The Elasticity of Corporate Taxable Income: New Evidence from UK Tax Records*

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Abstract

We use the population of UK corporation tax returns between 2001 and 2008 to estimate the elasticity of corporate taxable income with respect to the statutory corporation tax rate. We do so by analysing bunching in the distribution of taxable income at two kinks in the marginal rate schedule. We find a relatively small elasticity of between 0.14 and 0.18 for companies with profits around the £300k kink and a small marginal deadweight cost of 8% of the revenue that would have been generated by a marginal increase in tax, ignoring behavioural responses. We find a much higher elasticity of between 0.54 and 0.57 for companies around the £10k kink. By matching the corporate tax return data with accounting records and analysing joint bunching in the corporate and personal tax system, we decompose the overall elasticity of corporate taxable income into two parts: an elasticity of total income with respect to the net of tax rate of between 0.2 and 0.3, and an elasticity of the share of income taken as profit with respect to the difference between the personal and corporate tax rates of between 0.04 and 0.07. With these estimated elasticities, we find that the marginal deadweight cost of the tax around £10k is around 25% of the increase in tax revenue, absent any behavioural responses.

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1 Introduction

A growing literature has examined the marginal excess burden of personal income tax. Following seminal contributions from Feldstein (1995, 1999), this literature has derived estimates of the marginal excess burden of the tax from estimates of the elasticity of taxable income. This approach does not require differentiation of the various channels through which the tax may affect behaviour - for example, a reduction in effort or a rise in tax evasion - as long as all of these behaviours are optimally chosen by the economic agent. A number of papers have developed this approach further to consider cases when the elasticity is, and is not, a sufficient statistic for measuring the marginal excess burden (this literature is reviewed by Saez, Slemrod and Giertz (2012)). There have also been several developments in empirical approaches to measuring the elasticity (also reviewed by Saez, Slemrod and Giertz (2012)).

Relatively little attention has been paid to other taxes, and in particular to the corporate income tax. Although the corporate income tax typically raises considerably less revenue than the personal income tax, it has the potential to generate a very large excess burden. In most countries, most private economic behaviour is organised by corporations. And corporations can modify their behaviour in a number of ways in response to taxation, for example: changing the scale of production and hence the demand for labour, capital and other factors; the choice of financial policy; and the international location of real activities and profit. The effects of taxation on all of these forms of behaviour have been widely studied, and many margins have been found to be sensitive to taxation. There is also considerable evidence that governments have for some decades been engaged in international competition that is driving down statutory rates of corporation tax (Devereux, Lockwood and Redoano (2007)); such competition arises from a belief that high tax rates drive both real activity and taxable profits abroad. In addition, governments are rightly concerned about the extent to which differences in taxes on unincorporated and incorporated businesses affect the incorporation decision, and permit the shifting of income to a lower-taxed form. Despite these issues, there has as yet been little attempt to analyse the elasticity of corporate taxable income, and the corresponding marginal excess burden.[1]

This paper estimates the elasticity of corporate taxable income with respect to the statutory tax rate in the UK, using confidential tax return data provided by HMRC.

[1] Two published papers that estimate the elasticity of corproate taxable income are Gruber and Rauh (2007) and Dwenger and Steiner (2012). We discuss these further below.

We have access to the population of corporation tax returns (around 1 million returns per year) for an 8-year period 2001/02-2008/09. This period is useful since it provides variation in the statutory corporate tax rate in two dimensions. First, the UK tax system applies different rates of tax at different levels of income. In particular, there is a significant increase in the rate at taxable income of £300,000, creating a kink in the tax rate schedule. This allows the elasticity of taxable income to be estimated by analysing bunching at the kink, following the approach proposed by Saez (2010), and widely used and developed since.[2] Second, there have been a number of reforms to the tax rate schedule over this period. In particular, the UK introduced a zero rate of tax for the first £10,000 of taxable income, starting in 2002. The rate that applied to income between £10,000 and £50,000 was raised so that the average tax rate on income of £50,000 and above was unaffected. Two years later, this was modified by applying the zero rate only to retained earnings. And in 2006 the zero rate was abolished. As a result of these reforms, a significant kink in the tax schedule was first introduced, then modified, then abolished, all within the period of our data.

An important feature of the taxation of small companies, and in particular of companies where the owner and manager are the same person (or at least a small group), is that the owner/manager can decide whether to take income from the company in the form of corporate profit or personal income. A rise in the corporate tax rate may therefore induce a reduction in total income generated by the company, and also a reduction in the proportion declared as corporate profit. The excess burden of the corporation tax depends on the size of both these effects, since the latter reflects simply that some income is being taxed at a different rate. In the UK during this period, the tax rate on corporate profit, even including personal tax on dividends paid, was generally lower than the overall tax rate on personal income (which included national insurance contributions). Tax minimisation typically required declaring all - or certainly most - income above the tax-free allowance as corporate profit.

To analyse the share of total income declared as corporate profit, we combine the corporation tax return data with accounting data for each company and each year from the FAME database. We are able to match approximately 90% of corporation tax returns in this way. Accounting data include information on the remuneration paid to the directors of the company. For small companies we take the total taxable income of the company to be the sum of the corporate taxable income and directors' remuneration.

Analysis of these combined data reveal that very few companies followed a tax

[2] See, for example, Chetty et al. (2011).

minimisation strategy, with almost all declaring a significant part of their total income as personal income. One possible explanation of this is a salience problem: small business owners may typically take their income as personal income, but they may have been aware, for example, of the £10,000 tax-free corporate profit. They may not have understood that declaring more than £10,000 as corporate profit may reduce their tax liability further. While possible, this seems to imply that such businesses did not use professional advice in completing their tax returns, even though it is relatively complex to set up and administer a company to comply with UK law. An alternative explanation is that there are other costs associated with declaring income as corporate profit. This may reflect a liquidity issue. While wages are typically paid regularly - weekly or monthly - dividends are typically paid less frequently. A small business owner may prefer to receive a regular flow of income, thereby avoiding the cost of additional borrowing. We do not model this explicitly in the paper, but we introduce a convex cost of declaring income as corporate profit which is intended to reflect such costs.

Section 2 provides a conceptual framework for analysing the elasticity of corporate taxable income with respect to the statutory rate, which draws on the personal tax literature of, for example, Feldstein (1999) and Chetty (2009). The framework used allows for both forms of response to a change in the corporation tax rate: a shift in total income and a shift between the two alternative ways of declaring income. One difference from the literature on personal tax is worth noting. That is, in the personal tax literature, it is typically assumed that the costs of generating additional income are not tax deductible: they are typically assumed to reflect effort or hours worked. However, companies generate total income in a variety of ways in addition to the labour supply of the owner: for example, through greater investment and hiring labour, both of which generate a deduction. They may also avoid or evade tax; the costs of doing so may or may not generate a deduction, depending on whether there is an observable charge. Any deductibility of costs against taxable profit affects the elasticity of taxable income with respect to the tax rate. In an extreme case, suppose that all costs are deductible. Then in a standard framework the tax rate would have no effect on taxable income or output; in effect the tax would be levied only on economic rent, and no behavioural decisions would depend on the tax rate. Although in practice this is unlikely - even if all capital costs are deductible, for example - this does suggest that it is possible that the elasticity of taxable income with respect to the tax rate could be small. In fact our central estimates are lower than those typically found in the literature on personal income taxes.

The main empirical technique used in this paper is based on the analysis of bunching at kinks in the tax schedule, developed by Saez (2010) and extended by Chetty et al. (2011). The basic idea of this approach is that an increase in the tax rate at a certain kink point in the tax schedule is likely to induce agents to reduce their taxable income. Those relatively close to the kink would not reduce their taxable income below the kink point, implying that there would be bunching in the distribution at the kink point. To identify the scale of this bunching, it is necessary to estimate the counterfactual of what the distribution would have been without the kink in the tax schedule. Saez (2010) proposed estimating this counterfactual distribution by considering only agents whose income are not affected by the kink. Chetty et al. (2011) modified this approach slightly to ensure that the estimated counterfactual distribution is based on the same population as the observed empirical distribution. We follow this approach, and also allow for regular bunching at round-numbers in the distribution, as proposed by Kleven and Waseem (2012). In addition, when analysing bunching at the £10,000 kink, we compare these counterfactual distributions with the observed distribution in the period following the abolition of the kink, when the incentive to bunch had been removed. Our estimates are fairly insensitive to the estimation method of the counterfactual distribution.

Companies that are owned and managed by one person, or a small group, have greater opportunity to choose the form in which income is received. For such companies, especially those bunched at the £10,000 kink, we decompose the overall elasticity into two parts, reflecting the effect on total income and the effect on the share of income taken as corporate profit. Our approach exploits kinks arising in the personal tax schedule, which create bunching also in personal taxable income. Specifically, we follow the same approach as already described, but for the subset of companies where the total remuneration of directors is observed to be at the first kink in the personal income tax schedule. Since they are at this kink, we assume that such companies would not change their personal income in response to a marginal change in the corporation tax rate. Under this assumption, then any response in corporate taxable income to a change in the corporation tax rate must reflect a response in total income. This identifies one element of the elasticity, and allows us to decompose the overall elasticity into its two components.

The paper is organised as follows. In the next section we present a brief review of the relevant literature. In Section 3 we present a conceptual framework for analysing the impact of the corporation tax rate on corporate taxable income allowing for two effects: on the total income generated by the company, and on the share of that income that is declared as corporate profit, as opposed to personal income. Section 4 describes the empirical approach used in estimating the elasticity of the tax base with respect to the tax rate, and our method for decomposing that elasticity into the two parts. Section 5 presents the relevant institutional background for the UK. Sections 6 and 7 present our results from analysing two kink points in the UK tax schedule: at £300k and at £10k. Section 8 discusses the implied marginal deadweight costs of corporate income taxes using our elasticity estimates. Section 9 briefly concludes.

2 Previous Literature

The literature on the elasticity of personal taxable income with respect to the marginal personal tax rate has been thoroughly reviewed elsewhere (Saez, Slemrod and Giertz (2012)) and so does not require a lengthy review here. Briefly, this literature has focused on marginal efficiency cost of public funds taking into account (implicitly) all of the various behavioural margins that may be affected by taxation. The idea, from Feldstein (1995, 1999) is that it is not necessary to identify each of the behavioural effects separately as long as agents are optimising. That is because all of the effects are aggregated into an effect on taxable income: the marginal cost of additional effort and the marginal cost of additional evasion, for example, must both equal the tax rate. There are some caveats to this claim. One is that taxable income may be shifted to another base where it will be taxed at a different rate. The overall impact on the marginal cost of funds therefore needs to recognise the additional revenue raised elsewhere. This includes the possibility that tax may be deferred until a later date. A second caveat is that the appropriate policy response to a high elasticity may depend on the behavioural change induced by the tax. In particular, the policy response to greater avoidance should be different to the policy response to a real effect of, say, lower effort. Nevertheless, this approach does offer a direct method of estimating the overall effect of taxation.

