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Intertemporal income shifting and the taxation of owner-managed businesses

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Abstract

Owner-managed businesses are a fast growing group; how they respond to tax is central to the challenge of how to tax labour relative to capital incomes. We use newly linked UK tax records to estimate how personal taxes affect the real economic activity and tax avoidance of company owner-managers. All of the large responses to personal taxes are attributable to intertemporal income shifting, and not to reductions in the total amount of income created. Taxable income is shifted across time to smooth income that fluctuates around tax kinks and to access preferential capital gains tax rates; these two forms of income shifting have different implications for welfare and policy. Accounting for income shifting reduces the estimated deadweight loss associated with a marginal increase in personal taxes by around 80%. Systematic retention of income within owner-managed companies is large, particularly for higher income individuals; this income is held as cash and equivalent assets, and is not associated with increased investment in business capital.

Keywords: income shifting, elasticity of taxable income, owner-managers, closely held business, dividend taxation, capital gains
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1 Introduction

The nature of work is changing, with many more people now working through their own businesses (Katz and Krueger (2019)). In the US, the share of total business income accruing to "pass-through entities" rose from 21% in 1980 to over 50% by 2011 (DeBacker and Prisinzano (2015)); and in the UK, company owner-managers are the fastest growing part of the labour force. Many governments offer preferential tax treatment to owner-managed businesses to encourage investment and entrepreneurship, but this can also lead to costly tax avoidance[1] and increase post-tax income inequality (Smith et al. (2019)). The fact that the income of owner-managers is inherently "mixed" (i.e. reflecting returns to both capital and the labour) makes the behaviour of this group highly relevant for the design of labour and capital taxes and how they interact.

In this paper we use newly linked personal and corporate administrative tax returns to make three contributions. First, we show that the high responsiveness of UK owner-managers (individuals who are major shareholders and directors of incorporated businesses) to marginal tax rate changes is entirely due to the shifting of taxable income across time, and not to reductions in real business activity. Second, we distinguish between different motivations for the intertemporal shifting of taxable income, in order to analyse the welfare implications of this behaviour. We find that accounting for intertemporal income shifting reduces the estimated deadweight loss associated with a marginal increase in personal taxes by around 80%. Third, we study the effects of personal taxes on the company's asset portfolio choice, and find that tax-induced retained profits are held as cash and equivalent assets, and do not lead to higher investment in business capital.

For those running owner-managed businesses in the UK, it is tax-advantageous to incorporate. The corporate form also allows individuals to choose when to withdraw income from the company and pay personal income taxes, as well as whether to have income taxed as salary, dividends or capital gains. This flexibility to shift income across time can produce tax savings (and potentially distortions) much greater than those achieved by switching between salary income and capital income. Until recently, most owner-managers in the US have operated through pass-through S-corporations, which offers limited scope to shift intertemporally because income is taxed at the personal level as it arises. However, the recent corporate tax rate

[1] Common policies include lower rates of tax on dividends and capital gains, relative to labour income. Policies such as these have been shown to lead to tax motivated incorporation (Gordon and MacKie-Mason (1994), MacKie-Mason and Gordon (1997), Goolsbee (1998), Gordon and Slemrod (2000)), and to the relabelling of labour income as capital income (Gordon and Slemrod (2000), Harju and Matikka (2016)).

cut introduced in the 2017 Tax Cuts and Jobs Act is likely to lead more US owner-managers to choose a C-corporation form (Looney (2017)), which offers much more scope for shifting taxable income across time.[2] Our analysis of the UK's experience is therefore relevant for the US, particularly in light of recent reforms.

Owner-managers are known to be responsive to taxes and are often found to be important drivers of the aggregate elasticity of taxable income (Adam et al. (2017), Saez (2010)). This is consistent with such individuals having significant control over their labour supply choices (Chetty et al. (2011)) and access to a larger range of evasion responses than employees (Kleven et al. (2011)). It is also consistent with having flexibility over the timing of taxable income (le Maire and Schjerning (2013)).[3] To quantify the relative role of these responses requires data on both the company and its owner. We use the newly matched administrative tax records to estimate the effects of personal taxes on the total amount of economic activity produced by a business owner (as recorded at the company level) as distinct from the amount of personal income an owner chooses to withdraw from the company each year (as recorded in personal tax returns). This new match allows us to advance the existing literature by studying the effects of personal taxes on real business activity; distinguishing between the motivations for shifting income intertemporally; and looking at how this impacts capital investment choices.

We use two complementary empirical approaches. First, we use a bunching estimator (Saez (2010), Chetty et al. (2011), Kleven (2016)) applied to different income measures around the higher rate threshold – above which the marginal tax rate on income increases by 20 percentage points. We show that while there is sharp bunching in taxable (personal) income, there is no evidence of any (even diffuse) bunching in total income.[4] Second, we find similar patterns using a difference-in-differences strategy to assess responses to policy reforms that increased marginal tax rates for those earning above £100,000. There were large responses in taxable income but no evidence of a change in the total amount of income generated (relative to the control group), even 5 years after the reforms. Company-owner managers face significantly fewer constraints on their labour supply choices than other types of

[2]The personal income of owners of C-corporations is taxed when withdrawn from the company; they also have access to preferential capital gains tax treatment as a result of the exemption of qualified Small Business Stock.

[3]Similarly, highly paid corporate executives are found to be highly responsive to taxes, and this has been shown to be consistent with tax motivated shifting in the timing of compensation (Gorry et al. (2017) Goolsbee (2000), Kreiner et al. (2014)). Relatedly, Hanlon and Hoopes (2014) find that firms adjust the timing of their dividend payments in response to tax law changes.

[4]We may not expect to see bunching in annual total income if it is volatile and individuals can easily shift income across time. Following the approach of le Maire and Schjerning (2013) we consider bunching in average total income but find no evidence of this.

workers, such that the attenuating effects of adjustment costs on estimated labour supply elasticities (Chetty et al. (2011), Kleven and Waseem (2013), Bastani and Selin (2014)) are less of a concern. Despite this, we find that – conditional on an institutional setting in which income shifting is possible – higher marginal tax rates do not appear to change owner-managers' labour supply decisions.

To analyse the welfare implications of our results, we set out a simple theoretical framework in which owner-managers can adjust labour supply, invest in productive capital, and save in both the company and personal cash assets. Heterogeneity in individuals' preferences and borrowing constraints feed through to different responses to tax, including with regards to income shifting. We show that owner-managers will strategically retain and withdraw income from the company if either: (i) the total income flowing into the company fluctuates around a kink in the tax schedule or (ii) they are able to access lower tax rates by delaying withdrawal for a longer period; these forms of shifting have different implications for welfare and policy.

To empirically distinguish between these two motivations for income shifting, we exploit the panel nature of the UK tax records and use the fraction of years that we observe owner-managers bunching. We argue that those who are smoothing volatile total incomes bunch sporadically; this is consistent with the fact that, on average, net retention is zero for such individuals, and we see them retaining when their incomes are high, and withdrawing when their incomes are low. In contrast, those who are systematically retaining to access lower future rates bunch consistently, and have positive net retained profits. We find that around half of the observed bunching at the higher rate threshold is due to shifting to smooth volatility, and the remainder due to systematic retention to access lower future tax rates. In response to policy reforms there is evidence of dividend forestalling (i.e. short run adjustments in the timing of dividend payouts), followed by a permanent increase in retained income. This evidence, which is robust to different definitions of the treatment and control groups, and to whether we use a balanced or unbalanced panel, is consistent with evidence from Norway that income shifting explains the majority of the response to dividend tax changes (Alstadsæter and Fjærli (2009), Alstadsæter et al. (2014)).

Under the plausible assumption that smoothing income that fluctuates around a kink is costless (because consumption can be smoothed using personal assets or using short term loans against company income), this type of intertemporal shifting does not create efficiency losses. In fact, relative to a system that did not allow shifting, it is beneficial because it allows individuals with volatile incomes to smooth their tax liability and thereby not be penalised by a progressive tax

schedule relative to individuals with a more stable income (Meade (1978), Bradford (1982)). It is equally plausible that there are costs to systematically retaining over longer periods (such as incomplete credit markets); the fact that not all owner-managers retain to the tax minimising extent is evidence of such costs. In this case, the tax system creates a kink in the intertemporal budget constraint that can distort the intertemporal allocation of consumption. Although owner-managers do not fully retain to minimise their tax liability, there is, nonetheless, large net retention of profits for individuals with total incomes above the higher rate threshold (compared with zero net retention for those below). For example, among those earning £150,000, half retain in excess of £50,000 each year and 25% retain more than £90,000.

Taxes may also distort owner-managers' investment decisions. As highlighted by Chetty and Saez (2005), policy makers often perceive a trade-off when setting dividend taxes (or capital taxes more broadly): higher rates are desirable for redistributive reasons (because capital incomes accrue disproportionally to high earners) but they can generate large efficiency losses if they reduce savings and investments. Policy makers often go further than trying to avoid discouraging investment by supporting lower capital (relative to labour) tax rates as a way to promote greater investment in small businesses. Although there are market failures associated with such investment, they are poorly targeted by the types of tax policies that tend to be used in practice, including preferential rates on capital gains (Mirrlees et al. (2011), Gordon and Sarada (2018)), which opens the possibility of taxes leading to a misallocation of capital (for example towards the small business sector).

We argue that, for owner-managers (at the intensive margin), higher rates of dividend tax and access to preferential capital gains tax rates act to increase the incentive to retain earnings in a company but do not directly change investment incentives[5]; investment in a company's capital stock will only change if higher retained earnings affect the asset portfolio choice within the business. Empirically, and in response both to the higher rate threshold and to policy changes, we find that additional retained earnings are held in the form of current assets and lead to no change in a firm's own capital stock; this is consistent with evidence that the 2003 US dividend tax cut did not led to increased investment (Yagan (2015)). Our results imply that the UK's capital tax policies are not boosting investment at the intensive margin, and therefore neither increase activity that may have positive spillovers, but nor do they lead to capital misallocation. However, they are costly

[5]Under the "new view" of dividend taxes, changes in rates of dividend taxes do not affect the incentive to invest out of retained earnings (Auerbach (1979), Bradford (1981)).

in terms of foregone tax revenue: among owner-managers claiming the UK's preferential rate of capital gains tax, mean capital gains are £500,000, corresponding to a tax saving (relative to taxation on accrual) of £75,000 over the company's life.

We show that, overall, the deadweight loss associated with taxing business owners is lower than would be estimated if intertemporal income shifting were ignored. It is widely known that the conditions (as set out by Feldstein (1995, 1999)) under which the marginal welfare change from raising a tax rate can be expressed purely as a function of the elasticity of taxable income (ETI) break down if there are spillovers to other tax bases (Slemrod (1995), Slemrod and Yitzhaki (2002)).[6] In our setting there are spillovers across time and capital taxes. We use our theoretical framework to derive the sufficient statistics appropriate for our setting (an application of Chetty (2009a)). If we assume that shifting to smooth volatility does not generate deadweight loss, but systematic retention to shift to future periods does, we show that the estimated deadweight loss associated with a marginal increase in the higher rate on dividend income is reduced by around 80%. Our results are consistent with those of Gorry et al. (2018) who study income shifting by executives and show that accounting for the fact that shifted income is taxed at a future date decreases the estimated welfare loss from personal taxes.

In the next section we describe the data, and in Section 3 we outline the institutional setting and tax incentives faced by owner-managers. In Section 4 we set out a simple theoretical framework to analyse the ways in which company owner-managers might respond to the tax system, and the efficiency implications of such responses. In Section 5 we present our empirical results, and in Section 6 we discuss the implications of our results for policy design.

2 Data

Our population of interest are owner-managers of "closely held" companies i.e. company directors (managers) who are also major shareholders (owners), such that they have significant control over the business. Company owner-managers have been the fastest growing part of the UK labour force since the early 1990s; since 2000, the number of directors of companies with at most two directors has more than doubled (Cribb et al. (2019)). In many European countries, corporate forms that provide

[6]The ETI is a widely-estimated object (see e.g. Gruber and Saez (2002)) in large part because, under certain conditions, it can be used to estimate the marginal welfare change from raising tax rates without the need to identify all the different margins of response. It has also been used more widely; for example, Saez (2001) shows how earnings elasticities can be used to make inferences about the optimal progressive income tax schedule in the Mirrlees (1971) model.

vehicles for intertemporal income shifting have been the most tax advantaged form of business ownership and incorporation the source of most business growth for decades (de Mooij and Nicodème (2008)).

We use company level data from company accounts matched to administrative corporate tax records and newly matched to administrative personal tax records of company directors. The match between corporate and personal tax records allows us to simultaneously observe income and activities at the company level and individual incomes, thereby providing a more complete picture of the behaviour of company owner-managers than has previously been possible. We study closely held companies that have non-missing information on the number of shareholders and directors and that file 12 month accounts in the years 2005-15. The match between corporate and personal records is available for companies that are active in at least one year between 2013 and 2015. We summarise the data here and provide more details, including on precise variable definitions and samples, in Appendix A.

