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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 corporation tax rate are decomposed into a variety of responses. As well as distinguising 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 endogeneous 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.

Keywords: Corporation tax, profit shifting, revenue elasticity, tax asymmetries.

JEL classification: H25, H32.

1. Introducción

This paper examines a number of diferent 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.

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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. Here there is of course a significant role for transfer pricing; see Gresik (2001, pp. 808-811). In the context of personal income taxation, Feldstein (1995, 1999) introduced the concept of the elasticity of taxable income with respect to the retention rate (one minus the tax rate). 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 which cause the tax base to respond to exogenous changes in tax parameters.[1] The closely related concept of the elasticity of taxable profits with respect to the corporate tax rate is therefore central, and is the focus of attention here.

The components of companies' responses are considered by decomposing this elasticity and it is argued that it is particularly 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.

Income shifting arises where multinational companies can change the extent to which they declare their profits in different countries in response to diferences 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; see also Feldstein *et al.* (eds) (1995). 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 and corporate income tax regimes differ.

The present paper begins by examining the elasticity for individual firms. However, from a policy point of view, it is important also to consider what happens to aggregate tax revenues. A second aim of the paper is to consider the potential behaviour of the aggregate revenue elasticity with respect to the tax rate over the business cycle. In considering such dynamics, an important role is played by the asymmetric nature of the corporate tax system whereby losses do not give rise to a rebate, so that the use of loss pools over the cycle has a substantial influence. The implications of this asymmetry are investigated using a stylised dynamic process.

Section 2 defines and decomposes 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 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 considers declared profits and deductions. Subsection 2.3 then decomposes the overall change in a firm's tax, in response to a change in the tax rate, into its various components. Subsection 2.4 considers the likely signs attached to the components.

2.1. Taxable Profits

For a single company, net taxable profits, P^T, are defined as the difference between gross profits declared for tax, P^*, and total deductions claimed against those profits, $D^* = D(P^*)$, so that:

$$P_T = P_* - D_* \tag{1}$$

The firm's tax liability, $T(P^*)$, is some function of P^T. In many countries this is a multi-step function, containing a number of rates and thresholds. However, within any range, tax liability can be expressed as an equivalent single-rate structure. [2] Furthermore, the vast majority of corporation tax is typically raised at a main or standard rate. Hence it is suficient in what follows to consider a single rate structure:

$$\begin{aligned} T(P_*) &= 0 && \text{if } P_T \leq 0 \\ &= tP_T = t(P_* - D_*) && \text{if } P_T > 0 \end{aligned} \tag{2}$$

There may (as in some European Union countries) be some form of nonrefundable tax credit, associated for example with research and development expenditure. In most cases it is possible to redefine such credits in terms of their deductions equivalent. [3] Hence in what follows, the existence of credits is ignored.

There is clearly 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. This feature applies to the UK, the US and numerous other countries' corporate tax structures. [4] The implications of this 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.

For a firm with positive net taxable profits:

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

where dP^T/dt measures the combined extent of real changes and profit shifting in response to the tax rate change. Dividing both sides by P^T and using the fact that $dT/P^T dt = tdT/Tdt$ gives:

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

where in general $\eta_{x,y} = (dx/dy)(y/x)$ denotes the elasticity of x with respect to y. Thus the main elasticity of interest is the elasticity, $\eta_{P^T,t}$,of net taxable profit with respect to the tax rate. It is this elasticity that is decomposed, and examined further, below.

2.2. Declared Profits and Deductions

Allowing for behavioural responses requires the extent to which profits and deductions are declared in the home tax jurisdiction to be specified. At this stage the use of different 'schedules' for different sources of income is ignored. Define θ_p as the proportion of total gross profits, P, which are declared at home, so that, where time subscripts are omitted for convenience:

$$P^* = \theta_p P \tag{5}$$

Similarly, let θ_d denote the proportion of total deductions which are declared at home, and let E denote qualifying expenditures eligible as off-sets 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:

$$D^* = s\theta_d E \tag{6}$$

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.