Various methods have been used to identify the elasticity of personal taxable income: Saez, Slemrod and Giertz (2012) report that the "best available estimates range from 0.12 to 0.4", with a mean elasticity estimate of around 0.25. It is worth nothing that the few studies using bunching around kink points to identify behavioural responses find in general small elasticities of taxable income. For example, Saez (2010) estimates the elasticity of taxable income to be approximately 0.2 around the first kink point in the U.S. personal tax schedule and zero (and precisely estimated) around the higher kink points. Chetty et al. (2011) identify that the observed elasticity from bunching at the large 30% top kink in the Danish tax schedule is around 0.01 for all wage earners and around 0.02 for married women. They attribute the small elasticity estimates to the presence of optimization frictions including switching and attention costs combining with a small utility gain of bunching in response to jumps in marginal tax rates. Kleven and Waseem (2012) present strong evidence of behavioural responses to notch points in the Pakistan income tax system. They adjust the amount of bunching below the notch points by the fraction of taxpayers that respond to the tax incentives to estimate the long-run elasticity of taxable income that is not attenuated by optimization frictions. The baseline results suggest the long-run elasticity of taxable income in Pakistan is around 0.05 and 0.2, which is considerably larger than findings in the other two studies but is nevertheless at the low-range of the elasticity estimates in the existing literature. One general conclusion from these studies is that the elasticity of taxable income depends itself on the tax system: one with a broad tax base and extensive use of information reporting is usually associated with more modest responses in personal taxable income.

Fewer studies have directly addressed the elasticity of corporate taxable income. Two published papers have focused on corporation tax: Gruber and Rauh (2007) and Dwenger and Steiner (2012). The first of these uses accounting data and therefore suffers from the familiar problem that accounting records do not generally accurately record tax liabilities, but rather an estimated provision for tax. It estimates the elasticity of corporate taxable income with respect to a measure of the effective marginal tax rate on new investment, of the form developed by Hall and Jorgenson (1967), King and Fullerton (1984) and others. This implies a focus on one particular behavioural response to the tax which is not in the spirit of the literature on the personal tax. The second paper uses German tax administration data to estimate the elasticity of corporate taxable income with respect to an average tax rate. This average tax rate is equal to the statutory rate except where losses brought forward from the previous period can be used to reduce the current tax liability. This paper follows the approach of Gruber and Saez (2002) in identifying the effects of a tax reform by calculating the tax that would have been paid pre-reform if the post-reform regime had been in place but there had been no behavioural change. The difference from actual taxable income post-reform is therefore due to the behavioural response to the reform. In this case, however, the difference in the average tax rate appears to depend crucially on the losses brought forward into the period prior to the reform, rather than the behavioural response to the reform.

The existing empirical literature, on the other hand, provides strong and convincing evidence that corporate taxes influence business behaviour in several important ways. For example, the tax difference between corporate and non-corporate earnings play an important role in firms' choice of organizational forms.[3] Companies alter their financing choices in response to the tax advantage of debt and other tax incentives,[4] and also the scale of business investment[5] and dividend payouts.[6] Several recent studies survey the international aspects of corporate taxes and business behaviour, including de Mooij and Nicodeme (2008) and Feld and Heckemeyer (2011). These conclude that there are significant effects of corporate tax policies on multinationals' location decision, cross-border investment, and allocation of taxable income among taxing jurisdictions.

3 Conceptual Framework

Consider a company that aims to maximize the total net profit of the shareholders, π:

$$\pi = y - c(y) - T - h(s)B + E, \tag{1}$$

where y is the total output of the company with the output price normalized to unity, $c\left(y\right)$ is the minimum cost of producing y using a combination of inputs, and T is the total tax paid by the company including any taxes on dividends paid by shareholders, gross of virtual income, E. Total profit can be taxed in two ways, depending on whether the income is declared as corporate profit or as salary accruing to at least some of the shareholders. Assuming that allowances are common across the two forms of taxation (as in the UK), we define B to be total taxable income, s the share of B that is recorded in the form of profit, $1 - s$ the share of B recorded in the form of salary, and $h(s)$ the convex cost of transforming one unit of total taxable income into corporate profit. Virtual income E is the lump sum of taxable income arising from the graduated rate schedule up to the last unit beyond which the

[3] See, Gordon and MacKie-Mason (1994), Mackie-Mason and Gordon (1997), Gordon and Slemrod (2000), Goolsbee (1998, 2004), and Liu (2012) for evidence in the U.S. and de Mooij and Nicodeme (2008) and Egger, Keuschnigg and Winner (2009) for experience in Europe.

[4] Graham (2003) reviews the empicial evidence of corporate taxes on the financial policy of domestic firms. Altshuler and Grubert (2003), Desai, Foley and Hines (2004) and Fuest, Hebous and Riedel (2011), among others, suggest that corporate tax rates and thin capitalization rule also matter for the financial structure of multinational firms.

[5] See Hassett and Hubbard (2002) for a recent survey on this topic. A small selection of recent studies on tax policy and business investment include Caballero and Engel (1999), Cooper and Haltiwanger (2006), and House and Shapiro (2008).

[6] See, for example, Bond, Chennells and Devereux (1996), Chetty and Saez (2005) and Dharmapala, Foley and Forbes (2011).

next marginal rate begins. We assume that companies can allocate total income to each form - profit and salary - without cost up to the point at which allowances are exhausted and tax must be paid: that is, we consider only the case in which total taxable income is non-negative, $B \geq 0$.

The tax base, B, is defined as:

$$B = y - \alpha c(y), \tag{2}$$

where $0 \leq \alpha \leq 1$ is the proportion of the total cost of generating y that is tax deductible. This cost includes items that are entirely deductible such as wages paid to employees, items that may not be deductible at all such as the effort of an owner/manager, and the costs of capital investment which may be partially deductible. In the case where c reflects greater effort, it is measured in units of foregone consumption. For simplicity we assume that the cost of transforming total income into corporate profit, $h(s)B$, is not deductible, reflecting nondeductible efforts of the owner/manager.[7]

The overall tax rate is

$$\tau = st_c + (1 - s)\, t_p, \tag{3}$$

where t_c is the tax rate on corporate profit and t_p is the tax rate on salary of shareholders that are employed by the company. Total tax is τB. Note that, in the empirical application of the UK, generally $t_p > t_c$. The cost of transforming income into profit, $h(s)$, implies that not all income is declared as profit. We treat this cost as a real resource cost, rather than a transfer, and hence it reduces not only private consumption but also total welfare.

The company chooses y and s to maximize π. The first order conditions are

$$c'(y) = \frac{1 - (\tau + h(s))}{1 - \alpha(\tau + h(s))}, \tag{4}$$

and

$$h'(s) = t_p - t_c. \tag{5}$$

The first of these expressions implies the normal marginal condition: that output will be increased up to the point where the marginal value of output is equal to its marginal cost. In the absence of tax, this is just 1. In the presence of tax, the cost depends on the parameters of the tax regime, and on the costs of declaring income

[7] Making these costs tax deductible has no effect on the basic model.

as profit. The second expression indicates that the company will increase the share of total income declared as profit up to the point at which the marginal cost, $h'(s)$, is equal to the gain, $t_p - t_c$.

We are interested in the impact of corporation tax on total welfare, which we take to be a simple aggregate of private consumption plus tax revenue, $W = \pi + T$. Consider a small increase in the net of corporate tax rate, $1 - t_c$. Since the company is assumed to optimally choose y and s to maximize π, we can apply the envelope theorem to ignore any indirect effects of the change in $1 - t_c$ on π through y and s. In addition, the direct effects of a change in the tax rate on the tax liability net out since the tax is simply a transfer, reducing π, but increasing T. The overall effect on welfare is therefore:

$$dW = \left\{ \frac{\partial T}{\partial y} \frac{\partial y}{\partial (1 - t_c)} + \frac{\partial T}{\partial s} \frac{\partial s}{\partial (1 - t_c)} \right\} d(1 - t_c), \tag{6}$$

Given that the overall tax rate, τ, but not the tax base, B, is a function of s, and holding t_p constant, we can also write the effect on welfare as:

$$\begin{aligned} dW &= \left\{ \tau \frac{\partial B}{\partial (1 - t_c)} - B(t_p - t_c) \frac{\partial s}{\partial (t_p - t_c)} \right\} d(1 - t_c) \\ &= B \left\{ \frac{\tau x}{(1 - t_c)} - sz \right\} d(1 - t_c), \end{aligned}$$

where x is the elasticity of taxable income, B, with respect to $1 - t_c$ and z is the elasticity of the share of income taken as corporate profit, s, with respect to the difference in tax rates, $t_p - t_c$. Note also that

$$dB = (1 - \alpha c'(y))\, dy = \left(\frac{1 - \alpha}{1 - \alpha(\tau + h(s))} \right) dy. \tag{7}$$

These expressions indicate that there are offsetting effects of a rise in $1 - t_c$. For a given s and given the convexity of the cost function $h(s)$, a rise in $1 - t_c$ would increase output y. However, the extent to which there is a rise in B depends on the extent to which costs are deductible from tax. In the standard case considered for personal tax, costs are not deductible, in which case $\alpha = 0$ and $dB = dy$. In the other extreme, though, if all costs were deductible, then $\alpha = 1$ and $dB = 0$. This is because at the margin in this case, $c'(y) = 1$ and the marginal addition to output is just matched by a marginal addition to costs, leaving the tax base unaffected. In general, for $0 < \alpha < 1$, $dB < dy$: there is a smaller effect on the tax base than on output of a rise in the net of tax rate.

For a given tax base, a rise in $t_p - t_c$ would induce a higher share of income being taken as corporate profit. Since we assume that there are real costs associated with taking income in this form, then this would induce higher welfare costs.

We can compare the change in welfare to the mechanical change in tax revenue in the absence of any behavioral response. Holding y and s constant, the change in revenue is

$$dM = -s\left(B - A\right) d\left(1 - t_c\right), \tag{8}$$

where A is the lowest point in the tax bracket at which the tax rate applies. Hence

$$dW = \frac{B}{B - A}\left\{z - \frac{\tau x}{\left(1 - t_c\right) s}\right\} dM. \tag{9}$$

3.1 Implications for empirical approach

To identify the welfare costs associated with the corporate tax rate, it is necessary to estimate the two elasticities, x and z, as in eq. (9). We discuss the details of the empirical approach in the next section. First we set out the approach here in the context of this framework.

We can divide the total tax base into two: $B = B_c + B_p$, where $B_c = sB$ is the corporate tax base and $B_p = (1 - s)B$ is the personal tax base. We first use the standard procedure based on bunching at kink points in the tax schedule to estimate over all companies the elasticity of the corporate tax base with respect to $1 - t_c$. Since $B_c = sB$, for given t_p this elasticity is

$$\begin{aligned} e &= \frac{\partial B_c}{\partial\left(1 - t_c\right)}\frac{\left(1 - t_c\right)}{B_c} = s\frac{\partial B}{\partial\left(1 - t_c\right)}\frac{\left(1 - t_c\right)}{sB} + B\frac{\partial s}{\partial\left(1 - t_c\right)}\frac{\left(1 - t_c\right)}{sB} \\ &= x + \left(\frac{1 - t_c}{t_p - t_c}\right) z. \end{aligned} \tag{10}$$

We take two approaches to identify x and z separately. First, we consider a group of companies with a large number of directors/shareholders that bunch at the £300k kink in the corporation tax schedule. Second, we consider a subset of companies that bunch at the £10k kink in the personal tax schedule. We assume that companies in either group will not change their personal tax base in response to a change in $1 - t_c$. For the first group, this is because the company is widely enough held that shareholders will not want to transfer income to the managers. For the second group, this is because the company is at a kink in the personal tax schedule, and therefore less likely to adjust the personal income it declares in response to a marginal change in the corporation tax rate. For these companies, we assume that $dB = dB_c$ and so $x = e \cdot \frac{B_c}{B}$. Applying this estimate of x to all companies allows us to decompose e into its components and hence estimate dW.