2.1 Closely held companies

We use data on companies from two sources. We use information on turnover, costs and profits contained in corporate tax records filed at the UK tax authority (HM Revenue & Customs (HMRC)). This information is matched to company accounts data (specifically *Financial Accounting Made Easy (FAME)* provided by Bureau van Dijk), which provides information on company age, the number of directors and shareholders, industrial classification, and assets and liabilities listed on companies' balance sheet. Table 2.1 shows that the majority (70%) of UK companies have strictly fewer than three directors and three shareholders; in 90% of these companies, at least one director is also a shareholder (see Appendix A for more details). In what follows we refer to companies with at most two directors and two shareholders as closely held. In some parts of the analysis we consider the subset of closely held companies with one director and one shareholder. This is the configuration that has seen the largest growth, partly a result of a change in UK law that effectively meant that companies were no longer required to have two directors.[7]

[7]The UK Companies Act 2006 meant that from 6 April 2008 limited companies were no longer required to appoint a company secretary. It is common for company secretaries to be directors.

Table 2.1: *Distribution of number of directors and shareholders for UK companies*

Number of:	Shareholders			
Directors	1	2	3+	Total
1	21.6%	5.3%	1.2%	28.1%
2	17.9%	24.6%	5.4%	48.0%
3+	8.0%	6.7%	9.3%	24.0%
Total	47.4%	36.7%	15.9%	100.0%

Notes: Table shows the distribution (%) of numbers of shareholders and number of directors for companies that are active in at least one year from 2013-2015, for which we observe information on number of shareholders and number of directors (for 23% of companies this information is missing), and who file 12-month company accounts (approximately 90% of UK companies). See Appendix A for more information on the sample.
Source: Authors' calculations using HMRC administrative datasets.

Table 2.2 compares the characteristics of closely held companies to those of all UK companies. Closely held companies are slightly younger and are smaller in terms of turnover, profits and assets than all companies. Closely held companies do, however, have higher median profit-to-turnover ratios. This is likely because closely held company owner-managers have a strong incentive – which we show below that they act on – to take their income, including that part which reflects a return to their labour effort, the form of returns to capital (i.e. as dividends or capital gains) rather than returns to labour (i.e. wages) (see Section 3 for more details). As a result, a significant amount of corporate profit will reflect returns to labour of the owner-manager.

For part of our empirical analysis, we study the subset of closely held companies that have only one director and one shareholder. This allows us to more cleanly identify to whom the income generated at the company level flows. These companies are slightly less profitable than the larger closely held companies, but have larger ratios of profit-to-turnover, again reflecting the fact that profit for these companies includes at least some part of the returns to labour of the owner-manager. The incomes of these companies are volatile. Around 40% of the variation in log total income is due to the transitory component of income; this compares to an estimate for all US workers of roughly 10% in Kopczuk et al. (2010) (details of this decomposition are provided in Appendix A.6).

Capital and investment

On average, closely held companies' balance sheets record just under £200,000 in total assets. Current assets, which include liquid financial assets (i.e. cash or

Table 2.2: *Sample descriptive statistics*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
						Closely held companies							
		All companies				≤ 2 directors, ≤ 2 shareholders				1 director, 1 shareholder			
Source	Variable	Mean	Median	P10	P90	Mean	Median	P10	P90	Mean	Median	P10	P90
FAME	Number of directors	2.2	2.0	1.0	4.0	1.6	2.0	1.0	2.0	1.0	1.0	1.0	1.0
FAME	Number of shareholders	2.1	2.0	1.0	3.0	1.4	1.0	1.0	2.0	1.0	1.0	1.0	1.0
FAME	Firm Age (years)	9.9	6.0	1.0	22.0	7.6	5.0	1.0	16.0	4.0	3.0	1.0	9.0
CT600	Turnover (£th)	576.3	106.2	15.5	1,398.4	223.6	82.0	14.4	599.1	123.4	60.7	11.5	303.8
CT600	Profit (£th)	38.5	16.5	-5.0	115.7	30.4	16.8	-2.5	88.8	21.7	11.7	-2.8	66.9
CT600	Profit/Turnover (%)	30.9	22.4	3.6	73.5	33.8	27.3	4.4	74.9	36.5	32.2	4.2	77.3
CT600	Ever use capital allowances (%)	69.9				70.4				58.7			
CT600	Capital allowances (£th)	14.0	2.5	0.2	38.6	6.3	1.7	0.2	18.4	4.3	1.3	0.2	13.2
CT600	Capital allowances/Profit (%)	12.6	2.4	-0.9	52.3	11.3	2.0	-0.0	46.7	10.5	0.9	0.0	45.8
FAME	Total assets (£th)	624,561.0	70.1	7.0	1,669.4	190.4	42.8	5.7	495.8	81.6	23.5	3.5	199.8
FAME	Fixed assets (£th)	225,616.8	14.1	1.0	1,041.5	90.9	7.2	0.7	244.0	33.9	4.0	0.6	84.3
FAME	Current assets (£th)	280,268.3	45.0	4.5	912.1	110.2	30.0	3.7	272.5	51.8	17.9	2.5	131.2
FAME	Current/Total assets (%)	72.9	86.5	18.9	100.0	75.3	88.7	24.7	100.0	78.5	93.2	29.8	100.0
FAME	Shareholder equity (£th)	135,420.0	10.2	-11.0	514.6	55.1	6.0	-8.2	152.8	17.6	2.2	-7.1	59.0
CT600/FAME	Profit/Total assets (%)	75.3	40.5	3.1	217.1	92.3	56.7	7.0	249.1	117.6	78.9	11.0	300.3
	Number of firms	1,578,706				1,093,340				339,504			

Note: Table shows descriptives for three samples. The first sample (columns (3)-(6)) contain all UK companies that operate at some point between 2013 and 2015, have non-missing information on the number of shareholders and directors and file 12 month accounts (see Appendix A for more details). The second sample (columns (7)-(10)) is a subset of the first sample that have ≤ two directors and ≤ two shareholders. The third sample (columns (11)-(14)) is a subset that have only one director and one shareholder. For each company, we observe the variables listed in column (2) annually in the data source listed in column (1); for a description of the variables see Appendix A. For each company we take the mean of each variable across the period of time they are in the data. The statistics shown in the table are mean, median, 10th and 90th percentiles across companies. Mean calculations (across companies, not when constructing company means) are winsorised at the 1st and 99th percentiles. All monetary values are in 2014-15 prices.
Source: Authors' calculations using accounts data from Financial Accounting Made Easy (FAME) and from administrative corporate tax records (CT600) provided by HMRC.

cash equivalents), investments and any stock of products yet to be sold, account,on average, for over 75% of total assets.[8] Fixed assets measure a company's stock of "productive capital" and include plant, machinery, fixtures, buildings and intangible assets. The mean closely held company has total recorded fixed assets of £90,000, but the distribution is highly skewed; the median value of fixed assets is around £7,000. We also see evidence of this skewness in the use of capital allowances (tax deductions for investment in components of fixed assets as recorded on corporate tax returns): around 70% of companies use allowances, with a median value of £1700, and a mean of £6300. Any retained profits (i.e. that are not paid out in dividends nor invested in fixed assets), will appear as current assets. We use the information on fixed assets to investigate whether changes in the marginal rate of personal income tax affect owner-managers' capital investment decisions.

Industries and business models

There is growing recognition that business owners are a highly heterogeneous group spanning many industries and business models, and not synonymous with entrepreneurs (Humphries (2017)). This is true in the UK, with significant heterogeneity in the activities of closely held companies, including across and within industries. Some company owner-managers are carrying out innovative activity, making (possibly risky) investments and employing others or seeking to expand beyond only selling the labour of the owner-manager. However, others are effectively just selling their own labour services, sometimes by operating as a contractor to third party companies (IT contractors and locum doctors are common examples of this), and are not making or intending to make any significant investments.[9]

[8] Companies may make investments example in other companies (directly or indirectly via indexes). However, there are a number of reasons why a trading company will not want to hold investments that are sufficient to have them classified as an investment company, including the fact that investment companies are excluded from many of the preferential tax treatments given to trading companies.

[9] In some cases, such as when an individual contracts solely and regularly with a single third-party company, owner-managers may in effect be operating as a "disguised" employee. There are laws that seek to prevent genuine employment (i.e. where there is effectively a contract of employment between an individual and a third party) being disguised as a more tax advantaged legal form (IR35 rules). While these rules provide some constraint on who operates through a corporate form, they are imperfect.

Table 2.3: *Closely held companies in top 15 industries*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Distribution		Median (£th)			Mean % assets
Industry (SIC code)	Number	%	Profit	Turnover	Total assets	held as current
Other business activities (74)	245,592	22.5	21.7	68.0	33.5	83.9
Construction (45)	109,556	10.0	15.8	108.9	37.5	76.8
Computer & related (72)	79,544	7.3	35.1	77.2	32.5	89.4
Retail trade (52)	59,320	5.4	5.9	173.8	56.8	76.7
Real estate (70)	55,165	5.0	4.9	45.0	239.4	45.8
Other service activities (93)	48,110	4.4	8.1	64.4	23.3	71.2
Health & social work (85)	36,413	3.3	24.4	64.6	25.4	75.1
Hotels & Restaurants (55)	34,498	3.2	3.4	157.3	45.7	52.8
Wholesale trade (51)	32,658	3.0	8.9	232.6	104.5	85.4
Rec., culture & sport (92)	26,502	2.4	9.3	61.3	27.4	73.8
Vehicle sale & repair (50)	20,831	1.9	12.3	204.9	70.0	70.7
Land transport (60)	17,910	1.6	7.4	60.1	28.4	66.3
Publishing & printing (22)	13,429	1.2	4.9	66.8	31.4	77.2
Financial intermediation (65)	10,509	1.0	17.3	73.6	39.6	83.0
Manufacture NEC (36)	10,240	0.9	8.6	165.0	75.1	75.0
Total (top 15 industries)	800,277	73.2				

Notes: Closely held companies are classified based on 2-digit SIC code (2003-based). For around 20% of closely held companies, industry classification is not recorded in the data. The table shows the top 15 industries, ranked by the number of closely held companies in each industry. For more details on the sample, see Appendix A. For each company, we take the average profits, turnover and total assets over the period of time we observe them in the data. Columns (4)–(6) show the median values of these variables across closely held companies. All monetary values are in 2014-15 prices. Source: Authors' calculations using HMRC administrative datasets.

Consistent with this heterogeneity, there are systematic differences in the activities and returns across industries. Table 2.3 lists the top 15 industries (classified using 2-digit standard industrial classification (SIC) codes) among the closely held company population, and describes variation in the median profits, turnover and assets across industries. Over 1 in 5 closely held companies have the industrial classification "other business activities", which principally includes accountants, (management) consultants, architects, and those in human resources. A further 7% are in the computer services sector (e.g. IT consultants). Companies in these industries have higher ratios of profit to turnover and assets, consistent with the expectation that a significant share of the income of these reflects returns to labour of the owner-manager. There are also substantial numbers of company owner managers operating in construction, retail, health and social work (e.g. doctors), and land transport (e.g. taxi drivers).

2.2 Linking company and owner-manager information

We use a new match between the company data (company accounts and corporate tax returns) and the personal tax records of company directors. Without the match, it is possible to observe the income and capital investment decisions of the company and, separately, the incomes (by type) of owner-managers. The match makes it possible to link these outcomes and to accurately compute how much income is retained within the company.[10] It is only by combining the data sources that we can study whether the responsiveness of owner-managers' personal taxable income reflects adjustment in the real economic activity by the owner-managers (which will show up at the company level) or different forms of tax avoidance (including those related to using retention to adjust the timing of taxable profits).

The match between administrative corporate and personal tax records was performed by HMRC. The match is between all company directors that are listed in company accounts in 2013-14 (with a a non-missing date of birth and address) and all self-assessment income tax filers in that year. For matched directors, we have an (unbalanced) panel of personal and corporate data from 2005-06 to 2014-15.

The data are matched on director name, date of birth and address; more details on this are provided in Appendix A.5. Our matched sample of closely held companies (i.e. that have least one director matched to the personal tax records) is around half our full sample. Of those closely held companies not in the matched sample, 45% were not matched because the director's date of birth or address is missing in company accounts and a further 5% are excluded because they have a director with more than one company directorship. In Appendix A we compare the matched sample with the full sample of closely held companies. The matched companies are of a similar age and have similar turnover, on average, to the full sample of closely held companies. The matched companies do, on average, have higher recorded profit than the full sample; we find that these differences are driven mainly by the fact that companies with zero or negative profits are less likely to be matched. Median asset holdings and the split between current and fixed assets are similar for the matched and full samples, although there are fewer companies in matched sample with very high asset levels, which skews the mean downwards for this sample. Overall, we conclude that our matched sample is broadly representative of those owner-managed companies that do not lie at the very extremes of the profit or asset distribution.

[10] Company accounts data contain a measure of director salaries, but in most cases this variable is missing for our population of interest as it is not a mandatory reporting requirement.

Company owner-managers

Table 2.4 presents summary statistics for directors of closely held companies (those with strictly fewer than 3 directors and 3 shareholders). These individuals are disproportionately male and have an average age of just under 50. For comparison, UK employees are around 50% male and have an average age of 40 (Cribb et al. (2019)). The age of owner-managers is relevant as it will likely affect their ability and willingness to retain profits until they dissolve their company, or until retirement, when they may choose to draw down the stock of profits through dividend payouts. In Section 5 we investigate whether older owner-managers systematically retain more profits than younger individuals.

Table 2.4: *Summary statistics for closely held company owner-managers*

Variable	Mean	Median	P10	P90
Age (years)	49.1	49.0	35.0	63.0
Share female (%)	28.5			
Wages (£th)	14.4	8.4	1.7	31.0
Dividends (£th)	21.3	17.8	0.0	42.5
Personal taxable income (£th)	39.5	34.1	10.7	75.7
Share in top 1% of income taxpayers	2.5			
Number of owner-managers		689,258		

Notes: The table presents descriptive statistics for the sample of owner-managers (directors) of matched closely held companies. For each owner-manager, we observe variables annually and take the mean of the variable across the period of time they are observed in the data (including the dichotomous indicator variable of whether their income is high enough to be in the top 1% of taxpayers). Appendix A contains details of the sample and variable definitions. Source: Authors' calculations using HMRC administrative datasets.