Equation (1) can be rewritten as:

$$P^T = \theta_p P - s\theta_d E \tag{7}$$

It is convenient to let α denote the ratio of declared profits to the tax base, so that:

$$\alpha = \frac{P^*}{P^T} = \frac{\theta_p P}{P_T} \tag{8}$$

Hence, using (7):

$$\alpha = 1 + \frac{s\theta_d E}{P^T} = \left\{1 - \left(\frac{s\theta_d}{\theta_p}\right)\left(\frac{E}{P}\right)\right\}^{-1} = \left\{1 - \left(\frac{D^*}{P^*}\right)\right\}^{-1} \tag{9}$$

and α is strictly greater than one as long as there are some declared deductions (that is $D^* > 0$).

Key ratios used in later sections to examine the cyclical properties of behavioural responses to tax changes are the ratios of qualifying expenditures to gross profits, E/P, or the ratio of declared deductions to declared profits, D^*/P^*, where the latter is more readily observable in taxpayer data. These ratios can be expected to vary over the cycle as increasing or decreasing losses respectively raise or lower E and D^*, relative to the profit variables, P and P^*. Equation (9) shows that α varies (positively) with these ratios.

2.3. Behavioural Elasticity Components

To identify the impact of real and shifting deductions responses to tax rate changes the elasticity of net taxable profits in (4) can be expressed in terms of its components. Thus, differentiating (7) with respect to t, and using the definition of α in (9), it can be shown that:

$$\eta_{P^T,t} = \alpha\left\{\eta_{\theta_p,t} + \eta_{P,t}\right\} - (\alpha - 1)\left\{\eta_{\theta_d,t} + \eta_{E,t}\right\} \tag{10}$$

Equation (10) 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 extent to which firms shift profits or deductions out of the home 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. [5]

2.4. Expected Signs

In general the expected directions of change are indicated in the final column of Table 1. 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.

Even if the elasticity terms on the right hand side of (10) were to take similar values across firms, differences in α would ensure that $\eta_{P^T,t}$ varies. In particular, as is evident from (9), firms with a larger deductions base have a higher α, *ceteris paribus,* and hence a larger absolute $\eta_{P^T,t}$ [6]. 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 (10) 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, suppose a firm transfers production abroad in response to a tax change, so that 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. This automatic response can be expressed as the elasticity, η_{E,P^*}.

Furthermore, define the partial elasticity, $\eta'_{E,t}$, which captures the extent to which firms generate additional qualifying expenditures independently of declared profits (that is, the elasticity of E with respect to t,when P^* is held constant); this can be referred to as an 'autonomous' elasticity. The elasticity, $\eta_{E,t}$, can therefore be decomposed as:

$$\eta_{E,t} = \eta'_{E,t} + \left(\eta_{E,P^*}\right)\left(\eta_{P^*,t}\right) \tag{11}$$

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, $\eta'_{E,t}$ (and hence $\eta_{E,t}$) could be high relative to $\eta_{\theta_p,t}$ or $\eta_{\theta_d,t}$ in equation (10).

In general the sign of $\eta_{E,t}$ is ambiguous. Consider the components on the right hand side of (11). Although it is likely that $\eta'_{E,t} > 0$ and $\eta_{P*,t} < 0$, the sign of the automatic response, $\eta_{E,P*}$, depends 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 $\eta_{E,P*}$, firms may adopt a larger autonomous 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 off-setting value.

The automatic response elasticity $\eta_{E,P*}$ 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 $\eta_{E,P*}$ 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, $\eta_{E,P*}$ may be greater than unity. This could arise when, following a recession, deductions rise faster than profits. Alternatively it may be less than unity, or even negative, during booms when past losses are exhausted and profits grow faster than deductions.