So far we have focused on a single company. To evaluate the total welfare effect of a change in the tax rate, we need to aggregate over companies. We do so following Saez, Slemrod and Giertz (2012). Denote by $\overline{B}$ the average combined taxable income of companies within the relevant tax brackets, and $\overline{s}$ the average share of taxable income taken as corporate profit. Then we can define $\overline{x}$ as the aggregate elasticity of taxable income with respect to the net of tax rate, which is equal to the average of the individual elasticities weighted by individual taxable income. Similarly, we can define $\overline{z}$ as the aggregate elasticity of the share with respect to the difference in tax rates, which is equal to the average of the individual elasticities weighted by individual shares. Define the ratio $a = \overline{B}/(\overline{B} - A)$. If the distribution of B is Pareto, then a is the shape parameter of the Pareto distribution. Hence, in aggregate, we have:

$$dW = a \left\{ \overline{z} - \frac{\tau \overline{x}}{(1 - t_c)\, s} \right\} dM. \tag{11}$$

Note that, for widely-held companies at the £300k kink, we assume that all income at the margin is declared as profit, and therefore that $s = 1$ and $\overline{z} = 0$. Thus at the margin, $\tau = t_c$, $\overline{e} = \overline{x}$, and eq. (11) simplifies to the standard formula used in the literature for estimating the marginal deadweight cost by a small increase in the corporate tax rate[8]:

$$\frac{dW}{dM} = -\frac{\overline{e} a t_c}{(1 - t_c)}.$$

For companies bunching at the personal tax kink, we average over the marginal deadweight cost for each individual company with taxable profits between £10k and £50k:

$$\frac{dW}{dM} = \sum_{k_i \in (\pounds 10k, \pounds 50k)} \frac{B_i}{B_i - A} \left\{ \overline{z} - \frac{\tau_i \overline{x}}{(1 - t_c)\, s_i} \right\} / N_{k_i},$$

where the combined taxable income B_i, the overall effective tax rate on total income τ_i, and the proportion of total income taken as corporate profit s_i are firm-specific estimates.

[8] For example, see Saez, Slemrod and Giertz (2012).

4 Empirical Methodology

We use the bunching estimation method proposed in Saez (2010) and Chetty et al. (2011) to identify the elasticity of corporate taxable income. In the context of corporate income taxes, consider a tax reform that introduces a small increase in the marginal corporate tax rate from τ_1 to τ_2 at some income level K. Taxable income below K continues to be taxed at the rate τ_1, and income above K is now taxed at the rate τ_2. Abstracting from any income effects, the fraction of companies who choose to locate at the kink point K in response to the small increase in the marginal tax rate can be expressed as $B(\tau_1, \tau_2) = \int_K^{K+\Delta z} h(z)dz$, where $h(z)$ is the density distribution of taxable income when there is a constant marginal tax rate τ_1 throughout the distribution and $K+ \Delta z$ the highest level of pre-reform earnings that now bunch at the kink point. Assuming that $h(z)$ is uniform around the kink, the elasticity of corporate taxable income at the kink point is

$$e \simeq \frac{B(\tau_1, \tau_2)/h(K)}{K \ln(\frac{1-\tau_1}{1-\tau_2})} = \frac{b(\tau_1, \tau_2)}{K \ln(\frac{1-\tau_1}{1-\tau_2})}, \qquad (12)$$

where $b(\tau_1, \tau_2)$ denotes the fraction of companies who bunch at the kink relative to the counterfactual density. In eq. (12), the kink point K and the tax rates defining the kink point, τ_1 and τ_2, are given policy parameters, whereas the excess mass of companies $b(\tau_1, \tau_2)$ needs to be estimated empirically in order to identify e.

We aim to estimate the counterfactual density, that is, the distribution of taxable income had there been no kinks in the tax rate schedule, from the observed density outside the income range affected by bunching. A complication to the credible identification of bunching due to tax kinks, however, is that companies have a tendency to report taxable profit in round numbers, generating mass points at integer numbers in the empirical distribution. This is similar to round-number bunching in personal taxable income in Kleven and Waseem (2012), although the pattern of round-number bunching in the corporate taxable income is different and changes substantially through the income distribution.[9] Since kinks are themselves located at salient round numbers, a failure to control for round-number bunching could confound true kink bunching with round-number bunching and overstate behavioural responses

[9] Round-number bunching is strongest near the bottom of the distribution. There is excess mass at every income level that is multiple of 5k for profits up to £20k and at income levels that are multiples of 10k between £20k and £100k. Above £100k, excess mass is only noticeable at multiples of 50k for profits below £300k and at multiples of 100k for profits above £300k. Outside the context of taxable income elasticity, Manoli and Weber (2011) also present evidence of individual bunching around retirement thresholds that are multiples of 10 years.

to the kink. Like Kleven and Waseem (2012), we use counterfactual excess bunching at round numbers that are not kinks to control for round-number bunching.

We first group companies into small income bins of £100. Denoting by c_j the number of companies and z_j the level of earnings relative to the kink point in bin j, we then fit a flexible polynomial of order q to the bin counts in the empirical distribution, excluding bins around the kink point in the range (z_L, z_U) around the kink point by estimating a regression of the following form:

$$c_j = \sum_{l=0}^{q} \beta_i \cdot (z_j)^l + \sum_{i=z_L}^{z_U} \gamma_i \cdot \mathbf{1}\left[z_j = i\right] + \sum_{r \in R_k} \rho_{r_k} \cdot \mathbf{1}\left[\frac{z_j}{r} \in N\right] + \varepsilon_j, \tag{13}$$

where γ_i is a bin fixed effect for each bin in the excluded range. A set of round-number dummies is also included to control for bunching at integers. Specifically, N is the set of natural numbers, R_k is a vector of round number multiples that capture rounding in the annual tax return and equals $\{5k\}$ or $\{50k\}$ depending on income bracket k. The parameter ρ_{rk} is the fixed effect associated with round number multiple in income bracket k. The initial estimate of the counterfactual distribution is the predicted values from the regression (13) by setting all the dummies in the excluded range to zero but not omitting the contribution of the round-number dummies:

$$\widehat{c}_j^0 = \sum_{l=0}^{q} \widehat{\beta}_i \cdot (z_j)^l + \sum_{r \in R_k} \rho_r \cdot \mathbf{1}\left[\frac{z_j}{r} \in N\right].$$

The initial estimate of excess bunching, defined as the difference between the observed and counterfactual bin counts within the excluded range, is given by

$$\widehat{B}^0 = \sum_{j=z_L}^{z_U} (c_j - \widehat{c}_j^0).$$

This simple calculation overestimates $\widehat{B}$ for two reasons. First, it fails to account for the fact that the tax kink induces companies above the threshold to decrease their taxable income so that the observed distribution to the right of the kink point is everywhere lower than if there had been no kink. Therefore, the observed number of companies included in the counterfactual estimation may be higher or lower than the actual number of companies in the absence of the tax kink. This is a common problem for standard bunching method using cross-sectional data, although the difference in the two distributions should get smaller the further away from the kink.[10] Second,

[10] To address the first issue, we use an alternative method to estimate the counterfactual density,

it does not account for the fact that bunching companies just above the kink comes from the region to the right of the kink. To address the second issue, we follow Chetty et al. (2011) and shift the counterfactual distribution to the right of the kink upward until it satisfies the constraint that the area under the counterfactual must equal the area under the empirical distribution. Specifically, $\widehat{c}_j$ are the fitted values from the following regression omitting the contributions of bins in the excluded range:

$$c_j \cdot \left(1 + \mathbf{1}\left[j > R\right] \frac{\widehat{B}^0}{\sum_{j=Z_U+1}^{\infty} c_j}\right) = \sum_{l=0}^{q} \beta_i \cdot (z_j)^l + \sum_{r \in R_k} \rho_r \cdot \mathbf{1}\left[\frac{z_j}{r} \in N\right] + \sum_{i=z_L}^{z_U} \gamma_i \cdot \mathbf{1}\left[z_j = i\right] + \varepsilon_j, \tag{14}$$

and $\widehat{B} = \sum_{j=z_L}^{z_U}(c_j - \widehat{c}_j)$ is the excess mass implied by this counterfactual.[11] The empirical estimate of b, which is defined as the excess mass around the kink relative to the average density of the counterfactual distribution where bunching occurs, is derived as:

$$\widehat{b} = \frac{\widehat{B}}{\sum_{j=z_L}^{z_U} \widehat{c}_j / N_j},$$

with N_j the number of bins in the excluded range.

Standard errors are calculated using a residual-based bootstrap approach. From the regression model specifying the company counts, equation (14), we obtain the estimated residual $\widehat{\varepsilon}_j$. We draw a new set of errors by sampling from the estimated residuals with replacement and create bootstrapped company counts by adding the new set of errors to the original counts, $c_j^b = c_j + \widehat{\varepsilon}_j^b$. We use the bootstrapped company frequencies and follow the same steps above to compute new estimates of frequencies and excess mass. This bootstrap procedure is repeated 500 times and the standard error of the excess mass is estimated by computing the standard deviation of the 500 estimates. Finally we estimate the elasticity of taxable income as a non-linear combination of $\widehat{b}$, the tax kink K, and the relative changes in the net-of-tax rate $\ln(\frac{1-\tau_1}{1-\tau_2})$ as in equation (12). Standard errors of the implied elasticity are then computed using the delta method.

exploring variation in the £10k tax kink and the panel structure of the data. The difference between the elasticity estimates using the two methods appears to be small and statistically insignificant.

[11] We estimate (14) by iteration and recompute $\widehat{B}$ using the estimated $\widehat{\beta}_i$ until we reach a fixed point. The reported bootrapped standard errors account for this iteration procedure.

5 Institutional Background and Data

5.1 Income tax system in the UK: 2001 to 2008

Different types of income in the UK are subject to different taxes. Income received in the form of corporate profits is subject to corporate tax and dividend tax upon distribution to shareholders. Income received as non-corporate earnings such as wage and self-employment income, is subject to personal taxes and national insurance contributions (NICs). In the UK, the tax year for personal tax purposes runs from April 6 of the current year to April 5 of the next, while the financial year for corporate tax purposes runs from April 1 to March 31.[12] Unless stated otherwise, all years in the paper refer to financial years according to the calendar year in which they end. Table 1 provides a detailed overview of tax schedules by income type in 2001-2008.

Corporate tax

There are currently two rates that define the basic structure of the corporate tax schedule. Taxable profit over £1.5 million is taxed at the main rate, which was at 30 percent in 2001-2007 until being reduced to 28 percent in 2008. Companies with taxable profit below £300,000 are taxed at the small profits rate (previously known as the small companies' rate), which varied around 20 percent in 2001-2008. Taxable profits between £300k and £1.5 million are taxed at a higher marginal relief rate of around 32 percent during most years in this period.[13] For example, in 2002, adding £1 of taxable profit to £300k increases the marginal corporate tax rate from 19 percent to 32.75 percent. This discrete jump in the marginal rate creates a large convex kink point at £300k in the corporate tax rate schedule.