The personal taxable income of owner-managers is relatively high – the median is £34,000, compared with a median income of £27,000 for a full-time employee in April 2014.[11] Owner-managers are disproportionately located in the top of the income distribution; 2.5% of them are in the top 1% of UK income taxpayers (which, in recent years, reflect the top 0.6% of UK adults). How the tax system treats these individuals, and how they respond to this treatment, is therefore important both for the progressivity of the tax system and post-tax income inequality.

Variable construction

The variables we construct from the matched data and use extensively in our empirical analysis are described in Table 2.5. We observe company f's post corporate

[11] Source: Office for National Statistics, Annual Survey of Hours and Earnings.

tax profit, π_{ft}, in year t in the corporate tax returns, and the wage, y_{it}^w and dividend income, y_{it}^d, of the owner-manager i in the personal tax returns.

Table 2.5: *Key variables*

Variable	Source	Description
π_{ft}	CT600	Post-corporate tax profit of company f in year t
y_{it}^w	SA	Wage income of owner-manager i in year t
y_{it}^d	SA	Dividend income of owner-manager i in year t
z_{ft}	$\pi_{ft} + \sum_{i \in \mathcal{F}_f} y_{it}^w$	Total income (post-corporate tax) of company f in year t
y_{it}	$y_{it}^w + y_{it}^d$	Taxable income of owner-manager i in year t
r_{ft}	$z_{ft} - \sum_{i=\in \mathcal{F}_f} y_{it}$	Flow of retained profits for company f in year t

Notes: CT600 is the corporate tax record, SA is the self-assessment personal tax records. $\mathcal{F}_f$ denotes the set of owner-managers belonging to company f.

We define the total income of company f in year t (z_{ft}) as corporate profit minus corporate tax paid, plus any wage income paid to the owner-managers.[12] This is income that flows into the company each year (turnover), after deducting allowable costs (excluding the labour costs of the owner-manager) and corporate tax liability. The total taxable income of owner-manager i in year t (y_{it}) is measured directly from the individual's tax returns as the sum of dividend and wage income. Let $\mathcal{F}_f$ denote the set of owner-managers of company f. Retained profits of company f are the difference between the total income of the company (post-corporate tax) and what is withdrawn as taxable income by the company's owner-managers. For a subset of our empirical analysis we focus on one director one shareholder companies, where $\mathcal{F}_f$ is a singleton for each company. This is because, in the case of one director one shareholder companies, if these individuals were adjusting real activity (i.e the total amount of income they generate at the company level), then the relevant tax threshold is the same as for taxable income.

3 Tax system and incentives

Closely held companies are, like all UK companies, subject to corporation tax at the company level in the year in which profits are earned. Corporate taxable profits are calculated, broadly, as annual revenue (turnover) net of allowable deductions, the most notable of which are employees' costs (including wages, employer social security and pension contributions), interest expenses and capital allowances. From

[12] This is unobserved when there are multiple directors and both are not matched to the personal tax records.

2006-07 onwards, companies with profit below £300,000 (97% of closely held companies) faced a flat and stable "small companies' " corporation tax rate of between 19% and 21%.[13] Thus, corporate tax changes did not change the incentives to shift personal taxable income across time, nor to reduce the total amount of income generated by the company.

Our interest is in how the personal income tax system affects company and owner-manager behaviour. When income is distributed to the owner-manager (either as wages, dividends or capital gains) it is subject to personal taxes in the year the income is received (not necessarily the year it flows into the company). The tax treatment of UK company owner-managers means that they can freely choose whether to take their income in the form of returns to labour (wages) or capital (dividends or capital gains) and, by choosing when to take income out of a company, they can choose when to pay personal taxes.[14] The combination of lower rates of tax on capital incomes relative to salaries, and the ability to smooth taxable income over time makes operating as a company owner-manager the most tax advantaged legal form in the UK. Here we summarize the key tax features as they apply to company owner-managers; we provide more details on the tax system and marginal rate schedules for all years in Appendix B and Adam et al. (2017) provide a full discussion of the tax treatments of different UK legal forms.

3.1 Personal tax incentives

Taxation of wage and dividend income

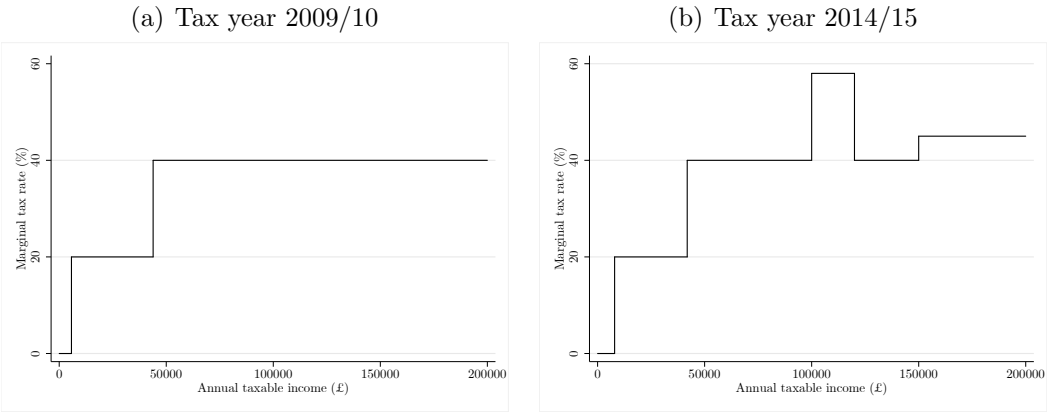
While the company is active, an owner-manager can choose to pay him/herself either in salary (wages) or dividend income. Income paid as salary is deducted from corporate tax, but is subject to both personal income tax and social security contributions (National Insurance Contributions (NICs)). Income paid as dividends is taxed first at the corporate level (in the year income arises), and then attracts personal taxes in the year dividends are paid out. Dividends fall within the personal income tax and are subject to the same thresholds as salary income but are taxed at

[13] In 2005-06, there was a 0% 'starting rate' of corporation tax on the first £10,000 of non-distributed profit. There was a system of "marginal relief" in place that increased the rate from 0% for companies with £10,000 profits to the small companies' rate at £50,000. As such, owner-managers with total incomes close to the higher-rate threshold (i.e. just below £50,000) faced a rate (on retained profits) only slightly below the full small companies' rate.

[14] In the UK there is no equivalent to "reasonable compensation" rules that apply to shareholders of S-corporations in the US and require that the salary portion of the shareholder's remuneration is a reasonable compensation of their labour input. The self-employed (owners of *unincorporated* businesses) are taxed on total income in the year it arises and, as such, have substantially less scope than company owner-managers to shift income intertemporally.

lower rates and do not attract social security contributions. The tax minimising way to take income out of the company in a given year (and in all years we study) involves taking a salary equal to the point at which personal taxes become payable (i.e. after exhausting tax free allowances) and withdrawing the remainder as dividend income. This is the most commonly used strategy by owner-managers.[15] In Appendix A.4, we show the composition of taxable income for individuals at different taxable income levels; up to around £10,000, most income is taken as salary, after which point, most income is taken as dividends. Dividend payments are usually less frequent that salary payments, making them less attractive in some cases. However, owner-managers can borrow against the income in their company (using "director's loans") in order to smooth an income stream.[16]

Figure 3.1: *Marginal personal tax rate schedules*



Notes: Marginal tax rate is the combined corporate and personal tax rate for earning and paying out of the company an extra £1. It assumes an owner-manager follows the strategy of paying him/herself a salary equal to the starting point of NICs (the primary threshold) and paying the remainder in dividends. Thresholds are in nominal terms. Source: Various government sources and authors' calculations. Exact rates and thresholds provided in Appendix B.

Figure 3.1 plots the marginal tax rate schedules faced by owner-managers assuming that they pay themselves according to the salary/dividend split described above; the marginal tax rate is the combined corporate and personal tax rate on an extra £ earned and taken out of the company. The left hand panel shows the schedule (in nominal terms) for the 2009-10 tax year. The marginal tax rate increases from 0% to 20% when taxable income exceeds the point at which NICs start to be

[15]Owner-managers can also reduce their tax liability by making a spouse a shareholder and paying them dividends. These will be included in our sample of companies with at most two directors and two shareholders.

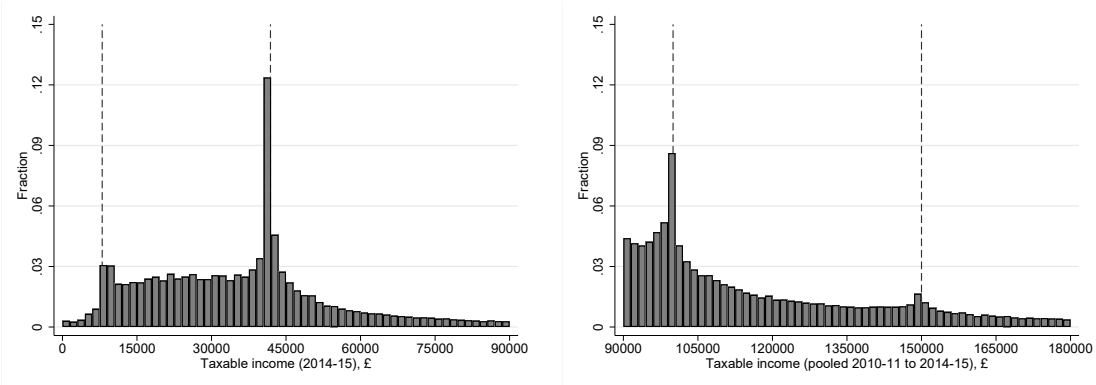
[16]The tax implications of a director's loan depends on the amount, the interest and when it is paid back. Broadly, for relatively small (£10,000 or less) short term (repaid in full within nine months of the company's accounting year-end) loans no tax is due.

due (the primary threshold), and from 20% to 40% at the higher rate threshold in income tax – roughly £40,000. This structure is representative of the marginal rate schedules in the tax years before 2009-10, albeit with small changes in the value of thresholds over time. Since the 2010-11 tax year, there have been additional marginal tax rate bands at £100,000 and £150,000 (fixed in nominal terms).[17] The right hand panel illustrates the schedule for the 2014-15 tax year.

There is clear evidence that owner-managers respond to the incentive to bunch at the thresholds in the personal tax system. Figure 3.2 plots the distribution of taxable income up to £90,000 in 2014-15, and the distribution of taxable income from £90,000 to £180,000 across the period 2010-11–2014-15.[18] There is strong evidence of bunching at the higher rate threshold, as well as at the kink points at £100,000 and £150,000 from 2010-11 onwards. The key objective of this paper is to understand what drives the high responsiveness of owner-managers to changes in the marginal tax rates they face.

Figure 3.2: *Distribution of taxable income for company owner-managers*

(a) Income $\leq$ £90,000 (2014-15) (b) Income > £90,000 (2010-11–2014-15)



Notes: Black dotted lines indicate increases in marginal rates at the primary threshold (£7,956 in 2014-15), the higher-rate threshold (£41,865 in 2014-15), the beginning of the withdrawal of the personal allowance (£100,000 in each year from 2010-11) and the additional-rate threshold (£150,000 in each year from 2010-11). Due to disclosure requirements, we pool observations of annual nominal taxable income across the years 2010-11 to 2014-15 for the right hand panel. Bin widths in both panels are £1500.
Source: Authors' calculations based on HMRC administrative datasets.

[17]The non-convex nature of the schedule at £100,000 is a result of a policy that withdraws the personal allowance above £100,000: an individual loses 50p of personal allowance for every £1 she earns above £100,000 until the personal allowance has been reduced to zero.

[18]In Appendix B we show the taxable income distributions for all years.

Taxation of capital gains

When an owner-manager chooses to sell all or part of their company or to liquidate the shares on company dissolution, the resulting income is subject to capital gains tax at the personal level. Capital gains are calculated as the difference between the current value of the shares (which is the net value of all assets, including accumulated retained earnings) and the value of the shares when the company was started (which is the initial shareholder equity if the whole company is being sold or dissolved).

In general, in the period we study, capital gains income is taxed more lightly (heavily) than dividend income above (below) the higher rate threshold. For example, from 2011-12, the corporate tax rate was 20%, dividends were taxed at 0% (25%) below (above) the higher rate threshold and owner-managers were eligible for a reduced 10% rate of capital gains tax under "Entrepreneurs' Relief". As a result, the marginal effective rate (including corporate tax) was 20% (40%) for dividend income below (above) the higher rate threshold and 28% for capital gains income.[19] This provides a tax incentive for owner-managers of companies with total income above the higher rate threshold to retain profits in the company and to withdraw it as capital gains upon sale or dissolution.

If an owner-manager is willing to delay taking income then an alternative, tax advantaged option is pension saving.[20] For an owner-manager who expects to be a basic rate income tax payer in retirement, this form of remuneration attracts the least tax. It does however come at the cost of inflexibility: while retained profits in a company can be used for investment or withdrawn at any time, pension pots can only be accessed when the individual reaches 55 years of age and, over our period, only 25% could be withdrawn as a lump sum with the remainder having to be used to purchase an annuity. There are also annual and lifetime limits (currently £40,000 and £1 million respectively) on how much can be saved in a pension. We cannot observe pension contributions or savings. However, pension saving is a cost that is deducted when calculating company taxable profits, which means that if pension saving was a key mechanism used by owner-managers, we would expect to see total income respond to changes in marginal tax rates. We show in Section 5 that there is no evidence of this.