It is often easier to observe declared deductions, D^*, rather than the associated qualifying expenditures, E, in taxpayer data. Hence it is useful to consider the equivalent of (10) expressed in terms of declared deductions, D^* and declared profits, P^*. First, define the elasticity, $\eta_{D*,t}$, using, as in (11):

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

where, as above, a prime on the elasticity indicates that P^* is held cosntant; that is $\eta'_{D*,t} > 0$ is the 'autonomous' elasticity of declared deductions with respect to the tax rate, for given declared profits. It captures any tendency for higher tax rates to encourage increased deductions ceteris paribus via either real or shifting responses.

Then, differentiating $P^T = \theta_p P - D^*$ gives:

$$\eta_{P^T,t} = \alpha\eta_{P^*,t} - (\alpha - 1)\eta_{D^*,t} \tag{13}$$

where $\eta_{P*,t} = \eta_{\theta_p,t} + \eta_{P,t}$. Using (12), equation (13) can be rewritten as:

$$\eta_{P^T,t} = \left\{\alpha - (\alpha - 1)\eta_{D^*,P^*}\right\}\eta_{P^*,t} - (\alpha - 1)\eta'_{D^*,t} \tag{14}$$

This expression reveals three effects on the tax base elasticity, $\eta_{P^T,t}$. The elasticities $\eta_{P*,t}$ and $\eta'_{D*,t}$ are the combined real and shifting responses for declared profits and autonomous deductions respectively, and $\eta_{D*,P*}$ is the endogenous or automatic deductions response. [7]

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 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, captured by $\eta_{D*,P*}$, that otherwise could be claimed against declared profit: this reduces the absolute value of $\eta_{P^T,t}$. From the first curly brackets in (14) the direct effect dominates if:

$$\eta_{D^*,P^*} < \frac{\alpha}{\alpha - 1} \tag{15}$$

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 (15) holds, a negative profit response to the increased tax rate generates a lower tax liability than when there is no response. However, where condition (15) 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 (15) 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. [8]

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 component elasticities. Subsection 3.1 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

Various estimates of responses are available in the empirical literature which can be used to guide choices in producing illustrative examples and simulations reported below. Income shifting responses were estimated for samples of multinational corporations 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 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, $\alpha\eta_{\theta_p,t} - (\alpha - 1)\eta_{\theta_d,t}$, 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. [9]

Grubert and Slemrod (1998) focused on profit-shifting to Puerto Rico by US multinationals, allowing for both real foreign investment and profit-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 afiliates 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 $\eta_{P^T,t}$.

3.2. Benchmark Parameters

This subsection considers a set of benchmark parameters for numerical examples. The following examples assume a steady-state, for which $\eta_{E,P^*} = 1$ with $\eta_{D^*,P^*} = 1$, so that:

$$\eta_{P^T,t} = \left(\eta_{\theta_p,t} + \eta_{P,t}\right) - (\alpha - 1)\left\{\eta_{\theta_d,t} + \eta'_{E,t}\right\} \quad (16)$$

Hence, in the steady state, the value of $\eta_{P^T,t}$ depends on α and the four elasticity components in (16). These elasticities determine the real responses of profits, P, and qualifying expenditures, E, and of the shifting parameters, θ_p and θ_d. The illustrations below also set $s - 1$. The examples report values of $\eta_{P^T,t}$ as the ratio E/P varies. Hence the value of α also varies as shown in equation (9) above.

Table 2 shows the assumed values of the four elasticity components and the declared proportions, θ_p and θ_d, required to calculate $\alpha - 1$ in (16). 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.

Table 2
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*

The benchmark case assumes a 5 per cent real profit response to changing tax rates, but alternatives of 10 per cent and 20 per cent are also examined.

Comparable positive values are used for the autonomous 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 autonomous or 'discretionary' to distinguish it from the automatic deductions response.

A benchmark elasticity of $\eta_{\theta_p,t} = -0.375$ is assumed, with deductions shifting assumed to be slightly more dificult such that $\eta_{\theta_d,t} = 0.25$. [10] Using $E/P = 0.5$ gives a value of $\alpha = 2$ from (9) with $s = 1$ and $\theta_d/\theta_p = 1$.This yields a benchmark total 'shifting elasticity' of $\eta_{\theta_p,t} - (\alpha - 1)\eta_{\theta_d,t} = -0.625$.