In addition to the small profits rate, an even lower starting rate was applied to taxable profits between £0 and £10k for a significant part of this period. This rate was 10 percent in 2001, reduced to zero for the next four years, and was eventually abolished in 2006. While the starting rate was in place, a higher marginal rate of approximately 20 percent was applied to taxable profits between £10,001 and £50k, thus creating another convex kink point at £10k. In addition, a non-corporate distribution rate (NCDR) of 19 percent was levied in 2005 and 2006; this was applied as a minimum rate to corporate profits distributed to persons who are not companies. Summarising, there are two large tax kinks at £10k and £300k before the abolition

[12] However, companies typically make tax returns based on their accounting year: these may therefore span different tax years.

[13] The purpose of marginal relief is to ensure that the total tax liability for profit at £1.5 million is equal to the main rate applied to £1.5 million.

of the starting rate in 2006. Since then, a flat rate of around 19 percent has been applied to taxable profits below £300k, leaving £300k as the only tax kink in the remaining years during this period. The corporate tax section in Table 1 lists the marginal rates around the tax kinks by year. While the difference in the marginal tax rates around £300k has remained relatively stable, we observe large and frequent changes in those around £10k due to the reduction and abolition of the starting rate.

Distributed profits in the UK are taxed both at the corporate level (via corporation tax) and at the personal level (via income tax), although dividend income at the personal level is not subject to NICs and carries a credit for corporation tax paid. As a result, the effective dividend tax rate is zero for taxpayers with personal income below the basic rate threshold and 25 percent for those above throughout the years 2001-2008.

Personal tax and National Insurance Contributions

The tax unit of personal tax in the U.K. is an individual rather than household. Similar to the corporate tax schedule, personal tax operates through a system of allowances and income bands that are taxed at a different rate. Each individual has a personal allowance, and income up to this amount in each year is exempted from taxes. Above this amount there are a number of tax bands. The basic rate applies to taxable income within the basic rate band and the higher rate is charged to taxable income above the basic rate threshold. A starting rate of income tax was also in place in 2001-2007, which taxed income between the personal allowance and the basic rate band at 10 percent.

In addition to paying income tax, employees, employers and the self-employed must also pay NICs. Employees and employers pay contributions according to a complex classification based on employment type and income. Class 1 NIC is charged to employees at several rates depending on various income thresholds, and to employers as well for each employee earning above the secondary threshold. Earnings below the Lower Earnings Limit (LEL) pay no NICs and received no credit for state pension. Earnings between the LEL and primary threshold, however, are not liable for any contributions but are nevertheless credited for contributory benefits. This interplay between the tax-free income threshold and the contribution-free threshold generates an interesting kink point in the combined personal tax and NICs schedule. The personal allowance or the primary threshold in the NICs schedule, whichever is lower, represents the first tax kink in the combined income tax schedule. As we show in Table 1, these two thresholds tend to track very closely with each other, with minor difference of few pounds during most years in this period.

Preferential tax treatment for corporate profits

A distinct feature of the U.K. tax system is that except at the very low end of the income distribution, income earned as corporate profits is generally taxed at a lower rate than non-corporate earnings such as wages and salaries (or self-employment income). Denote the marginal corporate tax rate by τ_c and marginal dividend tax rate by τ_{div}, we can express the effective marginal tax rate on corporate income as $\tau_c + (1 - \tau_c)\tau_{\text{div}}$ to reflect the double taxation of corporate income at the personal level. Similarly, denote the marginal personal tax rate by τ_p and the corresponding employee/employer NICs rate by $\text{nic}_{\text{employee}}/\text{nic}_{\text{employer}}$, we can express the effective marginal tax rate on wage and salary as $\tau_p +$ $\text{nic}_{\text{employee}} +$ $\text{nic}_{\text{employer}}$. Figure 1 plots the two series at every income level between £0k and £100k in 2001-2008. It is quite clear that income less than £10k is taxed at a much higher rate if earned as corporate profit after the zero starting rate was abolished. Corporate profits over £50k, on the other hand, are taxed at a much lower rate than wages and salaries.

5.2 Data and descriptive statistics

Our empirical analysis exploits two datasets. To study firms' bunching behaviour we use administrative tax return data on the population of UK companies through the financial years 2001-2008. The dataset has around 8.4 million observations for around 2.5 million separate companies and includes tax variables corresponding to the items recorded on the corporate tax return form. Since we are interested in the different margins through which companies respond to the tax structure, we include additional firm characteristics and accounting variables by linking the corporation tax return data with the FAME database. We combine the tax data and accounting data for each company and each year for approximately 90% of corporation tax returns in this way. Table 2 presents descriptive statistics of the key variables in this study. Income variables are presented in 2005 real GBPs. Companies with zero tax liabilities accounts for around 37 percent of the sample but are larger than average when measured in terms of trading turnover or number of employees. Small companies with positive taxable profits below £50k consists around 43 percent of the sample but pay relatively few corporate taxes. A small number of large companies with taxable profits above £1,500k, on the other hand, contribute the main share of the corporate tax revenue in the UK.[14]

[14]Specifically, the top 1 percent of companies contributes about 81 percent of corporate tax payable in the UK.

6 The Elasticity of Corporate Taxable Profit: Evidence from the £300k Kink

We begin our analysis by presenting evidence of bunching at the £300k kink. Companies with taxable income around this level are particularly interesting for two reasons. First, they are relatively small-sized business measured in terms of turnover and number of employees. But they are much less likely to shift income between personal and corporate tax base compared to the owner-manager companies with lower levels of taxable profits. The elasticity of taxable income can therefore be reasonably approximated by the elasticity of corporate taxable profit. Second, companies in this group have limited international activities. Compared to large multinational companies, they are therefore less likely to engage in profit shifting across borders.

6.1 Basic results

Panel (a) in Figure 2 shows the observed and counterfactual densities around £300K in 2001, with the excluded income range demarcated by the vertical-dash lines and the £300k tax kink demarcated by the vertical-solid line. The solid line with dotted markers plots the observed number of companies in income bins of £1k. Each dot denotes the upper bound of a given bin and represents the number of companies in each bin.[15] The solid-smooth line shows the counterfactual density based on fitting a 5th order polynomial using company counts with taxable income between £250k and £350k outside the excluded range. The next three panels focus on subsequent periods within which the marginal tax rates around the kink remained stable. In these panels, bunching b is defined as excess mass in the excluded range around the kink in proportion to the average counterfactual frequency in that range and elasticity e is defined as in equation (12), with standard errors shown in parentheses. All the elasticity estimates are also summarised in column 3 of Table 3. We compare the baseline elasticity estimates with those from alternative specifications in Appendix A and show that the estimated elasticity depends critically on careful specification of the estimation range, the polynomial order, as well as the income range excluded from estimation.

Three main findings are worthnoting in the figure. First, there is large and sharp bunching around £300k. The excess mass is between 6.51 and 8.83 times the height

[15] Note that we estimate the counterfactual density and excess mass using companies counts in income bins of £100. For disclousure purposes we aggregate the observed and predicted number of companies in each income bin of £1,000 subject to HMRC's confidentiality requirement.

of the counterfactual distribution and is precisely estimated. This provides strong evidence that companies respond to the tax structure. Second, bunching at £300k is asymmetric. The income range that is clearly affected by bunching around the kink lies between £290k and £307k, and there is considerably more excess mass to the left of the kink. Optimization error would generally lead to symmetric bunching around the kink. Greater mass to the left of the kink appears instead to reflect some risk aversion: that companies aim just below the kink to allow for errors. Third, despite the fact that the degree of bunching increases with the difference in the marginal net-of-tax rates, the underlying elasticity is consistently and precisely estimated to be between 0.14 and 0.18, and the pairwise difference in the elasticity estimates across years is statistically insignificant.

6.2 Restricting income/profit shifting

The elasticity of total taxable income can be reasonably approximated by that of corporate taxable income if companies have limited opportunities to shift profit between income bases. To identify this more precisely, we therefore investigate bunching for a restricted sample of companies with a large number of directors, where income shifting between personal and corporate tax bases is likely to be minimal. It is also possible that the elasticity may depend on opportunities to shift real activity and profits abroad. To address this, we also investigate a restricted sample of companies that appear to have no international activity. We identify this group as companies that do not claim any double tax relief.

In the dataset, we have information on the number of directors for around 65 percent of companies.[16] Intuitively, tax saving by shifting income to the lower taxed form for at least some of the shareholders is only feasible for companies with, at most, a handful of directors. This is consistent with Figure 3, which lists the estimated elasticities for companies with four/five/eight or more directors in 2002-2006. Using the same regression specification in the basic case, the estimated elasticity remains 0.14 for companies in the former two groups. The elasticity estimate decreases slightly to 0.11 for companies with eight or more directors, although the difference with the full-sample elasticity is statistically insignificant at 95%. This pattern remains qualitatively unchanged when comparing elasticity estimates for other periods, which

[16] A comparison between the unmatched and matched sample suggests that companies with non-missing director numbers are on average larger in terms of trading turnover and taxable profit. For example, the average trading turnover of the unmatched group is around 36 percent of the matched group. Thus the possibility of income shifting is further limited in the non-missing director sample.

are summarised in Column 4-6 of Table 3.

The last panel in Figure 3 examines the elasticity of taxable profit for companies that claim no double taxation relief in 2002-2006. The double taxation relief is a tax credit given against UK corporation tax under the terms of a unilateral or double taxation agreement, and is normally allowed as a deduction from the UK tax charged on the foreign income. Any positive double tax relief allowance is therefore a good indicator of significant multinational activity. Around 2 percent of companies claim non-zero double tax relief allowance in each year in the UK and almost all of them have taxable profits that are much higher than £300k. Not surprisingly, estimates of the excess mass and implied elasticity of corporate taxable income are therefore not affected when we exclude companies claiming double tax relief from estimation.

7 The Elasticity of Total Taxable Income: Evidence from the £10k Kink

7.1 Dynamics of bunching at £10k

Compared to the £300k kink point with relatively stable marginal tax rates, marginal tax rates around £10k went through large and frequent changes during this period. Panel (a) in Figure 4 reports the observed number of companies in bins of £1k when profits below £10k are taxed at a lower rate. The graphs also depict the corresponding marginal tax rate in dashed lines using the right y-axis. The starting rate of corporation tax was reduced from 10 percent in 2001 to zero in 2002. Correspondingly, bunching around £10k is stronger in the latter year. While the marginal tax rates remain the same in 2002-2005, a non-corporate distribution rate (NCDR) of 19 percent was in place between 1 April 2004 and 31 March 2006, which was applied as a minimum rate to corporate profits distributed to persons who are not companies. While in theory the NCDR has partially removed the benefit of the starting rate, there is no discernible decrease in the degree of bunching in 2005, the last year before the starting rate was abolished altogether.

Panel (b) in Figure 4 reports the observed company frequencies following the abolition of the starting rate of tax in 2006. Starting from 2006, companies with profits up to £300k were taxed at a flat rate of 19 percent. Consistent with the removal of the tax incentives, there is an immediate and large decrease in the excess mass around £10k in 2006. By 2007, clustering at £10k is entirely due to the integer number effect and the degree of clustering is no different than clustering at any income level that is a multiple of £5k. In contrast to the gradual adjustment in personal income bunching that has been documented in Chetty et al. (2011) and Saez (2010), these corporate earnings adapted to changes in the tax kink in a very quick and precise way. Such differences may shed some light on the type of adjustment cost in each case. While bunching around the personal tax kink involves costs in job search and hours choice, bunching around corporate tax kinks may only involve relabelling book income or expenses, which can be relatively quick.