[19] Effective rates are calculated as (corporate tax rate + (1 − corporate tax rate)∗X) where X is either the dividend or capital gains tax rate.

[20] An owner-manager can make employer pension contributions which are free of all tax at the point at which the saving is made (contributions are deductible from corporation tax and exempt from income tax and NICs). Upon withdrawal, 25% of pension savings are tax free and the remainder subject to income tax (and not NICs).

3.2 Investment incentives

The incentive to use retained earnings to invest in productive capital does not change across personal tax thresholds.[21] The parts of the corporate tax system that determine investment incentives – notably the corporate tax rate and capital allowances[22] – are not a function of personal tax rates and do not change across personal tax thresholds. There is also no incentive for someone to use investment as a way to reduce corporate level income below a personal tax threshold because doing so does not directly affect how much income is taxed at the personal level.[23]

Personal taxes do affect incentives to retain income within the company. The opportunity cost of retaining income is lower for individuals with annual personal taxable income at or above a personal tax threshold (i.e. withdrawing the income attracts more tax above the threshold). Whether this leads to increased investment in the company's capital stock depends on the portfolio choice of how to hold the retained income within the company – that is, whether to hold the income as cash (or third party investments) or as business capital. This choice will be determined by the relative rates of return on the different asset choices.

The effect of personal taxes on marginal corporate investments is central to the "new view" versus "old view" discussion of dividend taxation. The so-called "new view" argues that personal taxes (on dividends) are irrelevant for marginal investments financed from retained equity because they equally affect the opportunity cost of retaining today and the post-tax returns generated tomorrow (Zodrow (1991)). We would expect this line of reasoning to hold for an owner-manager who becomes a higher-rate tax payer today and expects to remain so in future. The irrelevance of dividend tax rates does not hold when returns are expected to be taxed at a lower rate in future (for example as a result of preferential capital gains tax rates). Therefore, *if retained income could only be invested in productive capital* (and not

[21] There is also no change in the incentive to undertake debt financed investments, since the related costs and available deductions are not linked to the personal tax system. Higher personal taxes do reduce the expected return on investment out of new equity; evidence suggests that this source of finance is rare for closely held company owner-mangers.

[22] Capital allowances affect incentives to invest in productive capital by determining how quickly investment expenditure can be deducted in the calculation of taxable corporate profits. Details of the UK regime are given in Appendix B

[23] A potential exception to this is if owner-managers purchase personal use assets (such as laptops) but claim them as a business assets that attract capital allowances. Anti-avoidance rules seek to prevent such tax evasion but are imperfect. While there is always an incentive to evade taxes in this way, it may be more attractive for owner-managers who choose to bunch at a personal tax kink since it provides a way to extract additional value from the company without increasing tax paid. Brockmeyer (2014) shows that companies increased investment, especially in fast depreciating assets, in response to the £10,000 kink in the corporate tax schedule in the early 2000s.

held as cash or other investments), we would expect to see increased investment incentives as individuals cross personal tax thresholds. In our setting, we argue that this restriction on portfolio choice does not hold, such that investment incentives will be driven by the different rates of return on available assets. We return to discuss this in Section 4, and in our empirical analysis we investigate whether individuals facing higher personal tax rates systematically retain more income and, if so, whether they also make more capital investments.

4 Theoretical analysis

In this section we analyse a dynamic model of company owner-manager behaviour. The aims of this analysis are to: (i) provide intuition for the ways in which owner-managers might respond to changes in their marginal personal tax rate; (ii) to consider which responses are likely to lead to deadweight loss, and how we can empirically estimate these efficiency losses; (iii) to provide sufficient statistics for the deadweight loss associated with a tax change.

4.1 Model set-up

Owner-managers maximise the expected net present value of lifetime utility, which is derived from consumption, c_t, and labour supplied, l_t, in each period, t:

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t[u(c_t)-\psi(l_t)], \tag{4.1}$$

where β denotes the standard discount factor, $u(\cdot)$ is a well-behaved concave per-period utility function, and $\psi(\cdot)$ is a convex function denoting the disutility from working.

They produce total income, $z_t = f(k_t, l_t, \eta_t)$, as a function of labour, l_t and capital, k_t; the production process is also subject to time varying mean zero shocks, η_t. Taxable income (at the personal level), y_t, is equal to total income (at the company level and net of corporate tax), z_t, minus the net retention of cash assets, a_t, and investment in capital, i_t: $y_t = z_t - a_t - i_t$. [24] Consumption equals taxable income minus tax paid (which depends on the tax function, $\mathcal{T}$) and any further net saving or borrowing at the personal level, s_t: $c_t = y_t - \mathcal{T}(y_t) - s_t$.

[24] For expositional ease, we abstract from the corporate tax rate. In practice, some investment is deductible from z_t before corporate tax is applied, with a_t denoting retention out of post-corporate tax profit. Adding a constant and linear corporate tax rate does not change the analysis below.

Owner-managers enter each period with capital, k_t, cash assets held in the company, A_t, and cash assets held at the personal level, S_t. The laws of motion for these three assets are:

$$k_{t+1} = (1-\delta)k_t + i_t \tag{4.2}$$

$$A_{t+1} = (1+r)(A_t + a_t) \tag{4.3}$$

$$S_{t+1} = (1+r)(S_t + s_t) \tag{4.4}$$

where we assume that capital depreciates at a rate, δ, and the rate of return on cash assets is equal to r, regardless of whether it is held in the company or at the personal level.[25] We also assume that owner-managers are subject to borrowing constraints at both the personal and company level, $S_{t+1} \geq \underline{S}$ and $A_{t+1} \geq \underline{A}$.

Owner-managers choose $\{l_t, k_{t+1}, A_{t+1}, S_{t+1}\}_{t=0}^{\infty}$ to maximise (4.1) subject to the period budget constraints, the laws of motion (4.2) – (4.4), and the borrowing constraints. The first order conditions are:

$$u_{ct} \cdot f_{lt} \cdot (1 - \mathcal{T}_t') = \psi_t' \tag{4.5}$$

$$u_{ct} \cdot (1 - \mathcal{T}_t') = \beta \mathbb{E}[u_{ct+1} \cdot (f_{kt+1} - (1-\delta)) \cdot (1 - \mathcal{T}_{t+1}')] \tag{4.6}$$

$$u_{ct} \cdot (1 - \mathcal{T}_t') = \beta(1+r)\mathbb{E}[u_{ct+1} \cdot (1 - \mathcal{T}_{t+1}')] + \lambda_t^A \tag{4.7}$$

$$u_{ct} = \beta(1+r)\mathbb{E}[u_{ct+1}] + \lambda_t^S \tag{4.8}$$

where u_{ct} denotes the marginal utility of consumption in period t; f_{lt} denotes the marginal product of labour in period t; $\mathcal{T}_t'$ denotes the marginal tax rate paid in period t; λ_t^A and λ_t^S denote the Lagrange multipliers on the borrowing constraints.

4.2 The effect of taxation on behaviour

It is straightforward to see that when the tax function is a constant linear function of taxable income, $\mathcal{T}(y_t) = \tau_0 y_t$, then the problem reduces to a standard consumption-labour model with investment and saving. In each period, owner-managers choose labour supply such that the post-tax marginal product of labour, converted into utils, equals the marginal disutility from working (equation (4.5)). The tax rate drops out of conditions (4.6) – (4.8) i.e. intertemporal allocations are unaffected. The owner-manager is indifferent between saving (or borrowing) in the company or

[25] To simplify the analysis, we assume that r – the post-personal tax rate of return – is common across assets held inside and outside of the company. In practice, they could differ, including as a result of the tax treatment of different types of personal savings vehicles. However, in the short run, we expect such differences to be small and not to affect the costs of (and therefore deadweight loss associated with) short run income shifting (to smooth volatility).

at the personal level, and does so to smooth the marginal utility of consumption over time, $u_{ct} = \beta(1+r)\mathbb{E}u_{ct+1}$ (assuming the borrowing constraints do not bind). Combining this condition with (4.6) yields the standard result that owner-managers invest such that the net return on capital equals the return on cash investments, $f_{kt+1} - (1-\delta) = 1 + r$.

When the tax system deviates from the constant rate (i.e. when there is a kink and/or different tax rates on dividend and capital gains income), there are incentives for owner-managers to shift taxable income intertemporally, which can lead to distortions in the inter (as well as intra) temporal allocation of resources. To illustrate this, we consider a piecewise linear tax function:

$$\mathcal{T}(y_t) = \tau_0 \min(y_t, y^K) + \tau_1 \max(y_t - y^K, 0) \tag{4.9}$$

i.e. taxable income up to the kink point, y^K, is taxed at the lower rate, τ_0, with income above that point taxed at a higher rate, τ_1. We additionally assume that all owner-managers have access to an intermediate rate of tax, $\tau_k \in [\tau_0, \tau_1)$ in some future period(s). This captures the fact that all owner-managers can withdraw income in the form of capital gains on company liquidation, accessing a lower rate of tax than the higher rate applied to dividends; owner-managers may also choose to draw down a stock of retained profits as dividend income (such that taxable income remains below y^K) once they have ceased working.

This particular system is broadly representative of the system faced by owner-manager in practice. However, the incentives that we describe below apply more widely, for example, if owner-managers expect variation in the tax rate across time.

The questions in which we are interested are: (i) how do owner-managers with different preferences and constraints respond to the variation in marginal rates across time and income levels? And (ii) do these responses create distortions to the allocations of consumption, labour or capital (i.e. deadweight loss)? Let $l^*(k_t, A_t, S_t, \eta_t)$ and $c^*(k_t, A_t, S_t, \eta_t)$ denote the optimal policy functions for labour supply and consumption choices, respectively, given a linear tax rate, τ_0. Analogously, let $l^{**}(k_t, A_t, S_t, \eta_t)$ and $c^{**}(k_t, A_t, S_t, \eta_t)$ denote the optimal policy functions when owner-managers are faced with the kinked tax function. We define distortionary responses to be those that lead the optimal labour and consumption paths to differ under the kinked tax function i.e. $l^* \neq l^{**}$ and/or $c^* \neq c^{**}$, since these are the determinants of utility. We conduct our analysis relative to the constant linear tax rate τ_0 because our empirical setting allows us to study the effects of the higher rate above y^K relative to the lower rate, rather than the effect relative to a zero

tax world. However, the intuition for the behaviour we describe below can easily be applied in the setting where $\tau_0 = 0$.

Shifting to smooth volatile incomes

The theoretical model produces two key insights about the type of intertemporal shifting responses to taxes and the consequences fo welfare. First, some owner-managers will respond to the tax kink, but in a way that does not create deadweight loss (i.e. utility is the same regardless of whether there is a kink at y^K). These are owner-managers who use the ability to retain in the company to smooth volatility in total income and thereby avoid being penalised by the progressivity of the tax system. Effectively, this type of shifting allows owner-managers to mimic a tax schedule without a kink and therefore mitigates the effect of the kink on labour supply choices.

Consider an agent whose average total income is less than the kink, $\bar{z}^* < y^K$, and further assume that $\beta = \frac{1}{1+r}$. Consumption smoothing thus implies that optimal consumption in each period will fall below the kink $c^* < y^K$. Now suppose that there are some periods in which $z_t^* > y^K$ (due to the shocks, η_t). In these periods, the owner-manager optimally (in the absence of the kink) would set $s_t = z_t^* - c_t^*$ i.e. they would want to save their higher than usual income. Now, in the presence of the kink, they can simply set $a_t = z_t^* - y^K$ instead, and $s_t = y^K - c_t^*$. In this way, the agent ensures that they never pay the higher rate of tax, and therefore they have no incentive to change labour supply (as $\mathcal{T}_t' = \tau_0$ in all periods).[26] Their consumption in each period is the same as in the absence of the kink. A similar argument applies to owner-managers with average total income at or above the kink. These owner-managers may adjust their labour supply and hence total income in the face of the higher tax rate (more on this below), but, conditional on this lower value of $\bar{z}^{**}$, the shifting that they may do to smooth out any volatility does not itself create distortions.

The incentive to shift to smooth out volatility exists specifically for those owner-managers whose total income fluctuates around the kink. If owner-managers are primarily engaging in this form of shifting, then we would expect to see, on average, that they are not systematically retaining income. We would also expect to see them only bunching at the kink in some years e.g. when their income exceeds the kink (if, on average, total income is below the kink). We use these predictions to investigate the empirical importance of this response.

[26]The derivative of the tax function, $\mathcal{T}_t'$ is not defined at the kink; however, this result holds if agents set $y_t = y^K - \varepsilon$, for some arbitrarily small ε when $z_t^* > y^K$.

Shifting to take advantage of a lower future tax rate

The second key insight is that owner-managers with $\bar{z}^* \geq y^K$ have an incentive to shift taxable income across time in order to access a lower tax rate, $\tau_k < \tau_1$, in some future period, $\bar{T}$. If $\tau_k > \tau_0$ (i.e. if the rate below the kink is lower than the rate available in a future period), owner-managers with average total income above the kink may reduce their labour supply (see below). Conditional on z^{**}, however, whether this type of retention response leads to a distortion in the intertemporal allocation of resources depends on whether owner-managers face personal borrowing constraints.