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 reactions to tax changes.

3.3. Numerical Results

Some numerical results are shown in Figure 1, where each of the four diagrams shows the elasticity $\eta_{P^T,t}$ on the vertial axis and the size of qualifying 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, $D^*/P^* = (s\theta_d/\theta_p)(E/P)$, is in the range 0.45 to 0.56 for companies in aggregate. [11]

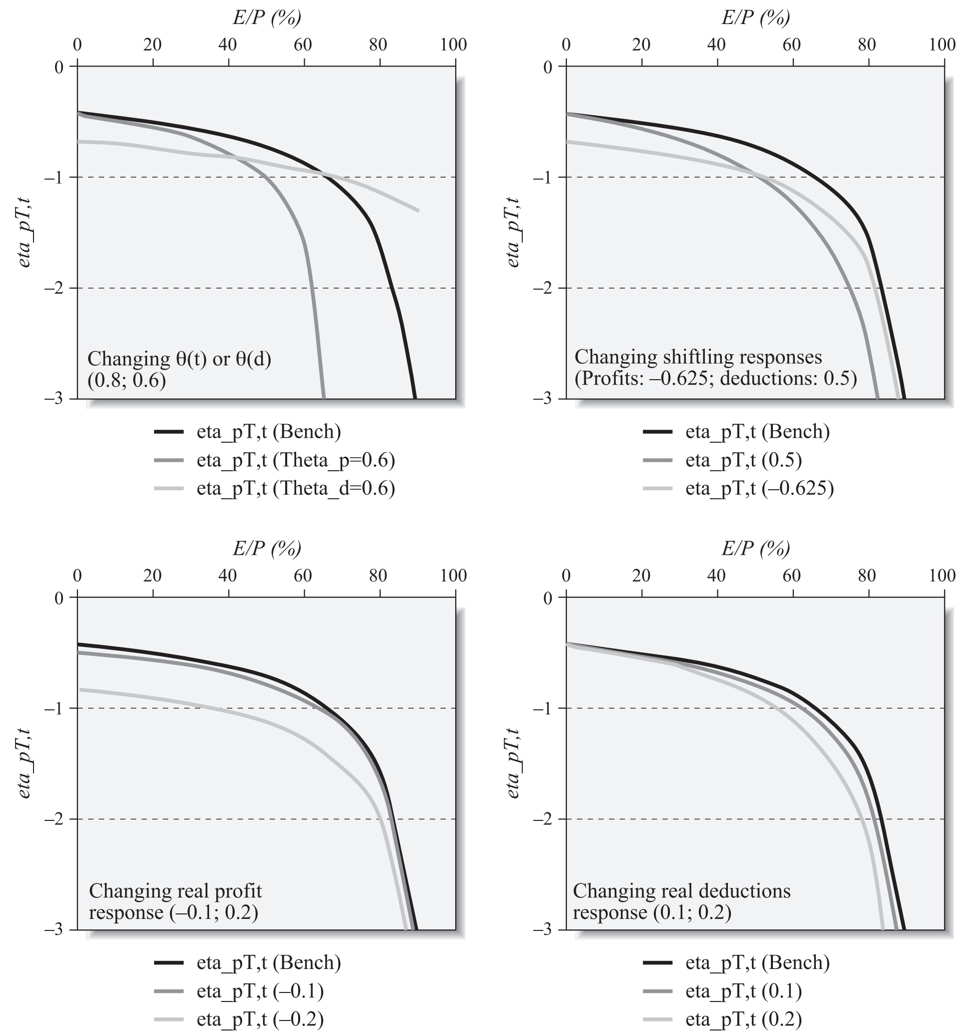

Figure 1. Relationship between $\eta_{P^T,t}$ and *E/P*: Individual Firms.

