\} \tag{13}$$

Since it is often easier to observe D^*, rather than E, in taxpayer data it is useful to rewrite (13) in terms of declared deductions, D^* and declared profits, P^*, so that:

$$\begin{aligned} \eta_{P^T,t} &= \alpha \eta_{P^*,t} - (\alpha - 1) \eta_{D^*,t} \\ &= \alpha \left\{ \eta_{\theta_p,t} + \eta_{P,t} \right\} - (\alpha - 1) \left\{ \eta_{\theta_d,t} + \eta'_{D^*,t} + \left(\eta_{D^*,P^*} \right) \left(\eta_{P^*,t} \right) \right\} \end{aligned} \tag{14}$$

where $\eta_{P^*,t} = \eta_{\theta_p,t} + \eta_{P,t}$, and $\eta'_{D^*,t} > 0$ is the 'autonomous' elasticity of declared deductions, *for given declared profits*, with respect to the tax rate. This captures any tendency for higher tax rates to encourage increased deductions *ceteris paribus* via either real or shifting responses. Rearranging equation (14) as:

$$\eta_{P^T,t} = \left\{ \alpha - (\alpha - 1) \eta_{D^*,P^*} \right\} \eta_{P^*,t} - (\alpha - 1) \eta'_{D^*,t} \tag{15}$$

reveals three effects on the tax base elasticity, $\eta_{P^T,t}$. The elasticities $\eta_{P^*,t}$ and $\eta'_{D^*,t}$ are the combined 'discretionary' real and shifting responses for declared profits and autonomous deductions respectively, and η_{D^*,P^*} is the endogenous automatic deductions response. They are shown in Table 2.

Table 2: Three Effects on Tax Base Elasticity, $\eta_{P^T,t}$

Variable	Effect on $\eta_{P^T,t}$	Magnitude depends on:
$\eta_{P^*,t}$	$-ve$ direct effect	Relative size of deductions, α
	$+ve$ indirect effect	Relative size of deductions, α, and endog. response to profits, η_{D^*,P^*}
$\eta'_{D^*,t}$	$-ve$ direct effect	Relative size of deductions, α

Both profits and deductions have direct negative effects on $\eta_{P^T,t}$. That is, the responses of both to increases in tax rates (profit outflow, deductions

[10] The nature of the tax code generally affects the magnitude of the elasticity η_{E,P^*}. For example, a condition that deductions can only be claimed against any currently declared positive profits effectively limits the scope of those qualifying expenditures.

inflow) serve to increase the absolute value of $\eta_{P^T,t}$. However, there is an additional indirect effect of a profit outflow, namely the loss of some deductions that otherwise could be claimed against declared profit: this reduces the absolute value of $\eta_{P^T,t}$. From (15) the direct effect dominates as long as:

$$\eta_{D^*,P^*} < \frac{\alpha}{\alpha - 1} \tag{16}$$

This inequality identifies the conditions under which a reduction in declared profits in response to a tax increase (whether via real or shifting effects) raises or lowers tax liabilities, relative to the case where $\eta_{P^*,t} = 0$. If condition (16) holds, a negative profit response to the increased tax rate has a lower tax liability than when there is no response. However, where condition (16) does not hold, the loss of deductions which could be used to off-set profits, when declared profits are reduced by a tax rate rise, would have a net effect of increasing firms' tax liabilities. In this case, firms have incentives to shift profits *into* the tax jurisdiction when the tax rate rises due to the value of associated deductions.

In general, there is no reason to expect (16) to hold since it depends on how the endogenous response of deductions to profit *changes* compares with the relative *size* of deductions to profits. Both could be determined by different characteristics of a corporate tax system.[11]

If, as argued earlier, $\eta_{E,P^*} = 1$ (and $\eta_{D^*,P^*} = 1$) in a steady-state, (13) simplifies to:

$$\begin{aligned} \eta_{P^T,t} &= \left\{\eta_{\theta_p,t} + \eta_{P,t}\right\} - (\alpha - 1)\left\{\eta_{\theta_d,t} + \eta'_{E,t}\right\} && (17) \\ &= \eta_{P^*,t} - (\alpha - 1)\,\eta'_{D^*,t} && (18) \end{aligned}$$

Hence, in the steady state, the value of $\eta_{P^T,t}$ depends on α and four elasticity components. These elasticities determine the real responses of profits, P, and qualifying expenditures, E, and of the shifting parameters, θ_p and θ_d.

[11] For example, the use of past and current losses as profits off-sets tends to generate a relationship between deductions and profits. However, the introduction of other deductions which may be unrelated to profits, or changes in qualifying expenditures, can raise the level of total deductions allowable against profits.