If owner-managers are not borrowing constrained i.e. $\lambda_t^S = 0$, then they can adjust taxable income so that $y_t^{**} = y^K$ (i.e. they bunch) in all t. The intertemporal allocation of consumption is not affected because they can borrow to fund today's consumption above current income.

However, now consider agents with $\bar{z}^* \geq y^K$, who are borrowing constrained ($\bar{z}^* - y^K \geq \underline{S}$) such that if they retained all income above the kink in the company, they could not borrow at a personal level in order to keep consumption today as high they would like. We think this a plausible situation given that many owner-managers report taxable income above the kink, which would not be optimal if they could costlessly borrow against income held in the company. Owner-managers who are borrowing constrained face a kink in their intertemporal budget constraint: consuming an extra dollar below $y^K + \bar{S}$ costs $(1+r)^{\bar{T}}$ dollars $\bar{T}$ periods in the future, but consuming an extra dollar today above $y^K + \bar{S}$ costs $\frac{1-\tau_0}{1-\tau_1}(1+r)^{\bar{T}}\big(> (1+r)^{\bar{T}}\big)$. The optimal amount owner-managers choose to retain depend on their marginal rate of substitution between today and the future.

Let $MRS(y_t|\mathbf{z}) = \frac{u_{ct}}{\beta^{\bar{T}}\mathbb{E}u_{ct+\bar{T}}}$ denote the marginal rate of substitution between consumption today and consumption in the future period $\bar{T}$ (at which point τ_k is available). It depends on the taxable income chosen today y_t, and is conditional on the stream of future total income flows. $MRS(y_t|\mathbf{z})$ is declining in y_t; in the absence of the kink, y_t is chosen such that $MRS(y_t|\mathbf{z}) = (1+r)^{\bar{T}}$ (i.e. the slope of the intertemporal budget constraint). The kink in the intertemporal budget constraint creates an incentive for agents for whom $(1+r)^{\bar{T}} \leq MRS(y^K) \leq \frac{1-\tau_0}{1-\tau_1}(1+r)^{\bar{T}}$ to bunch at y^K. The "marginal buncher" is the agent for whom $MRS(y^K) = \frac{1-\tau_0}{1-\tau_1}(1+r)^{\bar{T}}$. There is also an incentive for owner-managers with $MRS(y^K) > (1+r)^{\bar{T}}\frac{1-\tau_0}{1-\tau_1}$ to reduce their taxable income today (i.e. retain more) given the higher cost of consuming today relative to consuming tomorrow. Unlike the incentive to shift income to smooth volatility, the incentive to shift to access lower future tax rates exists for all agents whose total income exceeds y^K. We would expect that agents

who are using this form of response (as opposed to those only smoothing volatility) to systemically retain profits and, in some cases, to consistently choose taxable income at the kink. We use this to empirically disentangle the two types of shifting behaviour in Section 5. We also consider how the heterogeneity in responses, which we expect to be linked to personal borrowing constraints, varies with the age of owner-managers.

Labour supply

In addition to the distortions to owner-managers intertemporal allocation of resources decisions, the higher rate of tax, τ_1, may lead to labour supply reductions, and therefore reductions in total income, which also create deadweight loss. The extent to which they do this depends on the disutility individuals get from working, as well as the tax rate they effectively face due to their ability to shift income across time. Suppose that an owner-manager shifts taxable income across time such that, at the margin, they face the tax rate τ_k on income earned above y^K; this still creates a kink at y^K (albeit a less convex one), and therefore owner-managers who would otherwise choose total income just above the kink may choose to reduce their labour supply. It is difficult, given the various dimensions of heterogeneity in this general model, to give precise predictions about who is likely to reduce total income in the face of higher marginal rates above a kink. However, the key point is that increased tax rates may lead to reductions in the total amount of income generated. We empirically quantify the importance of this response in Section 5.

Investment

Those owner-managers who respond to tax by systematically retaining income face a choice of whether to hold retained earnings as cash (or investments in third parties) in the company or to invest in the capital stock of their business. As highlighted in Section 3, personal taxes do not directly affect the incentive to use retained earnings to invest in productive capital. This can be seen in the theoretical model by analysing the first order conditions for the different asset choices. As discussed above, the kink in the tax schedule creates a kink in the intertemporal budget constraint. This means that owner-managers who would (in the absence of the kink) set taxable income today above the kink, instead may retain (and may also adjust labour supply) such that $\frac{u_{ct}}{\beta^{\bar{T}}(1+r)^{\bar{T}}\mathbb{E}u_{ct+\bar{T}}} \leq \frac{1-\tau_k}{1-\tau_1}$ (where $\bar{T}$ denotes the number of periods in the future the owner-manager expects to access τ_k) with a strict inequality for owner-managers bunching at the kink. For these agents, substitution in to equation (4.6) yields the same condition for capital choice as in the absence of

the kink, i.e. $(1+r)^{\bar{T}} = (f_{kt+\bar{T}} - (1-\delta))^{\bar{T}}$ such that the return on the assets within the company are optimally equalised.[27] Although some owner-managers are willing to consume less today than tomorrow (because of the kink in the intertemporal budget constraint), this does not also lead to misallocation in their asset choice within the company.

This result rests on the assumption that there is a constant return to saving in the cash asset, r, that does not depend on the amount saved. If capital is chosen such that r is equal to the rate of return on capital and if the marginal return on capital is declining, then we would expect any additional retained earnings to be held in the company's cash asset. This implies no misallocation of capital because the rate of return on the cash asset is the same as for the asset held outside of the company. There are two broad cases where this would not be true. First, if the rate of return on capital relative to saving in the cash asset was increasing in investment then higher retained earnings may lead some agents to alter their asset portfolio and increase investment in k_t rather than saving in A_t. This would occur if, for example, the rate of return on the cash asset was declining at a faster rate than the marginal product of capital or if the rate or return to the safe asset was non-linear and dropped below the marginal product of capital at some point[28]. Second, if investment is lumpy (such that the marginal product of capital may be above r) then the probability of investing would be increasing in retained earnings and the portfolio of capital would not adjust smoothly. In both scenarios, investment may increase as an *indirect* result of tax motivated increases in retained earnings (i.e. not because taxes directly change investment incentives but because portfolio allocations vary with the size of retained earnings). We investigate empirically whether there is any evidence of changes to investment decisions as a result of changes in marginal personal tax rates.

4.3 Sufficient statistics

It is useful to distinguish between intertemporal income shifting and labour supply reductions because, although both can distort behaviour, shifting income across time implies that some tax will eventually be paid on that income. This has im-

[27] Note that recursion implies $u_{ct}(1-\tau_1) = \beta^{\bar{T}}\mathbb{E}[u_{ct+\bar{T}}(f_{kt+\bar{T}} - (1-\delta))^{\bar{T}}(1-\tau_k)]$. Substitute in $u_{ct} = \beta^{\bar{T}}(1+r)^{\bar{T}}\mathbb{E}u_{ct+\bar{T}}\frac{1-\tau_k}{1-\tau_1}$ yields $\mathbb{E}[u_{ct+\bar{T}}(1-\tau_k)\big((1+r)^{\bar{T}} - (f_{kt+\bar{T}} - (1-\delta))^{\bar{T}}\big]$.

[28] One very specific example of this would arise if there was an implicit cap on the size of investment in a cash asset within a company as a result of a company not wanting to have investments so large that they started being classified as an investment company. In any case where the rate of return on the cash asset held in the company falls below that on the cash asset held outside of the company, the incentive to retain earnings creates a misallocation of capital

plications for the efficiency cost of taxation in this setting. We follow the recent literature and analyse what statistics are sufficient for the deadweight loss of tax in this setting (Chetty (2009b)).

We perform the following thought experiment: what is the welfare loss from a marginal increase in the higher rate of tax, τ_1, assuming revenue is redistributed lump sum back to individuals? In this setting, the efficiency cost is as follows:

$$\frac{dW}{d\tau_1} = \frac{\mathbb{E}[\bar{\mu}_t]}{1-\beta}\left[\epsilon_y \mathbb{E}[y_t]\frac{(\tau_1 - \tau_k)}{1-\tau_1} + \epsilon_z \mathbb{E}[z_t]\frac{\tau_k}{1-\tau_1}\right] \tag{4.10}$$

where $\mathbb{E}[\bar{\mu}_t]$ denotes the expected average marginal utility of consumption, $\epsilon_y = \frac{\partial \bar{y}_t}{\partial \tau_1}\frac{(1-\tau_1)}{y_t}$ denotes the elasticity of taxable income, after stripping out the effects of shifting to smooth volatile total incomes, and $\epsilon_z = \frac{\partial \bar{z}_t}{\partial \tau_1}\frac{(1-\tau_1)}{z_t}$ is the elasticity of total income. The derivation is provided in Appendix C.

This result is an application of that derived in Chetty (2009a), and nests more standard results. For example, if $z_t = y_t$ i.e. there is no intertemporal shifting, or if $\tau_k = 0$ (i.e. no tax is paid on the shifted income[29]), then the expression in the parentheses collapses to the usual $\epsilon_y \frac{\tau_1}{1-\tau_1}\mathbb{E}[y]$. In Section 6.2, we evaluate this expression empirically and discuss the implications for the efficiency cost of taxes in this setting.

5 Results

In this section we present our empirical results. First, we quantify the importance of income reduction and intertemporal income shifting – the two key mechanisms company owner-managers can use in response to changes in the marginal tax rate faced – and distinguish between intertemporal shifting that can be attributed to a desire to smooth volatility in taxable income versus to take advantage of lower rates in some future period. Having shown that income shifting accounts for all of observed responses and that a large part of this response is the result of the systematic retention of profits, we investigate whether there is evidence that tax motivated increases in retained earnings lead to higher investment.

5.1 Income reduction versus intertemporal shifting

We use two different methods with different samples of owner-managers to investigate the extent to which owner-managers respond to changes in their marginal tax

[29] One specific example of this in the UK context is if capital gains accrued within a company are bequeathed at death and therefore subject to complete forgiveness of capital gains tax.

rates by reducing the total income generated or by intertemporal income shifting of different forms. First, we study bunching behaviour around the higher rate income tax threshold – an increase in the marginal tax rate of 20 percentage points at approximately £40,000. Second, we study the effect of two policy changes in 2010-11 that increased the marginal tax rate for individuals earning above £100,000.

Bunching at the higher rate threshold

There is large bunching in annual (personal) taxable income around the higher rate threshold (Figure 3.2). This will capture the combined effect of all responses to the increase in the marginal rate at the kink. To disentangle the different ways that owner-managers may respond to the higher marginal rates we compare the bunching mass in annual taxable income to the bunching mass in total income (we use both an annual and an average measure). Responses in total income will reflect changes in labour supply as well as capturing evasion (for example in how much total income is declared) and pension savings (as discussed in Section 3.1) but will not include changes due to intertemporal income shifting.

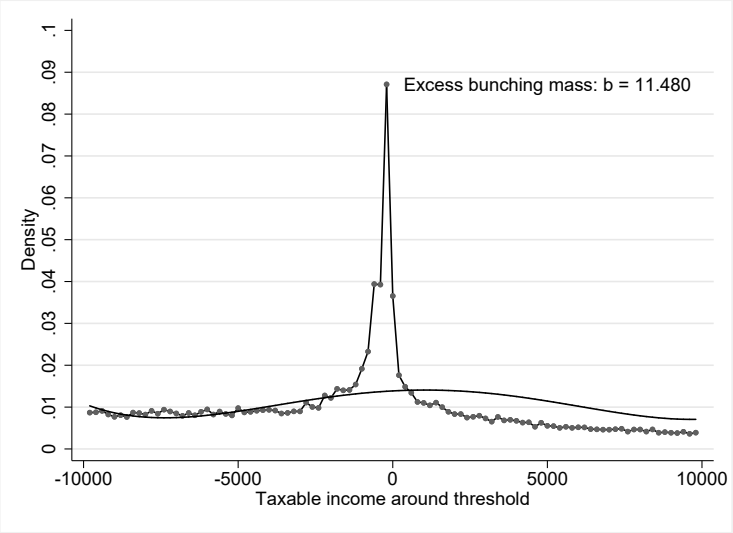
To estimate the excess mass in income due to bunching we follow Chetty et al. (2011) by using a flexible polynomial fitted to the observed distribution of income as an estimate of the counterfactual income distribution in the absence of the kink. For each income measure, x, we exclude observations in a window, $[x_-, x_+]$, around the threshold x^* and account for the fact that owner-managers who bunch come from above the kink point by imposing the integration constraint that the area under the counterfactual distribution of income must equal the area under the empirical distribution.[30]

The key identifying assumptions are: (i) that the only thing that changes across the kink is the marginal tax rate (i.e. all other owner-manager characteristics are smoothly distributed) and (ii) our parametrization of the counterfactual distribution (Blomquist and Newey (2017)). In Appendix D.2, we show robustness of our results to the degree of polynomial, p, and the excluded region around the kink, $[x_-, x_+]$.