To interpret the diagrams, it is useful to bear in mind, as stressed above, that the impact of the *E/P* ratio on $\eta_{P^T,t}$ operates via changes in α. At the extremes, as *E/P* tends to 1, then with $s\theta_d/\theta_p = 1$ 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 (16). In all the diagrams it is clear that the E/P ratio has important, non-linear effects on the overall behavioural 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.

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 (14). 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. [12]

In this section it is convenient to work with the elasticity of net 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:

$$\eta_{P^T,P^*} = \alpha - (\alpha - 1)\eta_{D^*,P^*} \tag{17}$$

where, as previously, $\alpha = P^*/P^T$. That is, the two elasticities in (17) differ only by a factor due to the relative size of declared profits and deductions. Substituting (17) into (14) then gives:

$$\eta_{P^T,t} = \eta_{P^T,P^*}\eta_{P^*,t} - (\alpha - 1)\eta'_{D^*,t} \tag{18}$$

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 $\eta_{P^*,t} < 0$). [13]

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. [14] 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: thus $s = 1$ in (6) above. More complex tax planning could be modelled, but the simple model developed here is suffcient to illustrate the relevant cyclical properties. [15] 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:

$$\Omega_{P^T,P^*} = \sum_j \eta_{P^T,P^*}\left(\frac{P_j^T}{P^T}\right) \tag{19}$$

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 $P^+_{i,j} = \max(P^*_{i,j}, 0)$ and losses are $P^-_{i,j} = \max(-P^*_{i,j}, 0)$. 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 $P^D_{i,j} = L_{i,j} + P^-_{i,j}$. Hence taxable profit for each firm is:

$$P^T_{i,j} = \max\left(P^+_{i,j} - L^D_{i,j}, 0\right) \tag{20}$$

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

$$L_{i,j+1} = L^D_{i,j} - \min\left(P^+_{i,j}, L^D_{i,j}\right) \tag{21}$$

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. [16] Hence, if A is the amplitude of the cycle and W is its wavelength, the time stream is given by:

$$P^*_{i,j} = A\sin\left(\frac{2\pi(i-1)}{W}\right) + d_j \tag{22}$$

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 $(P_{i,j}^T - P_{i-1,j}^T)/P_{i-1,j}^T$ divided by $(P_{i,j}^* - P_{i-1,j}^*)/P_{i-1,j}^*$ 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. [17] Once gross profit becomes negative, asymmetric tax loss treatment ensures 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.

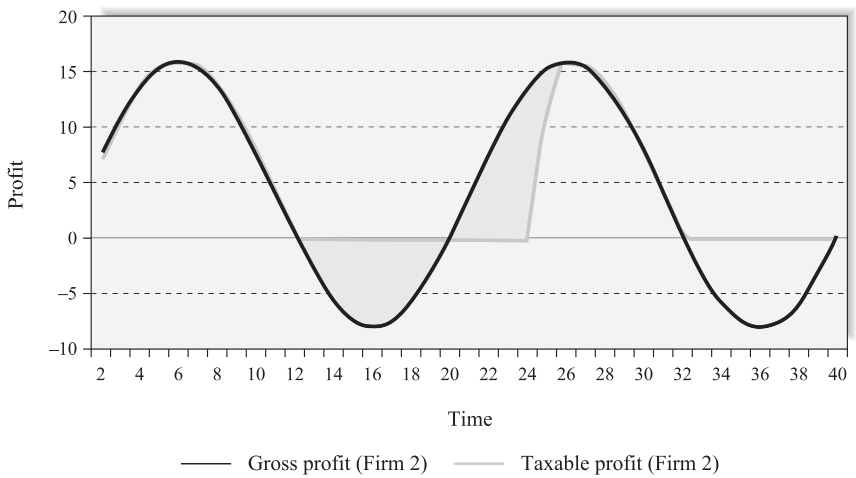

Figura 2. Gross and Taxable Profit Profiles for Firm 2

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 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 $\Omega_{P^T,P^*} > 1$.