Figure 5 reports the observed and counterfactual densities around £10k using the full sample, with the elasticity estimates summarised in column 3 of Table 4. The regression specification now accounts for finer bunching at 5k integers at the very low end of income distribution. We include companies with profits up to £40k in estimation for two reasons. First, since the higher marginal relief rate only applies to profits between £10k and £50k, companies with profits above £50k are taxed at the same rate before and after the introduction of the lower starting rate. Second, because profits above £50k (up to £300k) are taxed at a lower rate, there is a discontinuous increase in the marginal tax rate at £50k. The standard taxable income model predicts that there are strong incentives for bunching on the low-tax side, generating a hole in the observed distribution to the left of £50k and excess mass to the right of £50k. Therefore, we bound the estimation range £10k away from this kink. Bunching is symmetric around £10k and earnings within £2k of the kink are excluded from estimation of the counterfactual. The point elasticity estimate increases by around 0.1 from 2001 to 2002-2003 when the starting rate was further reduced to zero, and remains around 0.57 in the later period.

Because companies bunching around £10k may differ from those around £300k in many dimensions, it is not surprising that we obtain different elasticity estimates of corporate taxable income for these two groups. On the other hand, the scope of the tax incentives also varies for the two groups. Lowering the starting rate to zero in 2002 also reduced the average tax rate for companies with profits between £10k and £50k. As a result, companies with profits less than £50k saw a decrease in the effective average tax rate, with the largest decrease applying for companies with profits around £10k. A decrease in the average tax rates represents a tax advantage to incorporation and encouraged firm responses along the extensive margin of becoming incorporated. We examine whether the elasticity estimate is different for new and existing companies and summarise the results in column 4-5 of Table 4. The elasticity estimate for the new firms is quite similar to that for existing firms in 2002-2003 and significantly decreased following the introduction of the NCDR in 2004, which may suggest that companies that incorporated afterwards did so primarily for non-tax reasons.

7.2 Using post-reform distribution to estimate the counterfactual density

The standard bunching method relies on the identification assumption that in the absence of the tax kink, companies at the tax kink would behave similarly to companies further away from the kink. If so, the distribution of taxable income had there been no tax kinks can be predicted from the observed density outside the income range affected by the kink. As we have demonstrated in the case of £300k bunching, this method requires careful choice of the excluded region around the kink point. A conservative choice of the excluded region under-captures the full excess mass of the firm and leads to an underestimate of the underlying elasticity. Conversely, excluding observations over a wider range underutilizes useful information in the data and implies a loss of efficiency.

The 2006 tax reform, which replaced the zero starting rate with a flat rate of 19 percent for profits up to £300k, introduced additional variation in the post-reform distribution of taxable income around £10k. This offers us an opportunity to estimate directly the counterfactual distribution from the post-reform income around the old kink. The identification assumption for this approach is that the shape of the underlying probability density function is stationary and does not change as a result of the tax reform. More formally, we require that $h(z) = h(z|t)$. Under this condition, we estimate the probability density function over the finite income interval $(z_{\min}, z_{\max})$ non-parametrically using the histogram estimator:

$$\widehat{p}_H(j) = \frac{c_{j,t_{post-kink}}}{\sum_{i=z_{\min}}^{z_{\max}} c_{i,t_{post-kink}}},$$

where $c_{j,t_{post-kink}}$ is the number of companies in income bin j after the abolition of the tax kink. We choose the income interval to be between £2k and £40k so that the counterfactual region does not include part of the bunching region for the other kink point. We then compute the counterfactual density as

$$c_j = \widehat{p}_H(j) \cdot \sum_{i=z_{\min}}^{z_{\max}} c_{i,t_{kink}}.$$

The excess mass and elasticity and the associated standard errors are computed using the same procedure as before.

Panels (a) and (b) in Figure 6 show the counterfactual distribution in dotted line and corresponding elasticity estimate in 2002-2003 and 2004-2005, respectively. It also shows the counterfactual distribution and elasticity estimates using the standard bunching estimation method for comparison purposes, with income between £8k and £12k excluded from estimation and demarcated by vertical dashed lines. The counterfactual density in the dash line accounts for the integration constraint and is higher everywhere to the right of the kink compared to the uncorrected density in the solid line. Though using different estimation methods, the underlying elasticity estimates are broadly similar. In all three cases, the elasticity is consistently estimated at around 0.6, and the pairwise difference in the point estimates is not statistically significant. The fact that the three elasticity estimates are statistically similar lends support to the validity of the identification assumption in the standard bunching method.

7.3 Bunching twice: decomposing the elasticity of corporate taxable income

In Section 3.1 we show that the elasticity of corporate taxable income can be decomposed into two elasticities of interest: the elasticity of total taxable income, and the elasticity of the share of income that is recorded as profit, by analyzing the response of corporate taxable income for companies that already bunch at the personal tax kink. While income shifting between the corporate and personal tax base has been discussed in the literature, there is relatively little direct evidence of the size of this behavioural response. We identify around 1.5 percent of companies with taxable profits up to £50k to be bunching at the first personal tax kink. Changes in the marginal corporate tax rate are unlikely to affect the salary payout for companies that are at the personal income tax kink. In this case, changes in the corporate taxable income reflect changes in total taxable income. The elasticity of total taxable income x is equal to the elasticity of corporate taxable income scaled by the share of total income paid as corporate profits: $x = e \cdot \frac{B_c}{B}$, with $B_c = \pounds 10\text{k}$ and approximately, $B = \pounds 15\text{k}$.

Figure 7 depicts the counterfactual density of corporate taxable income and the corresponding elasticity estimates for companies that bunch at the personal allowance kink. Some companies in this group continue to bunch at the £10k corporate income kink, implying that their total reported taxable income is bunched around £15k. For this group of companies, the estimated elasticity of corporate taxable income is 0.46

in 2002-3, compared to 0.57 in the full sample, and is 0.3 in 2004-2005 compared to 0.54 in the full sample, although the difference in either period is not statistically significant. Using these elasticity estimates, we compute the elasticity of total taxable income x assuming that it is the same for companies with corporate profits between £10k and £50k. Following eq. (10) we compute z, the elasticity of the share of income taken as corporate profit with respect to the tax rate difference $t_p - t_c$ for the same group. Since this depends on t_p, we use two sets of personal tax rates: one applies for the basic-rate taxpayers and one for the high-rate taxpayers, and calculate the elasticity of the share of income as corporate profit in each case. A tabulation of directors' remuneration suggests that the majority of companies pay their directors a salary above the basic rate threshold, with the rest (around 14 percent of the sample) paying their directors less than the basic rate threshold.

Table 5 summarises the corresponding tax parameters and elasticity estimates. For companies with taxable profits between £10k and £50k, we estimate their elasticity of total taxable income to be around 0.2-0.3. The elasticity estimate of the share of income recorded as corporate profit for basic-rate taxpayers is around 0.06 and 0.08, which is slightly higher compared to that for higher-rate taxpayers. The elasticity of total income with respect to the corporation tax rate is a little higher than that at the £300k kink. This may be due to a number of factors, one of which is simply that non-recording of income may be higher at this end of the distribution. The elasticity of the share of total income declared as profit seems surprisingly low. However, this may be due to the same reason: if it is perceived to be relatively cheap to evade taxes, then the main effect of a change in the tax rate may be greater evasion (and hence a fall in total declared income), rather than a switch in the form in which income is declared.

8 Marginal Deadweight Cost of Corporate Income Tax

We now estimate the marginal deadweight cost of corporate income tax combing all the relevant elasticity estimates from the previous sections. Following the discussion in Section 3.1, we first calculate the fraction of welfare loss through behavioural responses if every company with taxable profit between £300k and £1,500k sees a one-percent increase in their marginal corporate tax rate. In this case, the marginal deadweight loss can be calculated using the standard formula:

$$\frac{dW}{dM} = -\frac{\bar{e} a t_c}{(1 - t_c)},$$

assuming that all income at the margin is declared as profit. The ratio a denotes the shape parameter of the Pareto distribution and measures how thin the top tail of the corporate income distribution is. We estimate a throughout the sample period and plot its value in Figure 8. The upper panel plots the average value of a for profits up to £9 million and the lower panel plots a for each year and each profit level between £50 and £1 million. The value of a remains quite stable over the tail of the income distribution and is around 1.07 at £300k.

With an average estimate of $\bar{e} = 0.18$ and marginal corporate tax rate of 29.75 percent, the fraction of welfare loss relative to the mechanical change in tax revenue is around 8.2 percent if corporate profits are retained within the company or distributed to shareholders that are taxed at the basic rate. If dividend income is taxed at the higher rate then the estimated marginal deadweight cost increases to 17.3 percent. Although we are not aware of any previous estimate on the deadweight cost of corporate taxes, Saez, Slemrod and Giertz (2012) calculate the fraction of tax revenue lost through behavioural responses to be around 27.7 percent due to a small increase in the top personal tax rate in the U.S. Their estimate applies to taxpayers at the top federal income tax bracket in the U.S. and is substantially larger than ours.

The above calculation assumes that corporate taxable income £300k follows a Pareto distribution, allowing us to apply a common value of a to every profit level above the threshold. An alternative, assumption-free method is to calculate the ratio $B/(B-A)$ for every company above a certain income threshold. We follow this approach and calculate the marginal deadweight cost due to a slight increase in the marginal tax rate for profits between £10k and £50k:

$$\frac{dW}{dM} = \sum_{k_i \in (£10k, £50k)} \frac{B_i}{B_i - A} \left\{ \bar{z} - \frac{\tau_i \bar{x}}{(1 - t_c)\, s_i} \right\} / N_{k_i}.$$

Note that in the above expression, the combined taxable income B_i, the overall effective tax rate on total income τ_i, and the proportion of total income taken as corporate profit s_i are firm-specific estimates. Using tax rates and elasticity estimates summarised in Table 5, we estimate the marginal deadweight cost of corporate income tax to be around 28.67 percent should the statutory corporate tax rate for profits between £10k and £50k increase by one percent.

9 Conclusion

In this paper we estimate the elasticity of corporate taxable income with respect to the statutory tax rate, and derive estimates of the marginal deadweight cost of the tax, for the population of UK companies between 2001 and 2008. We use corporation tax return records that allow us to identify precisely the taxable income of each company, and hence to identify companies that are located at kinks in the marginal tax rate schedule. We exploit bunching of companies at these kinks, as well as several tax reforms that took place during this period, to estimate the elasticity.

We pay particular attention to the nature of the elasticity. For widely held companies bunching at a kink at £300k in the tax schedule, it is reasonable to assume that marginal increases in profit reflect increases in total income. For such companies we estimate a relatively small elasticity of between 0.14 and 0.18. This translates into a small marginal deadweight cost: our central estimate is a marginal deadweight cost of approximately 8% of the revenue that would have been generated by a marginal increase in tax, ignoring behavioural responses.

However, owner-managed companies have the opportunity to choose the form in which their income is declared for tax purposes: either as corporate profit or a personal income. For such companies, the elasticity of corporate taxable income may in part be determined by changes to the proportion of total income declared as profit. This issue is of particular importance at a much lower kink in the tax schedule at £10k. To address this, we match the corporation tax records with information on the remuneration of directors taken from company accounting records. Combining the two sources of income allows us to identify total income and the share taken as profit. For such companies, we decompose the elasticity of corporate taxable income into two parts: the effect of changes in the tax rate on total income and the effect on the share of total income taken as profit. The empirical decomposition is based on companies that are bunched at kinks in both the personal tax schedule and the corporate tax schedule. For companies at the £10k kink in the corporate income tax schedule, we find much higher elasticities of corporate taxable income with respect to the tax rate, of between 0.54 and 0.57. These can be decomposed into (i) an elasticity of total income with respect to the net of tax rate of between 0.2 and 0.3, and (ii) an elasticity of the share of income taken as profit with respect to the difference between the personal and corporate tax rates of between 0.04 and 0.07. Combining these estimates generates an estimate of the marginal deadweight cost of the tax at the £10k kink of around 25% of the revenue that would have been generated by a marginal increase in tax, ignoring behavioural responses.