2.4 Changes in the Deductions Rate

The response of the tax base to changes in the deductions rate can be obtained by differentiating $P^T = \theta_p P - s\theta_d E$ with respect to s to give the elasticity, $\eta_{P^T,s}$, as:

$$\eta_{P^T,s} = \frac{dP^T}{ds}\frac{s}{P^T} = -(\alpha - 1)\left\{1 + \eta_{\theta_d,s} + \eta_{E,s}\right\} \tag{19}$$

where $\alpha - 1 = s\theta_d E/P^T$ is the ratio of deductions claimed to net taxable profit. Furthermore, $\eta_{\theta_d,s} \geq 0$ and $\eta_{E,s} \geq 0$. Also $\alpha - 1$ is positive if there are any declared deductions; it exceeds unity when $D^* > P^*/2$, and tends to infinity as D^* tends to P^*.[12] It can be seen that (19) takes a similar form to the second term in (17), reflecting the fact that there is a deductions response, but no profit response, to changes in s. Equation (19) is unambiguously negative: raising the deductions rate reduces taxable profits by increasing declared profit off-sets. This captures both a direct effect on the tax base P^T, via $-(\alpha - 1)$, by raising the deductions value of each existing unit of qualifying expenditures, and a behavioural effect to the extent that $\eta_{\theta_d,s} > 0$ or $\eta_{E,s} > 0$.

3 Illustrative Examples

To illustrate orders of magnitude for the elasticity, $\eta_{P^T,t}$, for a single firm or group, it is necessary to consider possible values for the components in equations (13) or (17). Subsection 3.2 first reviews estimates from empirical studies which provide a guide to orders of magnitude relevant to the UK's corporate tax system. Based on these estimates, a set of benchmark parameters are described in subsection 3.2, after which subsection 3.3 presents numerical results.

3.1 Estimates of Response Parameters

There are various 'behavioural response' estimates available in the empirical literature. These can be used to guide choices in producing illustrative

[12] For tax-paying firms, declared deductions cannot exceed declared profits

examples and simulations below. The estimates of the 'Feldstein elasticity' of taxable income with respect to the retention or net-of-tax rate generally relate to personal, rather than corporate, incomes. After reviewing various approaches, Gruber and Saez (2002) suggest that best estimates for this are around 0.4. From (5), a value of $\eta_{P^T,(1-t)} = 0.4$ would imply $\eta_{P^T,t}$ in the range -0.13 to -0.27 for t in the range 0.25 to 0.4. Given their focus on personal taxes however, these estimates may be less representative of profit responses to corporate tax rates.

Estimates for various income shifting responses for samples of multinational corporations were reported by Bartelsman and Beetsma (2003), Grubert and Slemrod (1998) and Hines and Rice (1994). Using OECD country-level data on the share of labour income in value added, Bartelsman and Beetsma (2003) estimated pure profit-shifting for OECD countries on average. Their 'back-of-the-envelope' central estimate of profit-shifting is that about 65 per cent of additional revenue following a tax rate rise leaks abroad.

Thus the elasticity of declared revenue with respect to the tax rate is around 0.35. From (4), since $\eta_{P^T,t} = \eta_{T,t} - 1$, the implied tax base elasticity is -0.65. Bartelsman and Beetsma obtained UK parameter estimates close to the OECD average. This may be regarded as an estimate of the profit-shifting component, $\alpha\eta_{\theta_p,t} - (\alpha - 1)\eta_{\theta_d,t}$, in (13) rather than of the total real-plus-shifting response. By focussing only on shifting responses Bartelsman and Beetsma argued that their estimates could be regarded as lower bounds. More detailed recent estimates for European multinationals, from Huizinga and Laeven (2007), are somewhat smaller for the UK than those derived from the Bartelsman and Beetsma results. Their estimate of the semi-elasticity of reported profits with respect to the top statutory tax rate (of around 1.1 for the UK) implies an elasticity of -0.33, assuming a 30 per cent corporate tax rate.[13]

Grubert and Slemrod (1998) focused on profit-shifting to Puerto Rico by US multinationals, allowing for both real foreign investment and profit-

[13] However, the Huizinga and Laeven semi-elasticities are based on profits data in commercial accounts and are not necessarily equivalent to the elasticity measured here which relates to net taxable profits.

shifting to tax havens. Though estimates of an elasticity are not readily derivable, their results confirm that substantial real plus profit-shifting responses by US multinationals was mainly motivated by the profit-shifting opportunities which the real foreign investment provides.

Hines and Rice (1994) examined aggregate 1982 country-level data for reported non-financial profits of US parents and affiliates with investments in tax havens and other foreign countries. They report that a 1 percentage point higher tax rate reduces reported profits by 3 per cent. Across such a wide-ranging sample of countries, the corporate tax rate is likely to vary. An average of around 30 per cent implies an elasticity around -1; a 15 per cent tax rate implies an elasticity around -0.5.

The Hines-Rice elasticity probably includes both real and profit-shifting responses and so approximates $\eta_{P^T,t}$. However, part of the large observed tax response arises because of the US system of taxing world-wide income, which makes this unrepresentative of responses in countries such as the UK - for which other benchmark parameters below are based. The Bartelsman and Beetsma (2003) estimate relates only to shifting to other OECD countries while the Gruber-Slemrod and Hines-Rice estimates relate to shifting to especially low-tax havens – hence the larger estimates for the latter.

3.2 Benchmark Parameters

This subsection considers a set of benchmark parameters for numerical examples. Adopting a steady-state value of $\eta_{E,P*} = 1$ allows equation (17) to be used. The illustrations below also set $s = 1$. Table 3 shows the assumed values of the four elasticity components and the declared proportions, θ_p and θ_d, required to calculate $\alpha - 1$ in (17). It might be expected that these parameters cannot be chosen independently by firms. For example, as Slemrod and others have suggested, if it becomes more costly to shift further increments of profits abroad, then $\eta_{\theta_p,t}$ and $\eta_{\theta_d,t}$ may become smaller as θ_p and θ_d are reduced. However, the numerical illustrations examine individual parameter changes holding all others constant.