[30] We group owner-managers into income bins indexed by j; c_j is the number of owner-managers in bin j, x_j is the income level in bin j, $[x_-, x_+]$ is the excluded range and p is the order of the polynomial. We use an iterative procedure to estimate the counterfactual distribution, $\hat{c}_j = \sum_{i=0}^{p} \hat{\beta}_i (z_j)^i$ as the fitted values from: $c_j \cdot \left(1 + \mathbf{1} \cdot [j \geq x_+] \frac{\hat{B}_N}{\sum_{j=x_+}^{\infty} c_j}\right) = \sum_{i=0}^{p} \beta_i \cdot (z_j)^i + \sum_{i=x_-}^{x_+} \gamma_i \cdot \mathbf{1}[z_j = i] + \nu_j$ where $\hat{B}_N = \sum_{i=x_-}^{x_+} \hat{\gamma}_i$ and we define $\hat{b}_x$ as the excess mass around the kink relative to the average density of the counterfactual income distribution between x_- and x_+: $\hat{b}_x = \frac{\hat{B}_N}{\sum_{i=x_-}^{x_+} \hat{c}_j / (x_+ - x_-)}$

We use the sample of one director one shareholder companies who are observed in the data for at least three years. This is so total income reflects the total output of the owner-manager and the personal tax threshold is relevant for total and taxable income; if there were two owners who reduced effort to bunch at the personal tax kink, this would translate to total income of twice the kink. Restricting the sample to owner-managers present in multiple years ensures we can calculate an average total income; in Appendix D.2 we show that the distribution of taxable income for all one director, one shareholder companies is very similar to the one for those present for at least three years. Figure 5.1 shows the distribution of annual taxable income (centered at zero around the kink), pooling observations across the tax years 2005-6 to 2014-15. There is a large excess mass at the kink, reflecting the high degree of responsiveness of owner-managers' taxable income to changes in the marginal rate.

Figure 5.1: *Bunching in annual taxable around the higher rate threshold*



Notes: Method for estimating the counterfactual density described in the text. Bin width is £200. The distribution is drawn for the sample of owner-managers of one director one shareholder companies who are present in the data for at least 3 years. Details on sample definition are provided in Appendix D.1 and robustness to order of polynomial and excluded region in Appendix D.2.
Source: Calculations based on HMRC administrative datasets.

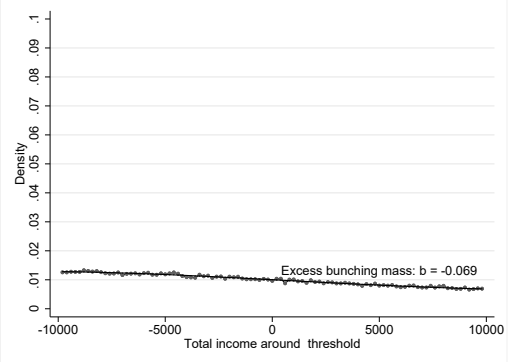
Figure 5.2(a) shows the distribution of annual *total* income. There is no evidence of bunching in this income measure (i.e. owner-managers are not adjusting total income to locate at the kink point). However, given that total income is subject to volatility, and owner-managers can easily shift personal income from year to year, we may not expect to see bunching in this measure, even if income is being reduced because of the kink (le Maire and Schjerning (2013)). We therefore plot

the distribution of *average* total income around the threshold.[31] This is shown in 5.2(b). If owner-managers were, on average, reducing their work effort, and hence total income generated, in response to the tax increase at the kink, we would expect to see bunching in this measure. However, there is no evidence of any bunching in average total income. Even if owner-managers struggled to exactly bunch in average total income, we would expect to see some diffuse bunching if they were indeed reducing their real activity in response to the kink.

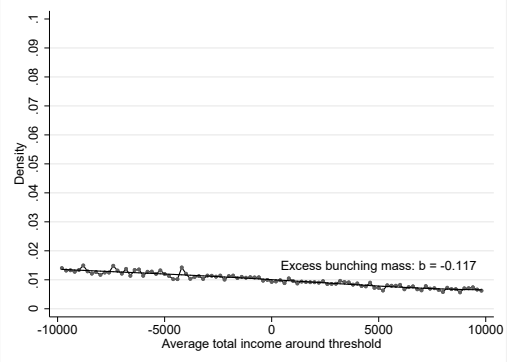
The difference between total and taxable income is driven by the retention of income within the company. The absence of any discernible response in average total income to the kink at the higher rate threshold indicates that the main margin of response is intertemporal shifting.

Figure 5.2: *Bunching in annual and average total income*

(a) Annual total



(b) Average total



Notes: See Figure 5.1.
Source: Calculations based on HMRC administrative datasets.

In Section 4 we argue that there are two main reasons why owner-managers may shift taxable income across time in response to changes in their marginal tax rate. First, to smooth out volatility in their total incomes, which allows them to avoid being penalised by the progressivity of the tax system if their total income fluctuates around the kink. Second, some owner-managers may systematically retain profits in their company in order to take advantage of lower tax rates in the future. To understand the relative importance of these two motivations, we consider persistence in bunching and retention behaviour.

We expect owner-managers who shift to smooth income volatility to: (i) only bunch at the threshold intermittently (e.g. when their total income temporarily goes above the threshold); (ii) to not systematically retain income (i.e. on average

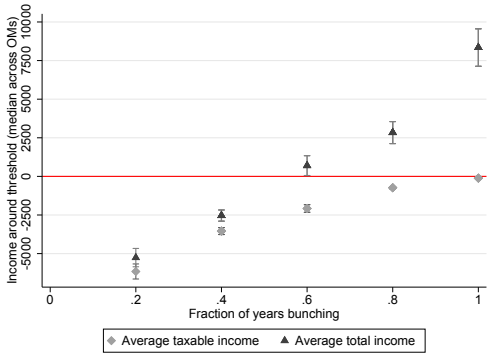
[31] We take a 3 year average for each agent; we get the same results if we take averages over 2, 3, 4 or 5 years.

their total incomes equal their taxable incomes). For the set of owner-managers that bunch at least once during their time in the sample we calculate the fraction of years that we observe them bunching, and use this to proxy whether they are bunching to smooth volatility or to systematically retain income and access lower future rates.

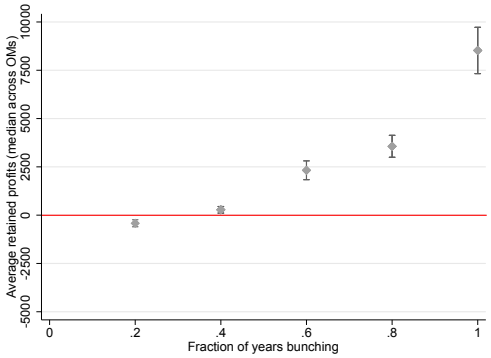
Figure 5.3(a) shows that owner-managers who bunch in fewer than 60% of the years in which we observe them have average total income below the higher rate threshold and very close to their average taxable income. In contrast, owner-managers who bunch in 60% or more of years have average total incomes significantly above average taxable incomes and, as a result are systematically retaining profits (Figure 5.3(b)). Retention is substantially higher, on average, for those bunching in all years. We also note that there is no difference in total income volatility across the fraction of years spent bunching – it is not the case, for example, that those that bunch more have more volatile incomes.[32]

Figure 5.3: *Total income, taxable income, and retained profits conditional on frequency of bunching*

(a) Total and taxable income



(b) Retained profits



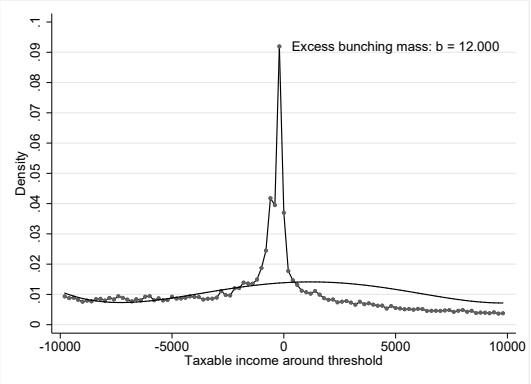
Notes: We use the sample of single director single shareholder companies that we observe in the data for at least three years. For each owner-manager, we calculate the fraction of years they bunch at the higher rate threshold in annual taxable income. We place owner-managers into one of five groups based on this fraction i.e. $(0, 0.2]$, $(0.2, 0.4]$, $(0.4, 0.6]$, $(0.6, 0.8]$, $(0.8, 1.0]$, *shown on the horizontal axis in each panel. For each owner-manager, we take their average taxable and average total income (centered around the higher rate threshold) and average retained profits across years that we observe them. The left hand panel shows the median of average taxable and average total income, and the right hand panel shows the median of average retained profits, across owner-managers within each fraction group. Source: Calculations based on HMRC administrative datasets.*

[32]Figure 5.3 uses the fraction of years that an owner-manager bunches regardless of how many years an owner-managers appears in the sample. The results – including estimates of the share of responsiveness accounted for by smoothing volatility shown in Figure 5.4 below – are robust to conditioning on the number of years that owners-managers are in the sample.

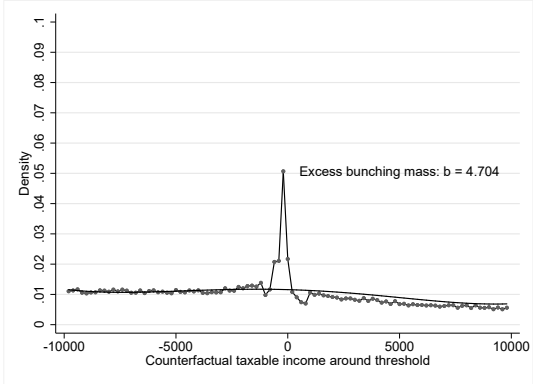
In order to quantify the extent to which shifting to smooth income volatility explains the observed responsiveness in annual taxable income, we first define "sometimes bunchers" as owner-managers who bunch at the threshold less than or equal to half of the time we observe them in the sample and "consistent bunchers" as those who bunch at the threshold more than half of the time we observe them. The bunching behaviour of "sometimes bunchers" is consistent with smoothing out volatility in total income. For example, those with average total income below the threshold are much more likely to bunch when their income is higher than usual (i.e. when there are benefits to retaining), compared with when their income is lower than usual. Similarly, those with average total income above the threshold are more likely to bunch when their income is lower than usual (i.e. when there are benefits to withdrawing).

Figure 5.4: *How much is bunching at the higher rate threshold explained by the different motivations for shifting?*

(a) Sometimes and consistent bunchers



(b) Consistent bunchers only



Notes: Method for estimating the counterfactual density described in the text. Bin width is £200. The left hand panel shows the observed distribution for one director one shareholder owner-managers who are present in the data for at least 3 years (this repeats Figure 5.1 above). The right hand panel shows the distribution when we replace the annual taxable income of the "sometimes bunchers" (owner-managers who bunch less than or equal to half the number of years they are observed) with their annual total income in that year.
Source: Calculations based on HMRC administrative datasets.

To quantify the extent to which shifting to smooth income volatility explains the observed responsiveness in annual taxable income at the higher rate threshold, we construct a distribution of annual taxable income that seeks to remove the effect of short run shifting. Specifically, we consider bunching in annual taxable income after replacing annual taxable income for "sometimes bunchers" with their annual total income. This effectively removes an estimate of the shifting which is due to income smoothing, such that the remaining excess mass around the threshold

consists only of "consistent bunchers". Figure 5.4(b) plots this distribution; Figure 5.4(a) repeats the distribution of observed taxable income for reference. The figure shows that "sometimes bunchers" make up around half of the excess mass in the annual taxable income distribution around the higher rate threshold. This means that a substantial proportion of the responsiveness of owner-managers to the kink results from people shifting taxable income across time to smooth volatility in their total income. There also remains a considerable excess mass due to owner-managers consistently bunching and retaining profits in order to take advantage of lower marginal rates in the future.

Tax rate increases on taxable incomes above £100,000

We use an alternative method and sample of owner-managers to provide additional evidence that (i) the responsiveness of owner-managers to changes in personal tax rates is driven by intertemporal income shifting (rather than reductions in total income) and (ii) that individuals shift income both to smooth short run volatility and to access lower future tax rates. Specifically, we use two policies that were announced in March 2009 and introduced in April 2010 and that resulted in individuals with incomes above £100,000 having their tax-free allowance withdrawn (at a rate of 50p for every £1, earned above £100,000) and individuals with taxable income above £150,000 facing a new higher 50% (subsequently reduced to 45% in 2013-14) marginal rate. We exploit the variation in personal tax rates that these reforms created across time in a differences-in-differences setting.

This approach does not require us to restrict our sample to only one director, one shareholder companies. We use the sample of closely held companies that have at most 2 directors and 2 shareholders and have at least one of the directors matched to the personal income tax records. This gives us more power, which is important as there are fewer owner-managers in this part of the income distribution. In this sample we cannot construct the total income measure, z_{ft}, for all companies because the match to the personal tax records of the owner-managers is incomplete.[33] Instead, we look at whether there are changes in post-corporate tax corporate profit (which will capture dividends and any retained profit, but not any wages paid to directors); the incentives to pay dividends rather than wages did not change over this period at any income level. We use the year-on-year change in shareholders'

[33]Recall: total income is the sum of post-corporate tax profit at the company level plus wage payments (as recorded on personal tax records) made to all directors.

equity to proxy retained earnings [34], and study whether this increased for those subject to higher personal tax rates.