There is clearly evidence of variation in the elasticity of corporate taxable income with respect to the tax rate across companies, especially depending on their size. We find a higher elasticity for companies with very low income. This may reflect the more informal nature of such companies: their accounts may not be audited and it is plausible that evasion may be much more prevalent. Medium-sized companies with profits around £300k appear to be much less sensitive to the tax rate. We speculate, though present no evidence in support and leave for future research, that very large companies may also have a relatively high elasticity as they may have more opportunities to avoid tax, or to shift activities between countries.

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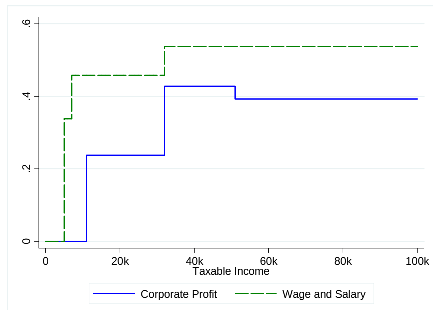
Figure 1. Effective Marginal Tax Rates by Income Type

(a) 2001

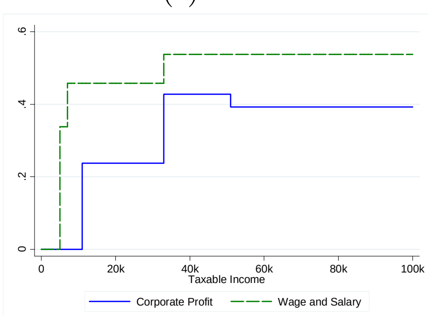
(b) 2002

(c) 2003

(d) 2004



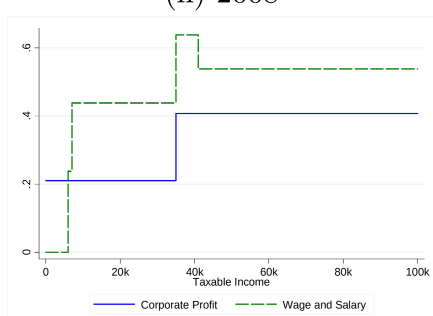
(e) 2005



(f) 2006

(g) 2007

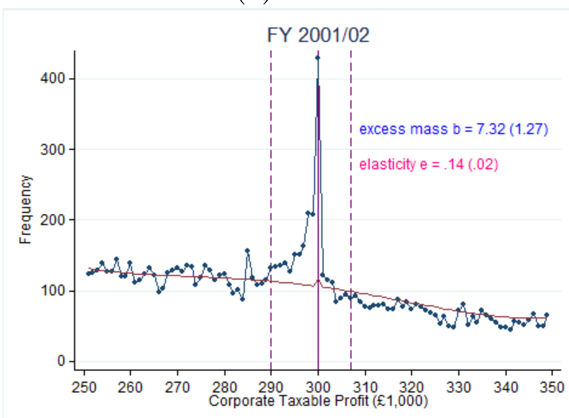
(h) 2008



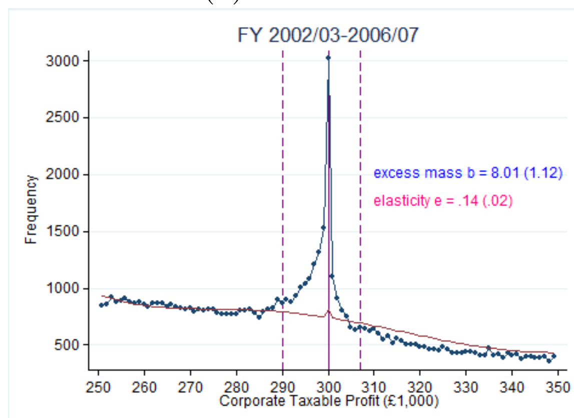
Notes: the effective marginal tax rate for corporate profit accounts for taxation of dividend income at the personal level. The effective marginal tax rate for wage and salary is the sum of the marginal personal income tax rate, employer's NICs rate and employee's NICs rate.

Figure 2. Bunching at £300k: Full Sample

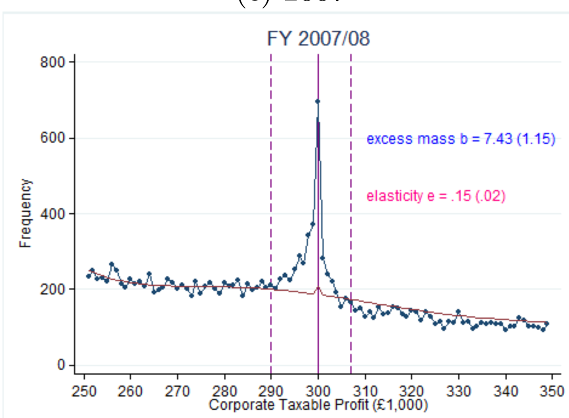
(a) 2001



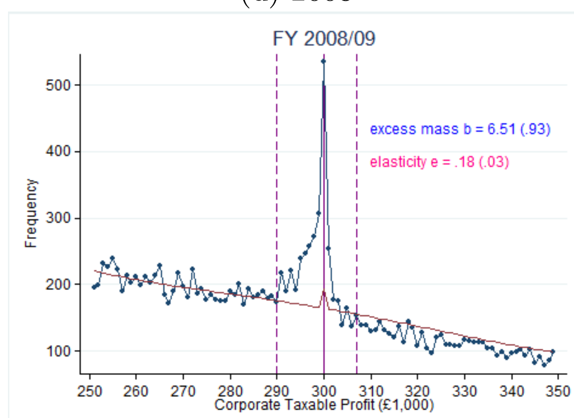
(b) 2002-2006



(c) 2007



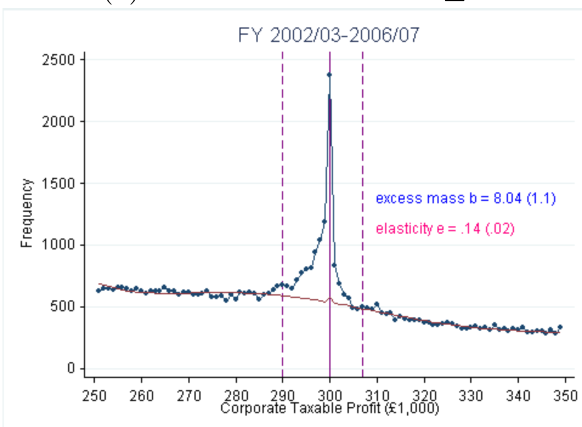
(d) 2008



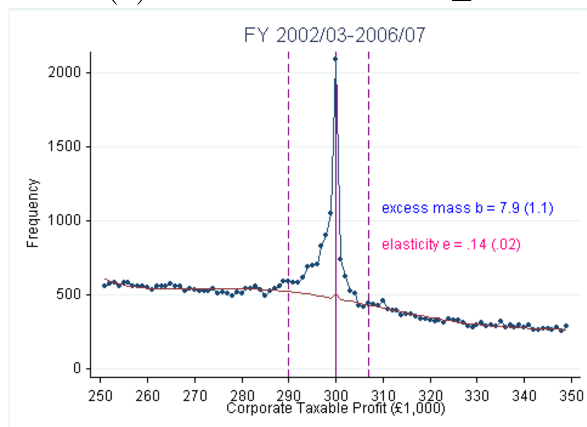
Notes: the figure shows the observed distribution (solid-dotted line) and the estimated counterfactual distribution (solid-smooth line) of corporate taxable income in 2001-2008. The counterfactual is a fifth-order polynomial estimated as in eq. (14). The excluded ranges around £300k are demarcated by the vertical-dashed lines. Bunching b is excess mass in the excluded range around £300k relative to the average counterfactual frequency in this range, and e is the implied elasticity of corporate taxable income. Standard errors are shown in parentheses.

Figure 3. Bunching at £300k: Selected Sample

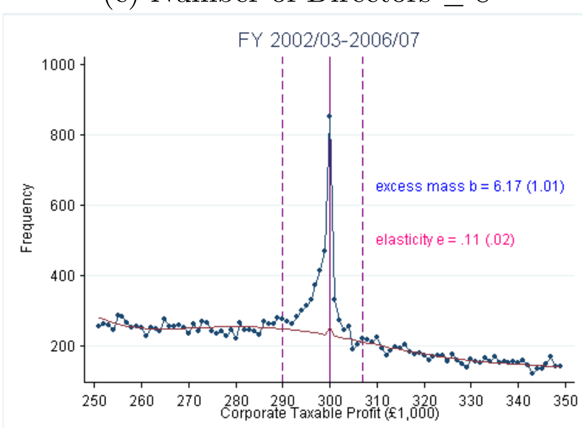
(a) Number of Directors ≥ 4



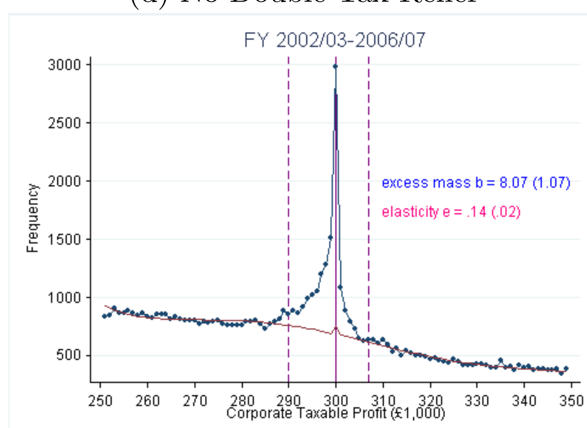
(b) Number of Directors ≥ 5



(c) Number of Directors ≥ 8



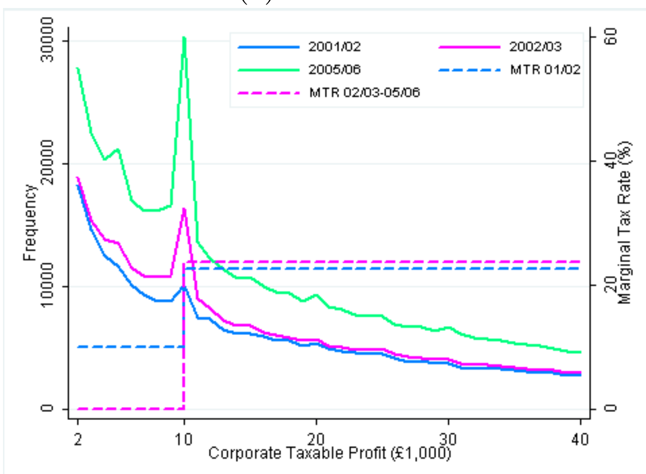
(d) No Double Tax Relief



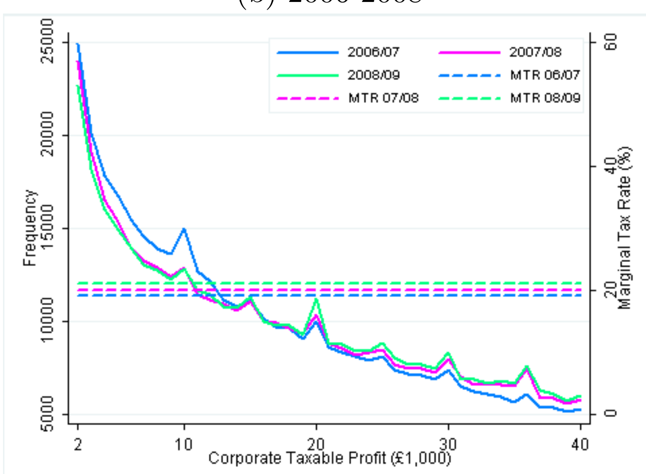
Notes: the figure shows the observed distribution (solid-dotted line) and the estimated counterfactual distribution (solid-smooth line) of corporate taxable income for companies with more than 4/5/8 directors and claiming no double tax relief in 2002-2006. The counterfactual is a fifth-order polynomial estimated as in eq. (14). The excluded ranges around £300k are demarcated by the vertical-dashed lines. Bunching b is excess mass in the excluded range around £300k relative to the average counterfactual frequency in this range, and e is the implied elasticity of corporate taxable income. Standard errors are shown in parentheses.