The benchmark case assumes a 5 per cent real profit response to changing

Table 3: Benchmark Parameter Values

	Elasticity	Benchmark	Alternatives
Profit shifting	$\eta_{\theta_p,t}$	-0.375	-0.625
Deductions shifting	$\eta_{\theta_d,t}$	0.25	0.5
Real profit response	$\eta_{P,t}$	-0.05	$-0.1, -0.2$
Real deductions response	$\eta_{E',t}$	0.05	$0.1, 0.2$
Proportion of P declared	θ_p	0.8	0.6
Proportion of D declared	θ_d	0.8	0.6
Deductions rate	s	1.0	$0.8, 0.6$

tax rates, but alternatives of 10 per cent and 20 per cent are also examined. Comparable positive values are used for the discretionary real deductions response, $\eta'_{E,t}$. With $s = 1$ and for a given θ_d, the response of qualifying expenditures is the same as that for declared deductions. This response is referred to as 'discretionary' to distinguish it from the automatic deductions response.

A benchmark elasticity of $\eta_{\theta_p,t} = -0.375$ and deductions shifting is assumed to be slightly more difficult with $\eta_{\theta_d,t} = 0.25$.[14] Using $E/P = 0.5$, so that $\alpha = 2$, gives a benchmark total 'shifting elasticity' of $\eta_{\theta_p,t} + (1-\alpha)\eta_{\theta_d,t} = -0.625$.

These illustrative values should not be interpreted as representing 'average' responses, since many firms' responses could be expected to be very small or zero. However they serve to illustrate the responsiveness properties of those firms with more substantial behavioural responses to tax changes.

3.3 Numerical Results

Some numerical results are shown in Figure 1 where each of the four diagrams shows the elasticity $\eta_{PT,t}$ on the vertial axis and the size of qualifying

[14]If profit-shifting is driven by changes in the tax rate differential between home and overseas tax jurisdictions, the assumed precentage change in the home tax rate is small compared with the percentage change in the differential. For example if the home rate falls from 25 per cent to 23 per cent (a -8 per cent change) but the relevant overseas rate remains at, say, 35 per cent, the differential has changed by 20 per cent (from 10 per cent to 12 per cent). Thus a relatively large response to a relatively small change in the home tax rate may not be so surprising.

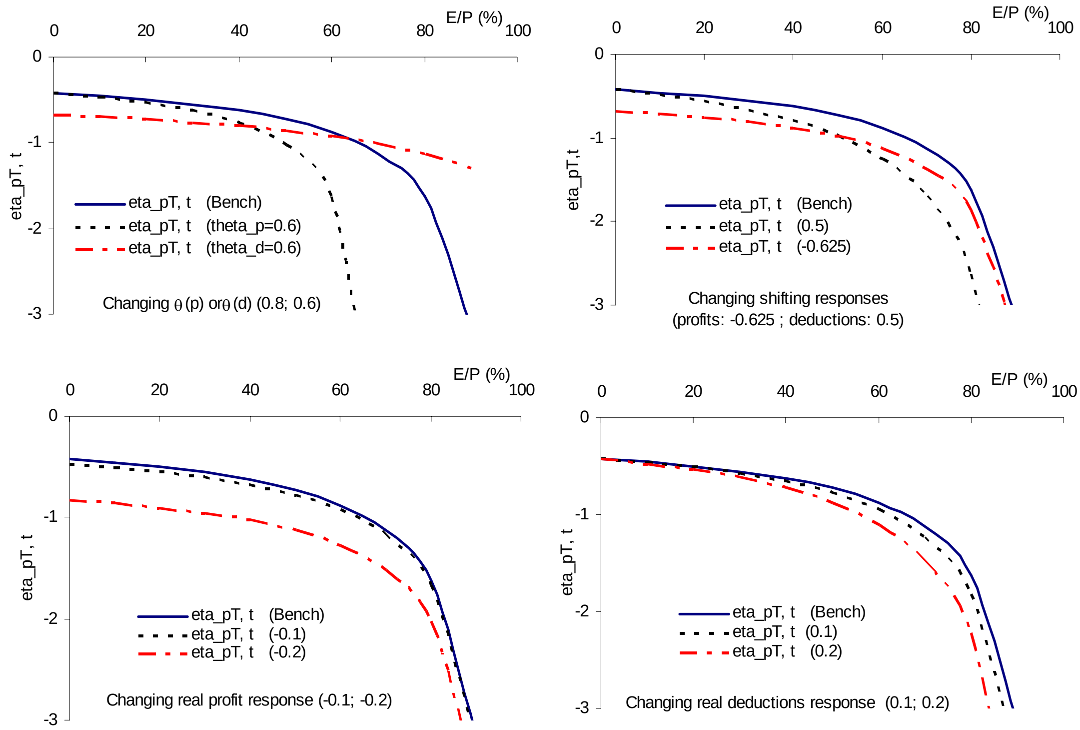

Figure 1: Relationship between $\eta_{P^T,t}$ and E/P: Individual Firms

expenditures relative to total profits, E/P, on the horizontal axis, expressed as a percentage. Each diagram shows a range of profiles for $\eta_{P^T,t}$, resulting from changes in one of the relevant parameters while leaving all others fixed at their benchmark values. The top left and right hand diagrams show respectively the effects of varying the proportions (of profits and deductions) declared and the degree of shifting (again of profits and deductions). The bottom left and right hand diagrams show respectively the effects of varying real profit responses and real deductions responses.