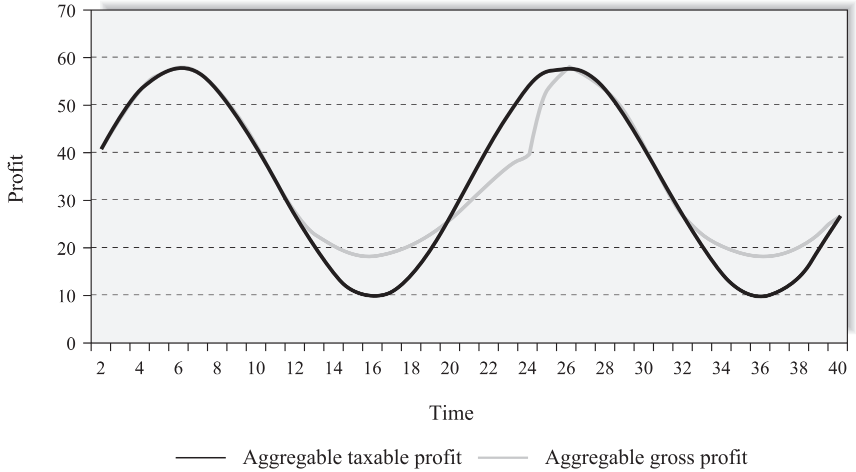

Figura 3. Aggregate Gross and Taxable Profits Over the Business Cycle

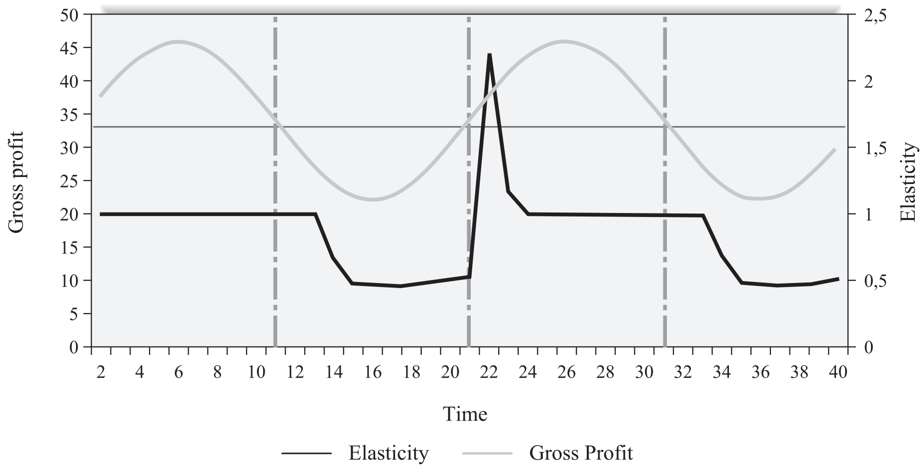

Figura 4. The Aggregate Elasticity of Taxable Profit with Respect to Gross Profit

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 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.