Figure 4. Dynamics of Bunching at £10k

(a) 2001-2005



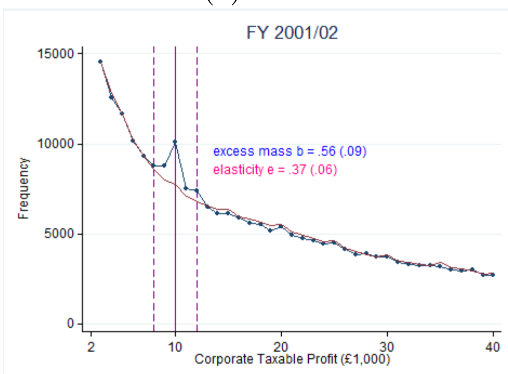
(b) 2006-2008



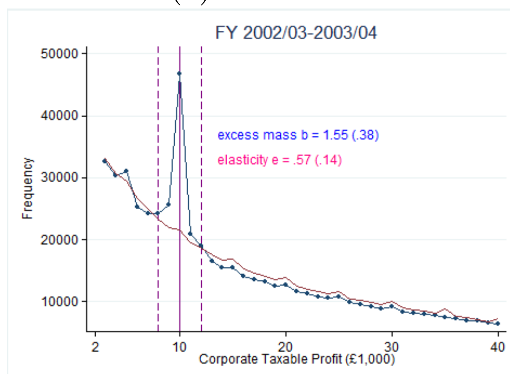
Notes: the figure shows the distribution of corporate taxable income in income bins of £1k in 2001-2008. The right y-axis depicts the corresponding marginal tax rates in horizontal-dashed lines.

Figure 5. Bunching at £10k: Full Sample

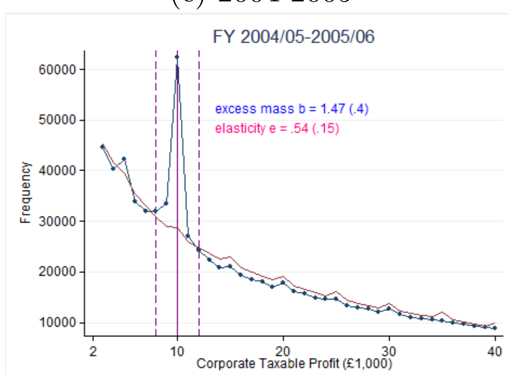
(a) 2001



(b) 2002-2003



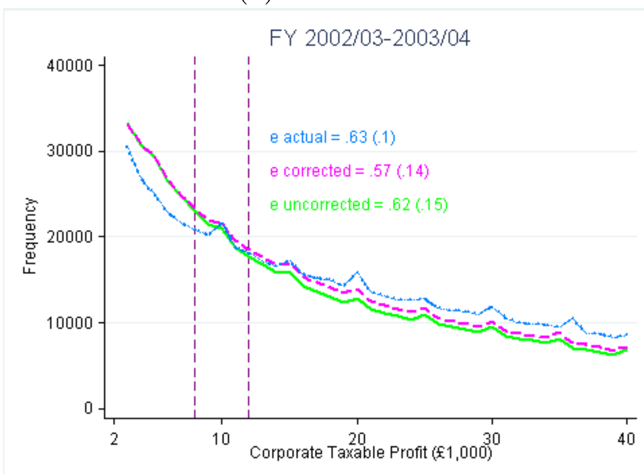
(c) 2004-2005



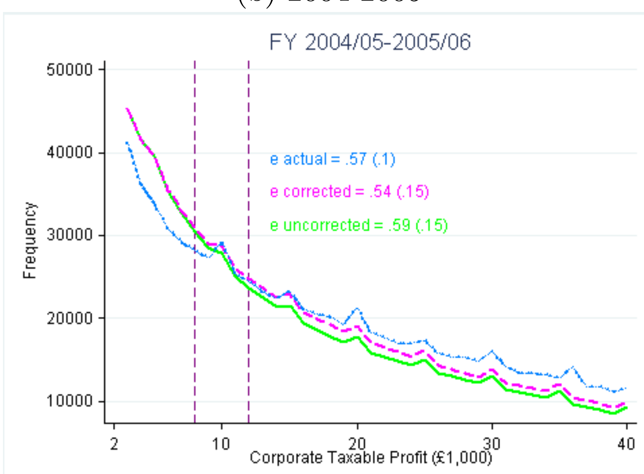
Notes: the figure shows the observed distribution (solid-dotted line) and the estimated counterfactual distribution (solid-smooth line) of corporate taxable income in 2001-2005. The counterfactual is a fifth-order polynomial estimated as in eq. (14). The excluded ranges around £10k are demarcated by the vertical-dashed lines. Bunching b is excess mass in the excluded range around £10k relative to the average counterfactual frequency in this range, and e is the implied elasticity of corporate taxable income. Standard errors are shown in parentheses.

Figure 6. Bunching at £10k: Estimation Method Comparison

(a) 2002-2003



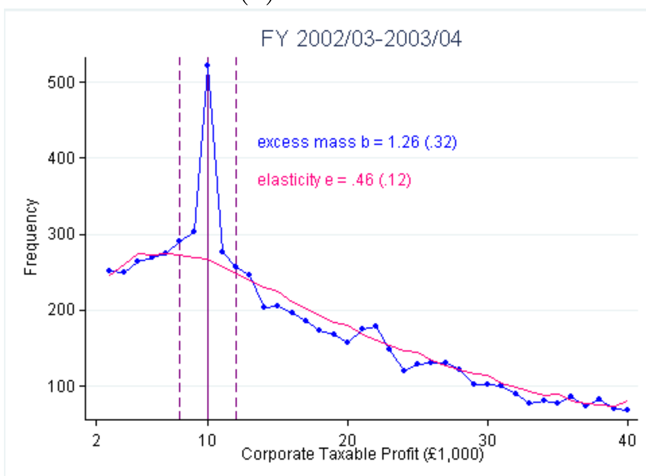
(b) 2004-2005



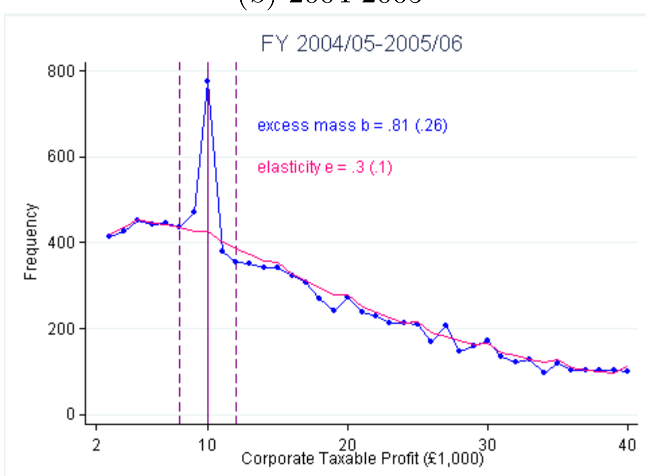
Notes: the figure compares the counterfactual density distribution and the corresponding elasticity estimate using different bunching estimation methods. "*e* uncorrected" refers to the bunching estimation ignoring the integration constraint. "*e* corrected" refers to the standard bunching estimation method which preserves the total number of companies to be the same as in the empirical distribution. "*e* actual" refers to the bunching estimation method based on the post-reform actual distribution of corporate taxable income.

Figure 7. Bunching Twice at £10k

(a) 2002-2003



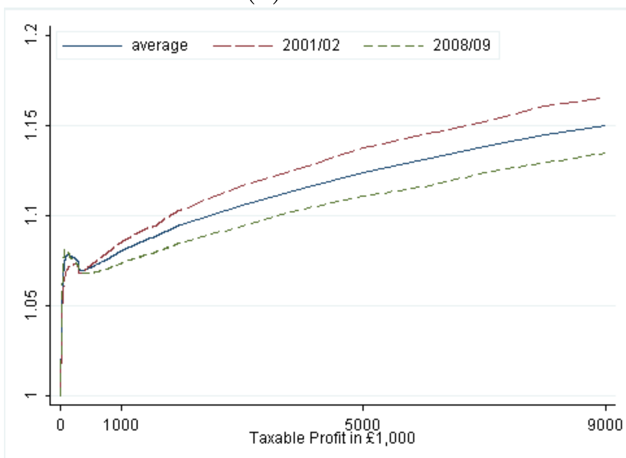
(b) 2004-2005



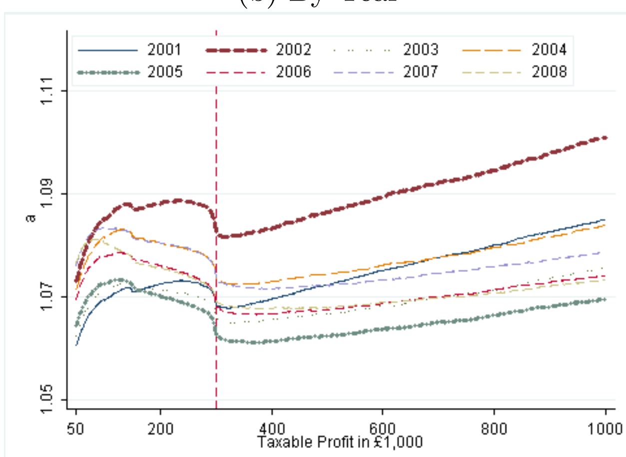
Notes: the figure shows the observed distribution (solid-dotted line) and the estimated counterfactual distribution (solid-smooth line) of corporate taxable income for companies that bunch at the first personal tax kink. The counterfactual is a fifth-order polynomial estimated as in eq. (14). The excluded ranges around £10k are demarcated by the vertical-dashed lines. Bunching b is excess mass in the excluded range around £10k relative to the average counterfactual frequency in this range, and e is the implied elasticity of corporate taxable income. Standard errors are shown in parentheses.