The E/P ratio is not typically observable in taxpayer data. However, for the UK, the ratio of declared deductions to profits, D^*/P^*, is observable. H.M. Revenue & Customs (HMRC) data show this to be around the range 0.45 to 0.56, for companies in aggregate.[15] The benchmark values of $\theta_p = 0.8$

[15] HMRC data on all companies (excluding Life Assurance and North Sea Oil companies) over 1997-98 to 2003-04 show that the ratio of all deductions (excluding a small amount

and $s = 1$ then yield E/P in the range 0.56 to 0.70.

To interpret the diagrams, it is useful to bear in mind that the impact of the E/P ratio on $\eta_{P^T,t}$ operates via changes in α in (17). For example, with a central estimate of $E/P = 0.5$ and $\theta_d = 0.8$, then $\alpha = 2$, and with $\eta_{E,P^*} = 1$, (17) simplifies to:

$$\eta_{P^T,t} = \eta_{\theta_p,t} + \eta_{P,t} - \eta_{\theta_d,t} + \eta_{E',t} \tag{20}$$

At the extremes, as E/P tents to 1, the weight $\alpha - 1$ tend to infinity, so that the absolute elasticity, $\eta_{P^T,t}$ becomes infinitely large. And as E/P tends to 0, the term $\alpha - 1$ tends to 0 and the elasticity is determined solely by the first two profit-related terms in (20). In all the diagrams it is clear that E/P has important, non-linear effects on the overall elasticity, $\eta_{P^T,t}$.

The top left and bottom right hand side diagrams of Figure 1 reveal that changes in θ_p, θ_d or $\eta'_{E,t}$ cause the benchmark profile to rotate (around a value at $E/P = 0$), whilst changes in $\eta_{P,t}$ cause the benchmark profile to shift (the bottom left hand diagram). The top right hand diagram also reveals that changes in the 'shifting elasticities' have differing effects on the overall elasticity. An increase in the absolute value of $\eta_{\theta_p,t}$ causes the profile to shift downwards whilst an increase in $\eta_{\theta_d,t}$ causes the profile to rotate clockwise. This difference reflects the fact that the impact of $\eta_{\theta_d,t}$ on the overall elasticity is affected by $\alpha - 1$, whereas this is irrelevant to the impact of changes in $\eta_{\theta_p,t}$.

These illustrations show how differences in α can affect observed profit and deductions responses. However, by maintaining $\eta_{E,P^*} = 1$ (or equivalently, $\eta_{D^*,P^*} = 1$), they cannot demonstrate the endogenous impact on deductions of changes in declared profits. This aspect is likely to be important when considering behavioural responses at different points in the economic cycle, and is examined in the next section.

of tax credits), to gross declared profits, ranges from a low of 0.46 in 1998-99 to a high of 0.56 in 2002-03. see http://www.hmrc.gov.uk/stats/corporate_tax/table11_2.pdf.

4 Responses over the Business Cycle

This section considers how the endogenous response of deductions to changes in declared profits, η_{D^*,P^*}, might change over the cycle as, for example, the ratio of losses to profits varies. This can translate into variations in $\eta_{P^T,t}$ over the cycle as shown in equation (15). The resulting cyclical pattern observed for $\eta_{P^T,t}$ also depends on any cyclical changes in the behavioural response elasticities. These might reasonably be thought of as fairly stable over the cycle, though firms may seek to increase their autonomous behavioural responses when endogenous responses otherwise restrict their ability to shift profits or deductions.[16]

In this section it is convenient to work with the elasticity of taxable profits with respect to declared profits, η_{P^T,P^*} rather than the equivalent deductions elasticity, η_{D^*,P^*}. Differentiating equation (1):

$$\frac{dP^T}{dP^*} = 1 - \frac{dD^*}{dP^*}$$

and the two elasticities are related as follows:

$$\eta_{P^T,P^*} = \alpha - (\alpha - 1)\, \eta_{D^*,P^*} \tag{21}$$

where, as previously, $\alpha = P^*/P^T$. That is, the two elasticities in (21) differ only by a factor due to the relative size of declared profits and deductions. Substituting (21) into (15) then gives:

$$\eta_{P^T,t} = \eta_{P^T,P^*}\eta_{P^*,t} - (\alpha - 1)\, \eta'_{D^*,t} \tag{22}$$

Hence, if it is reasonable to assume that the behavioural elasticities, $\eta_{P^*,t}$ and $\eta'_{D^*,t}$ are relatively stable over the business cycle, the overall tax revenue response, $\eta_{P^T,t}$, can be expected to follow a similar (but inverse) cycle to η_{P^T,P^*} (since $\eta_{P^*,t} < 0$).[17]

[16] Evidence for the US, reported by Auerbach(2007), suggests that, in aggregate, companies' effective average rates of corporate tax rise during recessions in association with increasing losses. Thus, if companies do indeed engage in profit- or loss-shifting, these responses appear to be insufficient to conteract fully the impact of exogenous profit-loss cycles.