Let i index owner-managers and f indexes companies. We define a treated group of owner-managers as those whose taxable income was always between £95,000 and £200,000 in the tax years 2005-6 to 2008-9; let $D_i = 1\big(y_{it} \in [95000,\ 200000]\ \forall t \leq 2009\big)$ denote the treatment dummy for owner-manager i. The control group of owner-managers is defined analogously as those whose taxable income was always between £50,000 and £95,000 in the pre-period: $C_i = 1\big(y_{it} \in [50000, 95000)\ \forall t \leq 2009\big)$. The treated group of companies are defined as the companies where all observed owner-managers are treated, $D_f = \min_{i \in \mathcal{F}_f} D_i$, and the control group of companies are those with at least one control owner-manager and no treated owner-manager, $C_f = \max_{i \in \mathcal{F}_f} C_i \times \min_{i \in \mathcal{F}_f}(1 - D_i)$. We show robustness to the treatment and control income cut-offs in Appendix D.3. In our baseline scenario, we estimate on an unbalanced panel, but we also show robustness to estimation on a balanced panel in Appendix D.3.

We estimate the following three regressions:

$$\ln(y_{it}) = \sum_{s \neq 2009} \beta_s^{\text{taxable}} D_i \times 1[\text{year}_t = s] + \varphi_t + \alpha_i + \nu_{it} \tag{5.1}$$

$$\ln(\pi_{ft}) = \sum_{s \neq 2009} \beta_s^{\text{profit}} D_f \times 1[\text{year}_t = s] + \varphi_t + \alpha_f + \nu_{ft} \tag{5.2}$$

$$A_{ft} - A_{ft-1} = \sum_{s \neq 2009} \beta_s^{\text{equity}} D_f \times 1[\text{year}_t = s] + \varphi_t + \alpha_f + \nu_{ft} \tag{5.3}$$

for (in the case of (5.1)) the sample of owner-managers in either the treatment or control groups ($\max\{D_i, C_i\} = 1$) and (in the case of (5.2) and (5.3)) for the sample of companies in either the treatment or control groups ($\max\{D_f, C_f\} = 1$). y_{it} is director taxable income; π_{ft} is company post-corporate tax profit, and $A_{ft} - A_{ft-1}$ is the change in shareholder's equity. φ_t denote common year effects, α_i and α_f denote owner-manager and company fixed effects, respectively, and ν_{it} and ν_{ft} are unobserved error terms.

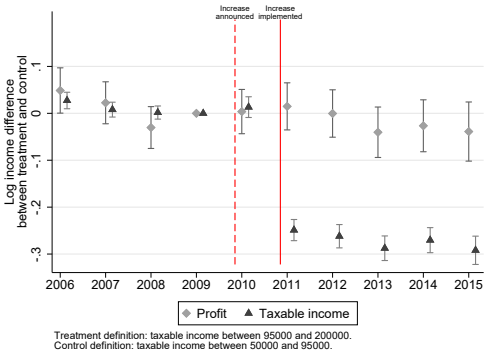
The key identifying assumption is the usual parallel trends assumption i.e. in the absence of the reform, the incomes and profits of the treatment and control groups would have evolved similarly. We have four years in the pre-reform period,

[34] Shareholders' equity is the difference between total assets (including any equity retained in the company), and total liabilities (i.e. it measures the net value of the company). Additional retained earnings (conditional on a level of liabilities) will appear as a one-for-one change in shareholder equity.

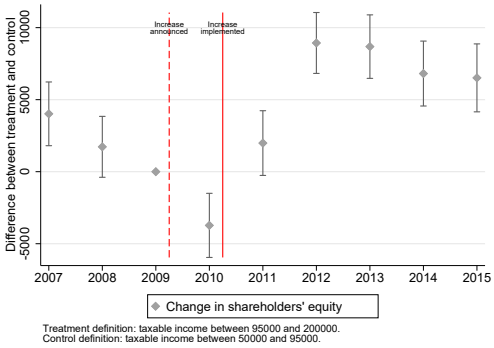
which allows us to check whether the pre-trends across the treatment and control groups look similar.

Figure 5.5: *Coefficients from differences-in-differences specification*

(a) Taxable income and profit



(b) Shareholder's equity



Notes: Left hand panel: black markers show the estimated $\beta_s^{taxable}$ coefficients from equation (5.1); grey markers show the estimated β_s^{profit} coefficients from equation (5.2). Right hand panel: the grey markers show the estimated β^{equity} coefficients from equation (5.3). In both cases the omitted year is 2009. Error bars show 95% confidence intervals. Years on the horizontal axis refer the calendar year in which the tax year ends i.e. 2007 refers to the tax year April 2006 to April 2007. Table of coefficients is available in Appendix D.3.
Source: Calculations based on HMRC administrative datasets.

Figure 5.5(a) shows the estimated coefficients from equations (5.1) and (5.2); these are relative to 2009, the omitted year. Taxable income evolves similarly for the treatment and control group in the pre-reform period; for profit, there is some evidence of a decline in the treatment relative to the control group in the pre-reform period, but these differences are not significantly different from zero. We see no statistically significant reduction in the corporate profit of companies with treated owner-managers compared with the control group following the introduction of higher marginal rates on high incomes after 2010. That is, the amount of underlying economic activity among the treated companies does not changing in response to the reform. However, the figure shows a clear fall in taxable income for treated owner-managers. This effect persists over the following four years.

These results indicate that owner-managers must have responded to the reforms by retaining income within their companies and is therefore consistent with the bunching evidence that the high responsiveness of company owner-managers to marginal tax rate changes is entirely explained by intertemporal income shifting. Figure 5.5(b) shows this directly. The year-on-year change in shareholders' equity was higher for the treatment group relative to the control group in the post-reform period. That is, following the reforms (which increased the difference between

current and future tax rates), owner managers persistently retained more income within their company. The estimated negative coefficient in 2010 (i.e. the change in shareholders' equity was lower for the treatment than the control group) is consistent with dividend forestalling (i.e. paying out additional dividends and thereby reducing shareholder equity) in anticipation of the reform. This is a form of short run shifting of taxable income in order to avoid a higher marginal tax rate.

5.2 Who retains profits and how do they invest them?

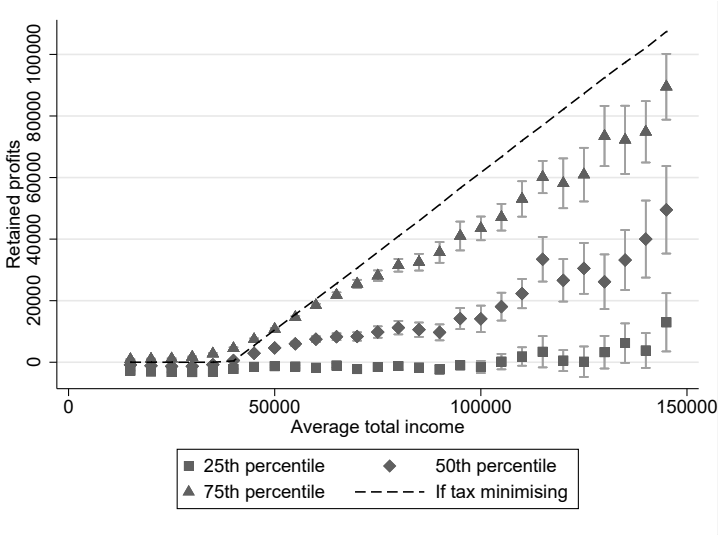
The above results show that the retention of profits is the main response of owner-managers to changes in marginal tax rates. The incentive to shift to smooth volatility is only relevant for those owner-managers whose total income fluctuates around a threshold. Among single director single shareholder companies, we find that 16% of owner-managers are "sometimes bunchers" around the higher rate threshold (i.e. engaging in bunching to smooth income volatility). A further 6% of owner-managers consistently bunch at the higher rate threshold and retain all income above this (this is the tax-minimizing strategy that we would expect everyone to follow if there were no costs to shifting).

However, the incentive to retain to shift income to the future exists for all owner-managers whose average total income exceeds the higher rate threshold: many more owner-managers with average total incomes above a threshold retain substantial amounts, even if they are not 'fully retaining'. Figure 5.6 shows the 25th, 50th and 75th percentiles of average retained profits at different levels of average total income. There is little systematic retention of profits by those with incomes below the higher rate threshold. Above the threshold (approximately £40,000) the amounts retained are large and increasing: for those earning more than £150,000, half retain in excess of £50,000 each year and 25% retain more than £90,000.

Following the line of argument set out in Section 4, we would expect retention to be highest for those individuals that face the fewest constraints (lowest costs) on their ability to retain and consumption smooth. Individuals may have relatively low costs associated with their retention because: (i) there is a relatively short period between today and when they expect to access a lower rate of tax (for example they are closer to retirement or liquidating their company); (ii) they have built up personal assets that they can draw down to offset the asset accumulation in the company, thus minimising the distortion to intertemporal consumption. Both of these factors are more likely to be true for older individuals. In line with this, we find that retained profits increase as owner-managers approach retirement age,

particularly for those with total incomes less than £25,000 above the higher rate threshold (results shown in Appendix D).

Figure 5.6: *Retained profits across the total income distribution*



Notes: For each single shareholder single director company owner-manager we construct their average total income and average retained profits. The figure shows the 25th, 50th, and 75th percentiles of average retained profits conditional on binned average total income, across owner-managers. Error bars show 95% confidence intervals.
Source: Calculations based on HMRC administrative datasets.

Policy makers often support lower capital gains tax rates (relative to taxes on salaries or dividends) as a mechanism to encourage business owners to invest in their own enterprises.[35] Here we show that there is no evidence that tax induced increases in retained profits lead to higher business investment. Instead, evidence suggests that owner-managers retain income for long periods in order to access lower tax rates, including preferential capital gains treatment. We consider how the retained income is held, specifically, whether retained earnings are held in cash (or cash equivalents) or invested in the company's productive capital stock.

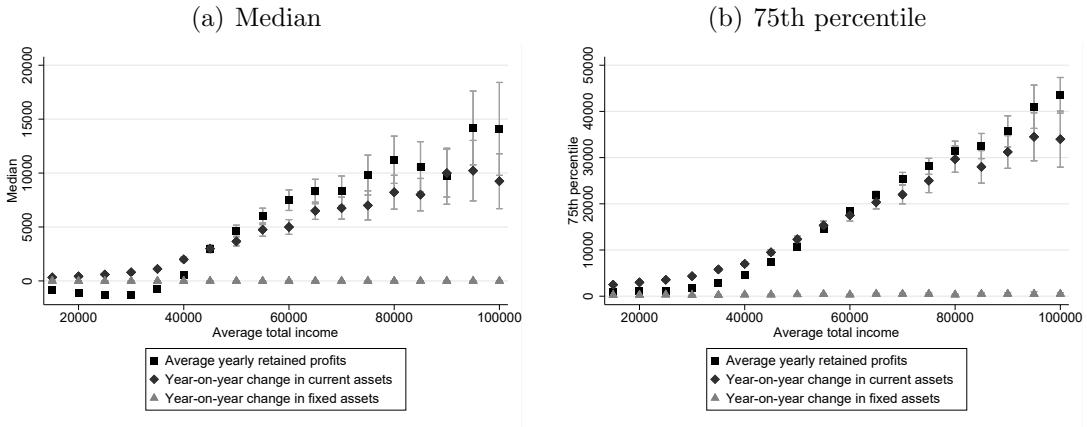
In Section 4 we argued that although higher marginal rates of personal taxes can incentivise owner-managers to retain additional income, they do not necessarily change the incentives over how much to invest in the capital stock of the company. This is because retained earnings can also be held in cash (or equivalents) or as investments in third parties. A change in the marginal personal tax rate does not affect the decision over how to allocate assets within the company. Investment may be increased as a result of additional retained earnings (and therefore portfolio choices distorted) if the rate of return on investment relative to a cash asset is

[35]Part of the rationale often relates to encouraging new start-ups; we do not investigate that here.

increasing in the size of retained earnings. We investigate whether there is any evidence of higher investment due to the larger incentives to retain income above kinks in personal tax thresholds, in two ways.

First, we construct, for each owner-manager, the average year-on-year change in current and fixed assets. Figure 5.7 shows the 50th and 75th percentile of asset changes and average yearly retained profits, conditional on average total income. At all income levels, the increase in retained profits above the higher rate threshold is matched by an increase in current assets, but not fixed assets.[36] This suggests that retained profits are held as cash, or cash equivalents, and not invested in the company's productive capital.

Figure 5.7: *Retained profits and asset growth*



Notes: For each single shareholder single director company owner-manager we construct their average total income, average yearly retained profits, and average year-on-year change in current and fixed assets. The left hand panel shows the median and the right hand panel shows the 75th percentile across owner-managers.
Source: Calculations based on HMRC administrative datasets.

This analysis of average asset growth may not capture the fact that investment choices are lumpy, or respond to lagged increases in retained profits. Our second approach therefore uses a differences-in-differences approach, as described in Section 5.1, to analyse the impact of the policy reforms that increased tax rates on higher income individuals in 2010-11 on subsequent investment in fixed assets. To allow for the lumpy nature of investment, we construct a dummy, $\tilde{i}_t$, equal to 1 if there was an increase in fixed assets greater than or equal to 20% of the stock of fixed assets.[37] That is, we consider whether tax induced increases in retained profits make it more

[36] We note that year-on-year changes in fixed assets are not zero, but merely very small relative to the change in current assets.