Figure 8. The Pareto Parameter

(a) Overall



(b) By Year



Notes: this figure shows the overall value of Parameter ratio a as a function of corporate income z between £0 and £9 million in the upper panel and the value of a in each tax year for corporate income between £50k and £1,000k. The ratio a is computed using the average income level above each income threshold z, z_m, divided by the difference between z_m and z: namely, $\frac{z_m}{z_m - z}$.

Table 1. Income Tax Schedules in the U.K.

	2001	2002	2003	2004	2005	2006	2007	2008
Corporate tax								
Income upper limit (UL)								
10,000	0.1	0	0	0	0	0.19	0.2	0.21
50,000	0.225	0.2375	0.2375	0.2375	0.2375	0.19	0.2	0.21
300,000	0.2	0.19	0.19	0.19	0.19	0.19	0.2	0.21
1,500,000	0.325	0.3275	0.3275	0.3275	0.3275	0.3275	0.325	0.2975
over 1,500,000	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.28
NCDR	0	0	0	0.19	0.19	0	0	0
Dividend tax								
tax credit rate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
basic rate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
higher rate	0.325	0.325	0.325	0.325	0.325	0.325	0.325	0.325
Personal tax								
personal allowance	4,535	4,615	4,615	4,745	4,895	5,035	5,225	6,035
starting rate UL	6,415	6,535	6,575	6,765	6,985	7,185	7,455	-
starting rate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-
basic rate UL	29,400	29,900	30,500	31,400	32,400	33,300	34,600	34,800
basic rate	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.2
higher rate	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Employed-income NICs								
Lower Earnings Limit	3,744	3,900	4,004	4,108	4,264	4,368	4,524	4,680
Upper Earnings Limit	29,900	30,420	30,940	31,720	32,760	33,540	34,840	40,040
employee's contribution								
primary threshold	4,524	4,628	4,628	4,732	4,888	5,044	5,200	5,435
basic rate contracted-in	0.1	0.1	0.11	0.11	0.11	0.11	0.11	0.11
basic rate contracted-out	0.084	0.084	0.094	0.094	0.094	0.094	0.094	0.094
higher rate	0	0	0.01	0.01	0.01	0.01	0.01	0.01
employer's contribution								
secondary threshold	4,524	4,628	4,628	4,732	4,888	5,044	5,225	5,435
basic rate contracted-in	0.119	0.118	0.128	0.128	0.128	0.128	0.128	0.128
basic rate contracted-out	0.089	0.083	0.093	0.093	0.093	0.093	0.091	0.091
higher rate	0.119	0.118	0.128	0.128	0.128	0.128	0.128	0.128

Notes: all rates and allowances are in nominal terms. NCDR refers to the non-corporate distribution rate. The lower basic NICs rates apply when the employee contracted out of the State Second Pensions and are associated with the reduced benefits.

Table 2. Summary Statistics for the Estimation Sample

	All	Corporate Taxable Profit				
		<=0	[0, 50k]	[50k, 300k]	[300k, 1,500k]	>=1,500k
Tax variables:						
Trading turnover (in mil)	3.23	3.87	1.03	1.62	11.30	155
	(528)	(579)	(588)	(81)	(219)	(1,220)
Corporate taxable profits (in k)	160.90	0	15.93	115.18	589.06	19200
	(13,200)	-	(14.22)	(62.25)	(295.01)	(166,000)
Corporate taxes (in k)	31.14	0.02	2.75	24.43	155.76	3,559.91
	(1,336.33)	(23.46)	(3.01)	(14.92)	(96.68)	(16,500)
Double taxation relief (in k)	480.85	0.03	0.49	4.84	82.69	8683.41
	(22,200)	(1.55)	(48.25)	(13.89)	(112.31)	(94,500)
Accounting variables:						
Directors' salary (in k)	154.53	214.90	40.66	115.17	369.47	999.08
	(652.73)	(835.71)	(193.33)	(321.70)	(666.33)	(2,137.92)
Number of employees	302	388	65	92	165	1331
	(3,662)	(4,420)	(874)	(709)	(1,058)	(8,345)
Number of directors	7	9	6	6	10	22
	(7)	(9)	(6)	(5)	(8)	(16)
Number of observations	8,410,741	3,107,826	3,628,199	1,429,332	192,449	52,935

Notes: summary statistics are constructed using 2001-2008 data.The taxable profit bands are in nominal terms, where all monetary values are in real 2005 British Pound (GBP) with 1 GBP = 1.55 USD as of June 2012. Standard deviations are shown in parentheses.

Table 3. Elasticity of Corporate Taxable Income around £300k

Year	Increase in 1-MTR (%-points)	Full Sample	Number of Directors >= 4	>= 5	>= 8	No DTR
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2001	0.170	**0.144**	**0.146**	**0.130**	**0.086**	**0.147**
		(0.025)	(0.026)	(0.024)	(0.024)	(0.024)
2002-2006	0.186	**0.144**	**0.144**	**0.142**	**0.111**	**0.145**
		(0.020)	(0.020)	(0.020)	(0.018)	(0.019)
2007	0.170	**0.146**	**0.151**	**0.147**	**0.137**	**0.147**
		(0.022)	(0.022)	(0.022)	(0.027)	(0.021)
2008	0.117	**0.185**	**0.187**	**0.194**	**0.124**	**0.189**
		(0.026)	(0.026)	(0.028)	(0.031)	(0.025)

Notes: the table presents estimates of the elasticity of corporate taxable income with respect to the marginal net-of-statutory tax rate around £300k. Column 3 shows results for the full sample while column 4-6 show results for companies with more than a certain number of directors. The last column shows the results for companies that claim no double tax relief. Standard errors are shown in parentheses and estimates in bold are significant at the standard 1% level.

Table 4. Elasticity of Corporate Taxable Income around £10k

Year	Increase in 1-MTR (%-points)	NCDR (%-points)	Full Sample	New Entries	Exisiting Firms
(1)	(2)	(3)	(4)	(5)	(6)
2001	0.150	0	**0.374**	-	-
			(0.057)	-	-
2002-2003	0.271	0	**0.572**	**0.500**	**0.574**
			(0.142)	(0.160)	(0.143)
2004-2005	0.271	0.190	**0.543**	**0.246**	**0.553**
			(0.146)	(0.076)	(0.152)

Notes: the table presents estimates of the elasticity of corporate taxable income with respect to the marginal net-of-statutory tax rate around £10k. NCDR refers to the non-corporation distribution rate. Column 4 shows the results for the full sample while column 5 and 6 show the results for new and existing companies, respectively. Our sample starts from year 2001 so we can only distinguish new entries and existing firms from 2002 onwards. Standard errors are shown in parentheses and estimates in bold are significant at the standard 1% level.

Table 5. Decomposition of the Elasticity of Corporate Taxable Income

					Estimated Elasticity of			
Year	$t_{c,basic}$	$t_{c,high}$	$t_{p,basic}$	$t_{p,high}$	Corporate Taxable Income $\widehat{e}$	Total Taxable Income $\widehat{x}$	Share of Income Declared as Profit $\widehat{z}_{basic}$	$\widehat{z}_{high}$
2002	0.2375	0.428125	0.387	0.518	**0.572**	**0.309**	**0.052**	**0.041**
					(0.142)	(0.078)	(0.001)	(0.001)
2003	0.2375	0.428125	0.407	0.538	**0.572**	**0.309**	**0.059**	**0.051**
					(0.142)	(0.078)	(0.002)	(0.001)
2004	0.2375	0.428125	0.407	0.538	**0.543**	**0.199**	**0.076**	**0.066**
					(0.146)	(0.064)	(0.002)	(0.001)
2005	0.2375	0.428125	0.407	0.538	**0.543**	**0.199**	**0.076**	**0.066**
					(0.146)	(0.064)	(0.002)	(0.001)

Notes: the table presents estimates of three different elasticities for companies with taxable profits between £10k and £50k. The elasticity of corporate taxable income refers to the one with respect to the marginal net-of-statutory tax rate and is estimated using the full sample with profits between £2k and £40k. The elasticity of total taxable income is computed from the elasticity of corporate taxable income for companies bunching at the first personal tax kink. The elasticity of profit share refers to the one with respect to the difference between the personal and corporate tax rate and is computed following eq. (11). Standard errors are shown in parentheses and estimates in bold are significant at the standard 1% level.

A Sensitivity Analysis of Parametric Assumptions

We examine the sensitivity of the estimation strategy to alternative order of polynomial, income range included for estimation and windows around the kink point for bunching around £300k.[17] First, while the main regression specification estimates the counterfactual distribution of corporate taxable income using companies with taxable profits between £250k and £350k, we explore alternative specification of estimation range by including companies with taxable profits around [225k, 375k] and [275k, 325k]. Table A.1 summarises the estimated excess mass b and implied elasticity of corporate taxable income e under these alternative estimation range. As illustrated, the wider the estimation range is, the larger the implied elasticity of corporate taxable income. This is because a wider estimation range includes more observations farther away from kink and under-estimates the counterfactual distribution to the right of the kink point. This in turn yields a somewhat larger elasticity estimate, although the difference with the baseline result is not statistically significant.

Second, while the main specification excludes company counts with profit between £290k and £307k, we estimate the counterfactual using alternative excluded ranges that are wider and asymmetric: [£285k, 305k] and narrower and symmetric: [£293k, 307k] and [£295k, 305k]. For the same reason that we explain above, large elasticity estimates are associated with wider excluded range. Lastly, while the main specification uses 5th order polynomials, we also estimate the counterfactual using 3rd-7th order polynomials. As illustrated, the estimation strategy is insensitive to using lower order polynomials. However, beyond 5th order polynomials, the counterfactual are significantly affected by using higher order polynomials as they overestimate the amount of excess mass at the kink point. Intuitively, the 5th order polynomials appear to be sufficiently flexible to capture the patterns in the company frequencies and provide a robust estimate of counterfactuals.

[17] Implications from sensitivity analysis for bunching around the £10k tax kink are qualitatively the same, which are not repeated here.

Table A.1. Bunching at £300k with Alternative Regression Specifications

Polynomial Order	Estimation Range	Excluded Range	Excess mass b	Implied Elasticity e
basic result				
5	[250k, 350k]	[290k, 307k]	**8.008**	**0.144**
			(1.121)	(0.020)
varying estimation range:				
5	[225k, 375k]	[290k, 307k]	**9.273**	**0.166**
			(0.823)	(0.015)
5	[275k, 325k]	[290k, 307k]	**5.136**	**0.092**
			(2.167)	(0.039)
varying excluded range:				
5	[250k, 350k]	[285k, 305k]	**8.828**	**0.158**
			(1.273)	(0.023)
5	[250k, 350k]	[293k, 307k]	**7.022**	**0.126**
			(0.889)	(0.016)
5	[250k, 350k]	[295k, 305k]	**6.109**	**0.109**
			(0.640)	(0.011)
varying polynomial order:				
3	[250k, 350k]	[290k, 307k]	**8.117**	**0.145**
			(0.847)	(0.015)
4	[250k, 350k]	[290k, 307k]	**7.022**	**0.126**
			(0.892)	(0.016)
6	[250k, 350k]	[290k, 307k]	**5.818**	**0.104**
			(0.872)	(0.016)
7	[250k, 350k]	[290k, 307k]	**5.818**	**0.104**
			(0.872)	(0.016)

Notes: the table presents estimates of the excess mass and the elasticity of corporate taxable income with respect to the marginal net-of-statutory tax rate around £300k in 2002-2006 using alternative regression specifications. Standard errors are shown in parentheses and estimates in bold are significant at the standard 1% level.