[17] However, $\alpha - 1$ in (22) is also likely to be cyclical, as the ratio of deductions to profits changes.

Since interest here is in the effect of loss asymmetries, this section focusses on loss-related deductions only, which are likely to be the main cyclically-related deduction.[18] However, in examining the cyclical behaviour of η_{P^T,P^*} it is clearly of little interest to consider only firms that are persistently in either profit or loss (for whom η_{P^T,P^*} is persistently 1 and 0 respectively) but to allow for firms that cycle between positive declared profits and losses. In fact the key dynamic properties of η_{P^T,P^*} can readily be illustrated using just two firms, each of which is taxed independently and obtains profits from just one source. This is equivalent to assuming that there is full flexibility in using losses from different sources in different time periods, with all losses fully deductible against any current positive declared profits.[19]

With more than one firm it is necessary to consider the *aggregate* elasticity of taxable profits with respect to the tax rate (across both firms), and its potential variation over the business cycle. Using Ω to denote the aggregate equivalent of η, it can be shown that Ω_{P^T,P^*} is a taxable profit share-weighted average of the individual elasticities:

$$\Omega_{P^T,P^*} = \sum_j \eta_{P^T,P^*} \left(\frac{P_j^T}{P^T} \right) \tag{23}$$

where, in the present illustration, there are $j = 1, 2$ firms.

Let gross declared profits in period i for firm j be $P_{i,j}^*$; positive profits are denoted by $P_{i,j}^+ = \max\left(P_{i,j}^*, 0\right)$ and losses are $P_{i,j}^- = \max\left(-P_{i,j}^*, 0\right)$. If $L_{i,j}$ is firm j's loss pool in period i, carried over from the previous period, the losses available to be used as deductions in period i are thus $L_{i,j}^D = L_{i,j} + P_{i,j}^-$. Hence taxable profit for each firm is:

$$P_{i,j}^T = \max\left(P_{i,j}^+ - L_{i,j}^D, 0\right) \tag{24}$$

[18] Capital allowances are the other main deduction in the UK system. to the extent that investment is related to current profits, these would tend to be pro-cyclical. However empirical data does not suggest a clear cyclical pattern.

[19] Thus $s = 1$ in (7) above. In a full treatment, allowing for many firms, the aggregate equivalent of η_{P^T,P^*} (across all firms) depends in a complex way on the changing distribution of profits over time and the use, including sharing of losses and other deductions. Creedy and Gemmell (2007) use a microsimulation model to examine this aspect for the UK, and which incorporates a number of the UK's loss asymmetries, such as the limitations of group loss-sharing.

and the loss pool carried forward to the next period is:

$$L_{i,j+1} = L_{i,j}^{D} - \min\left(P_{i,j}^{+}, L_{i,j}^{D}\right) \tag{25}$$

Suppose that there is no trend growth in profits, but $P_{i,j}^{*}$ follows a similar cycle for each firm, described by a sine wave.[20] Hence, if A is the amplitude of the cycle and W is its wavelength, the time stream is given by:

$$P_{i,j}^{*} = A \sin\left(\frac{2\pi\left(i-1\right)}{W}\right) + d_j \tag{26}$$

where d_j is a shift parameter for each firm, determining the profit levels at central points of the cycle (such as $i = 1, 11, 21, ...$).

Suppose that firm 1 is such that, over the business cycle, profit always remains positive. As noted above, in this simple context the individual elasticity, $\eta_{P_1^T, P_1^*}$, measured as $\left(P_{i,j}^{T} - P_{i-1,j}^{T}\right)/P_{i-1,j}^{T}$ divided by $\left(P_{i,j}^{*} - P_{i-1,j}^{*}\right)/P_{i-1,j}^{*}$ for $i = 1$, is always equal to 1. But firm 2 experiences losses during some of the 'depression' periods. Profiles of gross and taxable profit for firm 2 are shown in Figure 2.[21] Once gross profit becomes negative, it is clear that taxable profit is zero. But once the firm begins to make positive profits again, the loss pool built up during the periods of negative profits can be used to keep $P_2^T = 0$. Hence where the dashed line, indicating P_2^T, in Figure 2 follows the horizontal axis, it must be the case that over this period, $\eta_{P_2^T, P_2^*} = 0$. Hence the aggregate elasticity Ω_{P^T, P^*} must be less than 1.

Eventually, as the loss pool of firm 2 moves towards exhaustion, there is a period during which taxable profit is positive but less than gross profit, as the last of the loss pool is used. In the example in Figure 2 this affects the individual, and hence aggregate, elasticity over two periods. Moving into positive taxable profit the individual elasticity is infinitely large, and then moving from the period when taxable profit is smaller than gross profit to that when they are equal (when the loss pool has been exhausted), the

[20] An exogenous cycle in *gross* profits, P_j, rather than *declared* profits, P_j^*, is perhaps more appropriate but would require explicit modelling of profit-shifting, $\theta_{p,j}$, over the cycle. For the purpose of the present illustration it is convenient to treat $\theta_{p,j}$ and P_j similarly.

[21] The values were obtained using a wavelength of $W = 20$, an amplitude of 12, and shift parameters of $d_1 = 30$ and $d_2 = 4$.