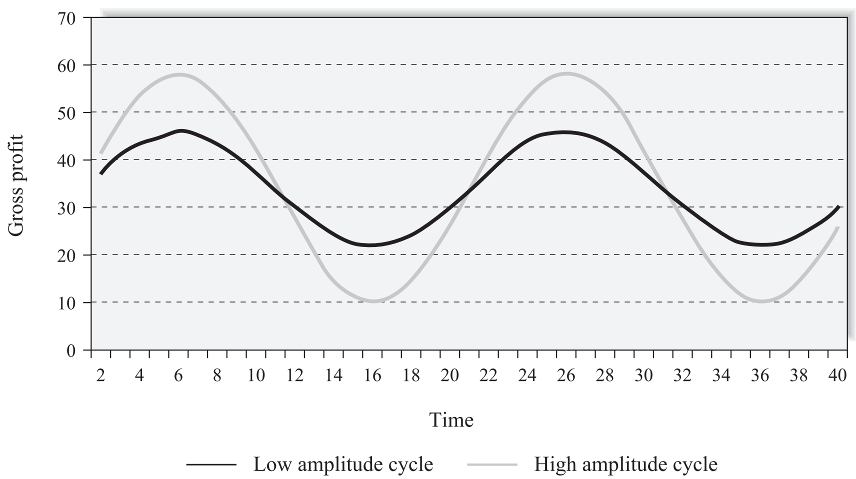

Figura 5. Low and High Amplitude Business Cycles

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 pe-

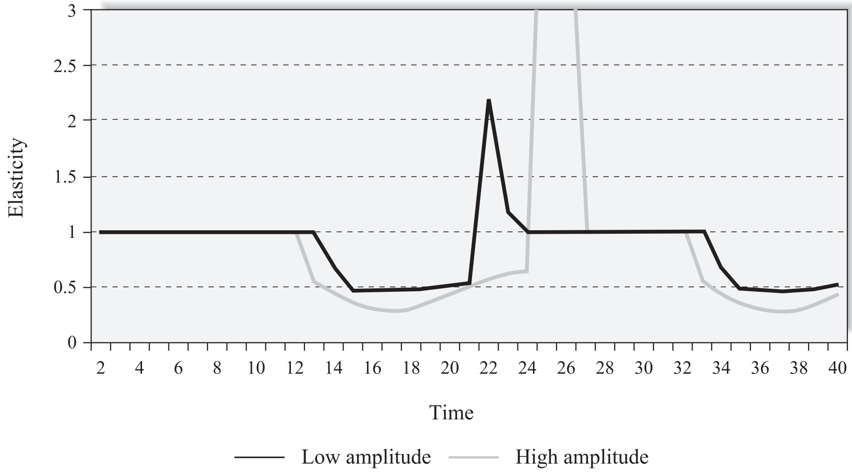

Figura 6. Elasticity Profiles for High and Low Amplitude Business Cycles

riod 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 (18), this means that the elasticity $\Omega_{T,t}$ is relatively high during depressions (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 has considered 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).

Empirical evidence on the impact on corporate tax revenues of the asymmetry modelled in this paper suggests that corporate tax revenues display much greater volatility than the corporate tax base (taxable profits). For the UK for example, Creedy and Gemmell (2008) show that large fluctuations in annual corporate profit growth tend to be associated with even larger fluctuations in revenues, and *vice versa.* For the US, Cooper and Knittel (2007, p. 651) find that 'many tax losses are used with a substantial delay' so that 'certain firms and industries suffer a significant penalty from the partial loss refund regime due to the erosion in the real value of their loss refund'. As a result up to 50 per cent of corporate losses remain unused after 10 years, and around 25-30 per cent of losses are never used. This evidence is consistent with the findings of Altshuler and Auerbach (1990) and Auerback (2007) that cyclical fluctuations in US corporate effective average tax rates are substatially due to tax loss asymmetries. [18] In addition, examining the drivers of tax revenues in OECD countries, Clausing (2007) finds that cyclical changes in those economies' economic growth rates have disproportionately large impacts on their corporate tax revenues; that is, faster growth is associated with a rise in the corporate tax to GDP ratio.

This evidence clearly supports the view that asymmetric tax treatment of losses has a substantial impact on observed revenues over time. This may or may not reflect behavioural responses since, even in the absense of such responses, cyclical fluctuations in revenues and effective tax rates would be expected. However, the evidence in this paper suggests an additional reason why such cyclical patterns may be expected; namely because behavioural responses are likely to be affected by these asymmetries, generating further cyclical movements in revenues. As note earlier from the condition in (15), behavioural responses may either enhance or mitigate other sources of revenue fluctuations, depending on whether net taxable profit responses to changes in corporate tax rates generate lower or higher tax liabilities compared to when there is no response.