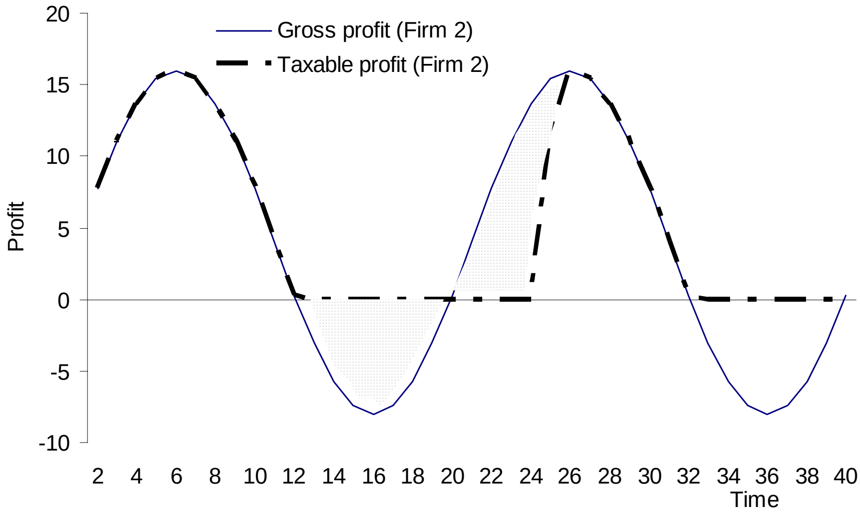

Figure 2: Gross and Taxable Profit Profiles for Firm 2

elasticity is greater than 1. In aggregate terms, taxable profit is growing faster than gross profit and hence the aggregate elasticity must exceed 1. In Figure 2 the shaded area between the horizontal axis and the profile of negative gross profit represents the loss pool built up during the depression. This must be equal to the subsequent shaded area above the horizontal axis. After this period, when gross and taxable profits move together for both firms, the aggregate elasticity Ω_{P^T,P^*} must again be 1.

The profiles of aggregate taxable and gross profits are shown in Figure 3. The dashed line, showing aggregate taxable profit, simply follows the gross (and taxable) profit of firm 1 during the period when firm 2 makes losses, and also in subsequent periods when firm 2 is able to keep its taxable profit equal to zero. Taxable profit thereafter moves up sharply to follow aggregate gross profit. When the two aggregate profiles are identical, then clearly $\Omega_{P^T,P^*} = 1$. When firm 2 has no taxable profit, $\Omega_{P^T,P^*} < 1$, and for the period when firm 2 moves from zero taxable profit to $0 < P^T < P^*$, the (two) individual elasticities are such that in aggregate $\Omega_{P^T,P^*} > 1$.

The elasticity profile is shown in Figure 4, where Ω_{P^T,P^*} is measured on the right vertical axis. This diagram also shows the profile of aggregate gross

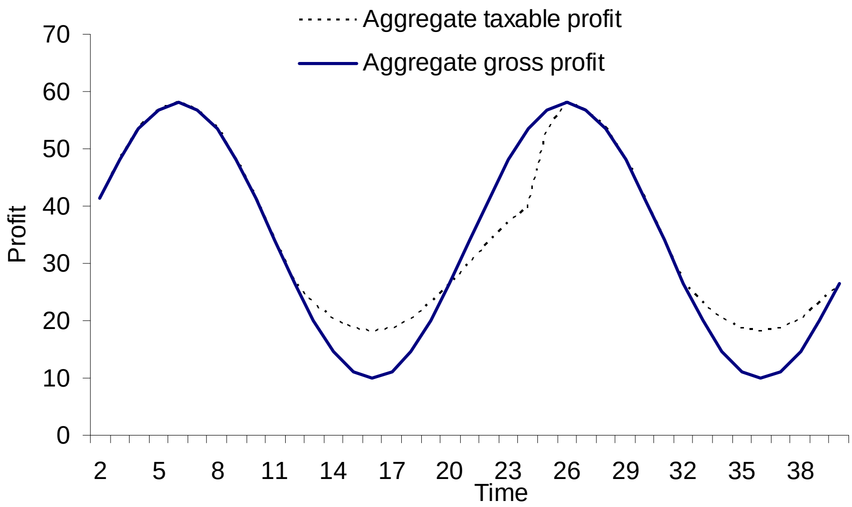

Figure 3: Aggregate Gross and Taxable Profits Over the Business Cycle

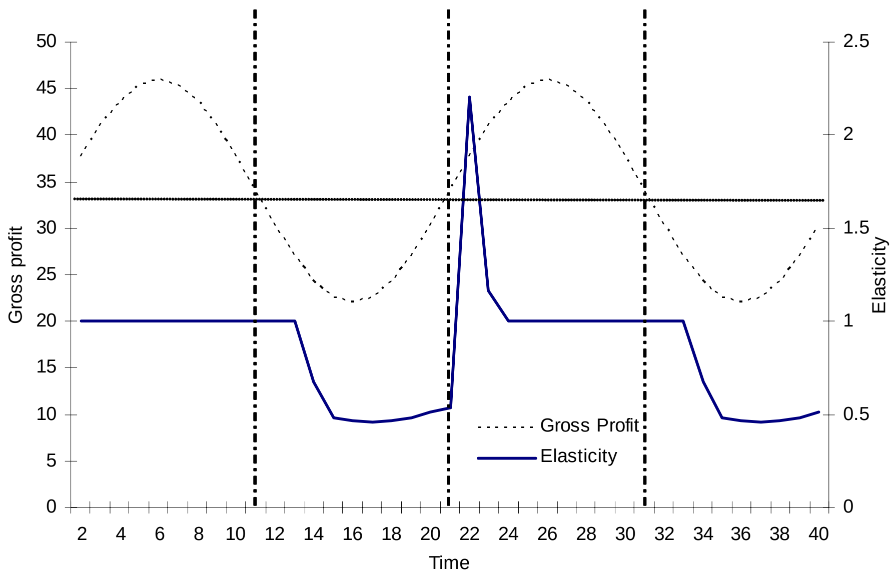

Figure 4: The Aggregate Elasticity of Taxable Profit with Respect to Gross Profit

profit, measured on the left vertical axis, so that the elasticity can easily be related to the business cycle. The horizontal and vertical lines drawn through the aggregate gross profit sine wave mark the mid-points of the cycles. As discussed above, the profile of the elasticity, Ω_{P^T,P^*}, is horizontal until firm 2 begins to make a loss. It then dips down below 1 until firm 2 moves into positive taxable profit, when the aggregate elasticity has a sharp spike before settling back to $\Omega_{P^T,P^*} = 1$ during the remaining part of the 'boom' period of the business cycle and the start of the 'depression' period up to the point where firm 2 starts to make losses again.

The question then arises of how the profile of the elasticity Ω_{P^T,P^*} is affected by the amplitude of the business cycle. Figure 5 compares two business cycles. The solid line is the relatively low amplitude cycle, for which the previous results were obtained. The dashed line represents a cycle for which the wavelength is the same but the variation around the 'zero growth' positions is greater in both directions. Nevertheless, by construction, firm 1 continues to obtain positive profits in every period. The first implication of a higher amplitude must be that firm 2 moves into negative profits at an earlier point in the depression phase of the cycle and does not move into positive profits until later in the 'upswing'. This, combined with the fact that the loss pool built up during the negative profit periods is larger than with the lower amplitude cycle, means that the elasticity profile is less than 1 for longer. The subsequent 'spike' in the elasticity profile is also greater. The two profiles are compared in Figure 6.

These results demonstrate that the asymmetry in the tax function's treatment of losses, compared with positive profits, implies that over the business cycle the variation in the aggregate elasticity Ω_{P^T,P^*} itself displays an asymmetric pattern. During part of the boom period the elasticity is unity but during the depression it moves below 1 as soon as firm 2 makes losses. This is followed by a brief period when the elasticity exceeds unity, before it again equals 1. A higher amplitude of the cycle cannot raise the elasticity above 1 during the relevant periods, although the extent of the 'spike' above 1 is greater and the extent of the movement below 1 is greater. From equation (22), this means that the elasticity $\Omega_{T,t}$ is relatively high during depressions