5. Conclusions

This aim of this paper has been to examine the composition of behavioural responses by companies to changes in the taxation of profits in their 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 taxable profits (net of deductions) 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 offsets. 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’ (those that qualify as tax deductions) were 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 affects 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 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 structure, 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 theamplitudeofthe profit cycle increases.

These findings have implications for empirical attempts to measure tax revenue or profit responses to corporate tax rate changes. This is because the nature and extent of corporate tax deductions, especially losses, can be expected to give rise to quite different response estimates. This is especially true for countries where the tax structure displays greater asymmetry in their treatment of losses, and circumstances where losses are high. 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 treatment of losses, response estimates may be relatively unaffected when firms’ profits are on-or above-trend.

Empirical estimates of corporate behavioural responses differ quite widely even for the same or similar countries. A range of conceptual, methodological or practical reasons might account for this. However, the present paper suggests that additional factors to consider, largely ignored so far, are the differential asymmetric treatment of losses across countries, and the point in a country’s economic cycle when responses are estimated.

Notes

1. A convenient feature of the concept is that, under certain conditions, it provides valuable information about eficiency costs of taxation. For a recent review of evidence, see Saez *et al.* (2009). An introduction to the concept is provided in Creedy (2009).
2. In the context of personal income taxation, see Creedy and Gemmell (2006, p. 25).
3. However, there may be special conditions governing when the credits can be claimed.
4. 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. See Agúndez (2006) for discussion of intra-group loss off-setting among European firms.
5. 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 $\eta_{\theta_p,t}$.

6. The term 'larger absolute' is preferred here to 'smaller (more negative)'. Similarly, the term 'smaller absolute' is preferred to 'larger (less negative)'.
7. In a steady-state, $\eta_{E,P*} = 1$ with $\eta_{D*,P*} = 1$.
8. 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.
9. 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.
10. 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.
11. In the UK, 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 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.
12. 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.
13. However, $\alpha - 1$ in (18) is also likely to be cyclical, as the ratio of deductions to profits changes over the cycle.
14. 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.
15. Creedy and Gemmell (2008) use a microsimulation model to examine this aspect for the UK, incorporating other loss asymmetries such as the limitations of group losssharing. The model contains algorithms for determining the tax-minimising strategy of firms. Agúndez (2006) discusses alternative ways of allowing intragroup losses to be used as tax offsets in the context of European formula apportionment, and where group members are located in different countries.
16. 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.
17. The values were obtained using a wavelength of $W = 20$, an amplitude of 12, and shift parameters of $d_1 = 30$ and $d_2 = 4$.
18. For the European Union, Agúndez (2006) argues that adopting a common consolidated tax base across EU countries would improve efficiency largely by allowing cross-border tax loss offsets in calculating the common corporate tax base. This might also be expected to have an impact on revenue fluctuations within EU countries.

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Resumen

Este artículo examina las reacciones de las empresas a cambios en la tributación en su país de origen. La elasticidad de la recaudación de impuestos ante cambios de la tributación de los beneficios empresariales se descompone en varias respuestas. Además de distinguir entre los cambios reales y los cambios de lugar de declaración de beneficios, es importante separar aquellos cambios en los beneficios brutos de los relacionados con las deducciones (como las reducciones por pérdidas pasadas o corrientes), donde estos últimos están relacionados endógenamente con los beneficios brutos declarados en el país de origen. Esta respuesta endógena puede ser distinta en diferentes momentos del ciclo económico, lo cual puede ser especialmente importante, aunque no exclusivamente, para las estimaciones empíricas realizadas en los periodos de crisis. Los resultados sugieren que la elasticidad de la recaudación puede ser asimétrica entre periodos de crecimiento por encima –o por debajo– de la tendencia a largo plazo, a consecuencia del tratamiento asimétrico de las pérdidas en la fiscalidad empresarial.

Palabras clave: impuesto sobre beneficios empresariales, cambios en asignación de beneficios, elasticidad recaudatoria, asimetrías fiscales.

Clasificación JEL: H25, H32.