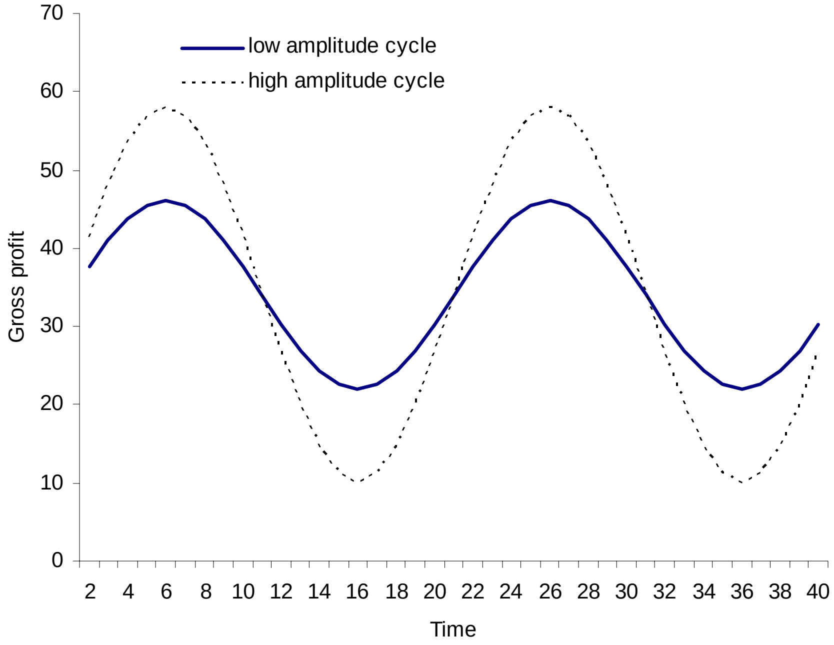

Figure 5: Low and High Amplitude Business Cycles

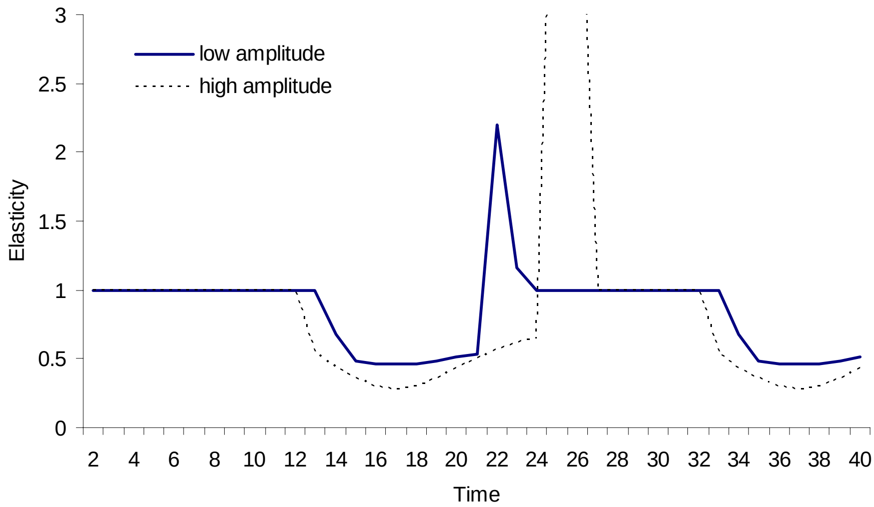

Figure 6: Elasticity Profiles for High and Low Amplitude Business Cycles

(when $\Omega_{P^T,P^*} < 1$) and relatively 'flat' and low during the phase where $\Omega_{P^T,P^*} = 1$. That is, the relatively *low* endogenous response of taxable profits to gross profits during depressions, contributes towards a *higher* value of $\Omega_{T,t}$, implying a smaller behavioural response of tax revenue to the tax rate. (Recall $\Omega_{T,t} = 1$ in the absence of any behavioural response; see equation (4)).

This simple model considers just two firms. The introduction of additional complexity arising from a distribution of firms does not affect the fundamental 'asymmetry' results. However, the existence of more firms moving into and out of losses at different phases of the business cycle must lead to a smoothing of the elasticity profile (rather than, for example, the sharp drop below unity when firm 2 begins to make losses) and a longer period during which the elasticity is above unity. The asymmetry over the business cycle nevertheless remains. This is because of the fact that the use of losses as deductions is relatively unimportant in above-trend growth (when aggregate losses are relatively small) but becomes particularly important in below-trend growth when losses are larger on average. This, in turn arises because the taxable profit distribution is effectively truncated at zero, unlike the gross profit distribution. Thus, large losses both generate additional deductions and simultaneously limit the ability of firms to claim them, until positive profits return (or they can be shared with group partners in profit).

5 Conclusions

This aim of this paper has been to examine the composition of behavioural responses by companies to changes in the taxation of their profits in the home country, and the possible pattern of such responses over the business cycle. Emphasis has been on the determinants of the elasticity of corporation tax paid, by individual firms and in aggregate, in response to a change in the corporation tax rate. This elasticity is closely related to the elasticity of net or taxable profits with respect to a change in the tax rate. In this respect the paper may be seen as following the broad agenda set by Feldstein (1995) who emphasised the importance of the elasticity of taxable income with respect to the retention, or net-of-tax, rate.

Firms' responses to tax rate changes can take the form of real responses, in which real activities change or are relocated to other tax jurisdictions, and income-shifting responses in which the location of economic activity is unchanged but the extent to which incomes are declared in the home country changes. The present paper has shown that it is also important to distinguish separate responses of gross profits and of deductions allowable as profit off-sets. In particular, the overall elasticity of taxable profits with respect to the tax rate can be decomposed into four elasticities relating to real/shifting and profit/deduction responses, along with the ratio of gross declared profits to taxable profits. The size and type of 'qualifying expenditures' was shown to be important as this determines both the extent of deductions and their endogenous or automatic adjustment in association with profit changes. This endogenous response directly impacts on measures of overall tax responsiveness.

The endogenous deductions response can be summarised by the elasticity of aggregate taxable profits with respect to gross declared profits. This was shown to be pro-cyclical, leading to a variation in the elasticity of total revenue with respect to the tax rate that, *ceteris paribus*, is counter-cyclical. However, this variation is unlikely to be symmetric, being especially pronounced in periods of recession. This asymmetry between booms and recessions arises because of the asymmetric treatment of losses in the tax code, together with the fact that losses tend to be relatively unimportant as tax deductions in circumstances of trend, or above-trend, growth. The asymmetry increases as the amplitude of the profit cycle increases.

An implication of these findings for empirical attempts to measure behavioural responses of tax revenue or profits to corporate tax rate changes, is that the nature and extent of corporate tax deductions, especially losses, can be expected to give rise to quite different behavioural response estimates. This is especially true for countries where tax codes display greater asymmetry in their treatment of losses, and in relatively high loss (recession) circumstances. In this context, firms are likely to be more constrained by the endogenous 'tying' of deductions to profits claimed in their home jurisdiction. By contrast, even with asymmetric loss treatment, behavioural response estimates may be relatively unaffected when firms' profits are on- or above-trend. Existing empirical estimates of corporate behavioural responses differ quite widely even for the same or similar countries. Various conceptual, methodological or practical reasons might account for this. The present paper suggests that additional factors to consider, largely ignored thus far, are the differential asymmetric treatment of losses across countries, and the point in a country's economic cycle when behavioural responses are estimated.

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