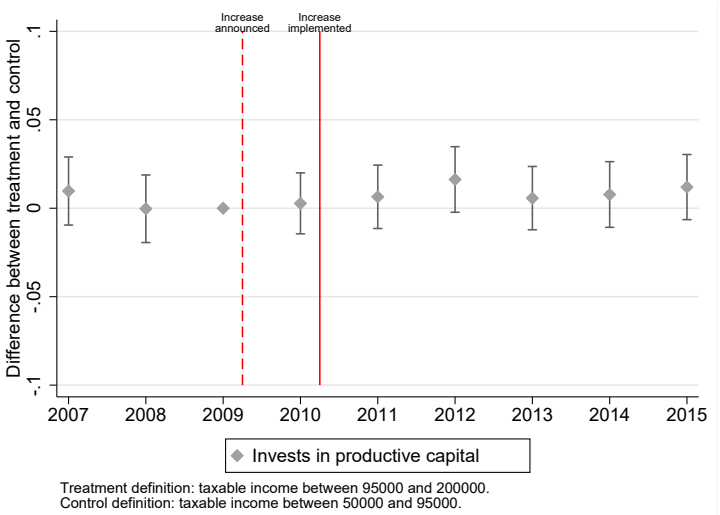
[37] It is well documented that non-convex capital adjustment costs (such as fixed costs) and indivisibility of investment projects lead to firm-level investment profiles characterised by periods of low or zero investment, punctuated by large discrete changes, commonly referred to as "spikes"

likely that a company will subsequently undertake a significant investment. We estimate:

$$\tilde{i}_t = \sum_{s \neq 2009} \beta_s^i D_f \times 1[\text{year}_t = s] + \varphi_t + \alpha_f + \nu_{ft} \tag{5.4}$$

where the sample and variable definitions are the same as those used in Section 5.1. Figure 5.8 shows that there is no difference in the capital investment of the treatment compared with the control group following the reform. The fact that we see no change in investment, alongside an increase in shareholders' equity (Figure 5.5(b)), suggests that the additional retained profits are held as cash rather than invested in productive capital.

Figure 5.8: *Coefficient estimates from differences-in-differences specification, investment*



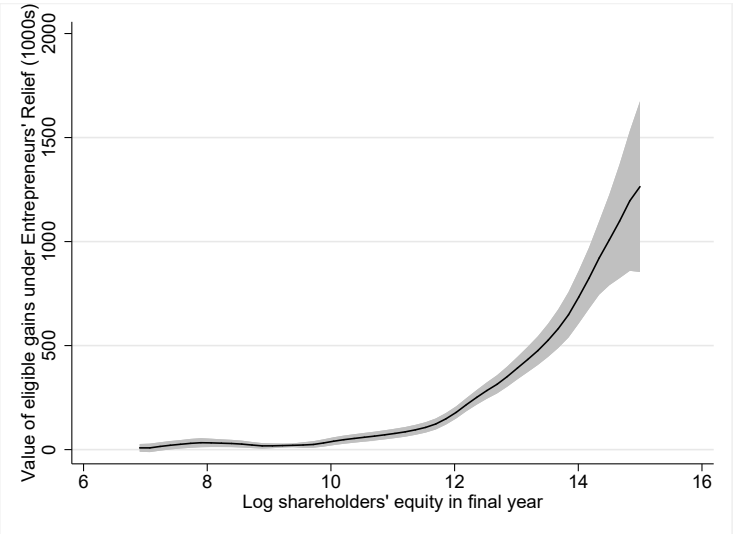
Notes: The markers show the estimated β_s^i coefficients from equation (5.4); the omitted year is 2009. The dependent variable is a dummy equal to 1 if there is an increased in fixed assets greater than 20% of the fixed assets stock. Error bars show 95% confidence intervals. Years on the horizontal axis refer the calendar year in which the tax year ends i.e. 2007 refers to the tax year that runs from April 2006 to April 2007. Tables of coefficients are shown in Appendix D.3.
Source: Calculations based on HMRC administrative datasets.

Finally, there is evidence that owner-managers retain income in their companies in cash or equivalent assets for long periods in order to access lower tax rates (accountants in the UK refer to this practice as "moneyboxing"). Those owner-managers with average total income above the higher rate threshold who wish to

or "lumps" (Doms and Dunne (1998), Cooper and Haltiwanger (1993), Caballero (1999), Cooper et al. (1999), Nilsen and Schiantarelli (2003), Cooper and Haltiwanger (2006)). Disney et al. (2019) use the same UK data, measure an investment "spike" as a change in fixed assets of at least 20% and discuss this choice.

withdraw income from the company without paying the higher rate have two main options: draw dividends out of a company (up to the higher rate threshold) as it is wound down or take capital gains on company liquidation. Most owner-manages will be eligible for "Entrepreneurs' Relief" - a preferential 10% rate of capital gains tax available to business owners. The most tax advantaged option is to bequeath capital gains, since the UK tax system forgives capital gains tax at death.

Figure 5.9: *Use of "Entrepreneurs' Relief" by owner-managers*



Notes: 95% confidence intervals shown.
Source: Calculations based on HMRC administrative datasets.

In 2014 and 2015, there were 7,707 owner-managers of closely held companies (both one and two director) who ceased being a director (we cannot observe those who ceased being a director in earlier years in available tax records). Of these directors, 20% claimed Entrepreneurs' Relief in 2016.[38] This rises to almost half for those with shareholders' equity that exceeds £100,000 during our sample period. Figure 5.9 shows the mean level of eligible capital gains on which relief was claimed, conditional on the value of log shareholders' equity in the preceding year. There is a strong positive relationship, which is close to one-for-one. That is, on average, owner-managers claim relief equal to the total value of shareholders' equity in the year before they cease being a director; all of their accumulated retained earnings are being subjected to the lower rate. The amounts of income taxed under Entrepreneurs' Relief are large: the average eligible capital gains, conditional on claiming the relief, is around £500,000 *per owner-manager*. This can produce substantial tax savings. For example, total tax due is £75,000 lower if £500,000 is

[38]Those not observed claiming Entrepreneurs' Relief in 2016 may do so in later years, outside of the scope of currently available data.

subject to a 10% rate of Entrepreneurs' Relief than if the same amount had been taxed at 25% (the higher rate of dividend tax).

6 Policy implications and discussion

We find that intertemporal income shifting is the key mechanism that owner-managers use to respond to changes in the marginal tax rates that they face (given the institutional features of the UK tax system). In this section we discuss the implications of our results for policy and tax design.

6.1 Tax progressivity and smoothing volatile incomes

Around half of the observed responsiveness of owner-managers' taxable income to the kink at the higher rate threshold can be attributed to intertemporal shifting that allows volatility in total income to be smoothed. The benefits of "tax smoothing" have been widely discussed, particularly in the context of savings taxation (Mirrlees et al. (2011)), and date back to Meade (1978) and Bradford (1982). Although large avoidance elasticities often reflect poorly designed tax systems (Piketty et al. (2014)), in this case allowing individuals with volatile incomes to smooth out fluctuations means that they are not penalized by the progressivity of the tax system relative to someone with the same average, but stable income. Effectively, smoothing allows the tax system to better approximate the taxation of lifetime incomes.

The total incomes of closely held company owner-managers are particularly volatile (see Appendix A.6), making the option to smooth taxable income particularly valuable. The benefit that an owner-manager derives from shifting to smooth out volatility depends on his/her average total income and the magnitude and frequency of fluctuations around this average. For example, among owner-managers that have average total income within £1000 of the higher rate threshold and that are not systematically retaining income, the median tax saving is 5% of tax paid each year; this rises to over 10% at the 75th percentile (i.e. for those with more volatile incomes).[39]

As well as (implicitly) allowing smoothing through the use of company structures, the UK operates explicit regimes that allow farmers and some artists and authors (groups which are known to have particularly volatile incomes) to smooth their tax liabilities over tax years. The option to smooth taxable income is not

[39]The tax saving is calculated as the difference between the tax that would be due if their total income were taxed annually and how much is actually paid on annual taxable income. Further details of the calculations and additional results shown in Appendix D.4.

available to the UK self-employed (those running unincorporated businesses) or to owner-managers operating in tax systems that treat company income on a pass through basis (such as S-corporations in the US). Income volatility is as high for these groups, such that there is a case for extending the ability to smooth taxable income.[40] Allowing smoothing for all business owners would remove one form of distortion to the choice of legal form within the UK (i.e. those with more volatile incomes have an incentive to incorporate), although it would also be costly in terms of reduced government revenue and potentially add additional complexity.

6.2 Efficiency cost of taxation

Our theoretical analysis suggests that shifting to smooth income volatility around tax kinks does not lead to distortions but that the systematic retention of profits within the company may do. Retention brings benefits (including the ability to smooth income over longer time periods and thereby reduce lifetime taxes) but is also costly to the owner-manager. As discussed above, the latter is supported by the fact that owner-managers do not fully retain all income earned above the higher rate threshold, which would be optimal if there was zero cost to doing so. Under these assumptions – and as shown in Appendix C – the statistics that are sufficient for evaluating the deadweight loss of a marginal increase in τ_1 are the elasticities of total and taxable income, where the latter excludes responsiveness that is attributable to shifting to smooth volatility. This is because shifting to smooth volatility does not create any efficiency loss, and therefore no impact on the fiscal externality (the impact of owner-managers' behaviour on the government's budget constraint).

We use estimates of the elasticities of total and taxable income derived from bunching around the higher rate threshold (i.e. corresponding to Figures 5.2 and 5.4).[41] We find no evidence that total income responds to changes in the marginal rate such that $\epsilon_z = 0$. The unadjusted (for shifting to smooth volatility) elasticity of annual taxable income is 0.199 (95% CI: $[0.178, 0.221]$). After excluding shifting to smooth volatility in total income (by removing "sometimes bunchers" as shown graphically in Figure 5.4), the adjusted elasticity of taxable income is 0.094 (95% CI: $[0.082, 0.106]$).

The welfare costs of a marginal increase in τ_1 are proportional to a weighted average of the elasticities of taxable income (adjusted to exclude the shifting to

[40] Denmark provides one example of how this can be done. There is an explicit savings vehicle to allow the self-employed to smooth total income across tax years (le Maire and Schjerning (2013)).

[41] Specifically, the elasticity of income measure x is given by $\epsilon_x \approx \frac{\hat{b}_x}{x^* \log\left[\frac{1-\tau_0}{1-\tau_1}\right]}$, where $\hat{b}_x$ denotes the excess mass at the kink and x^* is the kink point.

smooth volatility) and total income – see equation (4.10), which is a variant of the formula derived by Chetty (2009a). It also depends on the tax rate paid by the owner-manager in the future, τ_k. If the income is withdrawn as capital gains (and subject to the UK's preferential "Entrepreneurs' relief" rate"), then $\tau_k = 0.28$, but if the stock of retained profits is drawn down over several years as dividend income below the higher rate threshold, then it would be 0.2.

Table 6.1: *Sufficient statistics analysis*

(1)	(2)	(3)	(4)
	Future tax rate, τ_k		
Annualised welfare change, $\frac{\partial W}{\partial \tau_1} \frac{1-\beta}{\mathbb{E}[\mu_t]}$ when:	0	0.2	0.28
Include shifting to smooth volatility: $\epsilon_y = 0.20$	-0.133	-0.067	-0.040
Exclude shifting to smooth volatility: $\epsilon_y = 0.09$	-0.060	-0.030	-0.018

Notes: Each cell evaluates equation (4.10) under different conditions; in all cases we set the expected value of taxable income $\mathbb{E}_t[y_t]$, to 1. The first (second) row uses the estimated elasticity of taxable income that includes (excludes) shifting to smooth volatility; i.e. assumes $\epsilon_y = 0.2$ ($\epsilon_y = 0.09$). Columns (2)–(4) show the welfare change under different assumptions about what tax rate is eventually paid on the shifted income. Tax rates include the combined effect of corporate and personal taxes.

Table 6.1 shows the marginal welfare change (annualised and in money metric terms) per owner-manager under different values of τ_k, and depending on whether we account for the presence of shifting to smooth volatility in total income. We set the average taxable income, $\mathbb{E}_t[y_t]$, in equation (4.10) to 1, so the welfare changes can be interpreted as the change in welfare as a fraction of average income earned in a year. The "naive" estimate is shown in the top left cell: if all intertemporal shifting were costly and no tax was paid on the shifted income, the marginal welfare change is -0.133. After accounting for the fact that some shifting acts to smooth volatility in total income and likely incurs little or no utility costs, the deadweight loss falls to -0.060. The welfare loss falls further – to -0.030 if $\tau_k = 0.2$ and -0.018 if $\tau_k = 0.3$ – once we account for the fact that tax that is eventually paid on the retained income. Thus, accounting for the presence of shifting to smooth volatility, and the fact that there are spillovers to the future tax base, means that the estimated deadweight loss is between 78% and 86% (depending on τ_k) lower than in the "naive" case.

These results demonstrate that ignoring either the presence or nature of intertemporal income shifting leads to considerable misestimation of the efficiency costs of taxing company owner-managers. It should be noted that these numbers relate to marginal changes in τ_1, and that they are crucially dependent on the insti-

tutional context. In the this setting, the efficiency cost arises not from the reduction in labour supply (or real economic activity), but rather from the distortion to the intertemporal allocation of resources that creates incentives to shift consumption to the future.

6.3 Preferential capital taxes and capital allocation

Policy makers often perceive a trade-off between, on the one hand, using lower taxes on capital income, particularly capital gains, as a way to boost investment incentives and, on the other hand, raising capital tax rates towards personal income tax rates so as to minimise tax avoidance, avoid distorting choices and limit (post-tax) inequality.

Using taxes to encourage investment (as opposed to having a tax system that is neutral with regard investment decisions[42]) is only desirable to the extent that the market produces suboptimal levels of investment. It is likely that there are externalities related to some closely-held businesses (for example, related to trials of innovative new ideas), such that the market produces too few start-ups and too little subsequent investment. However, lower rates of tax on capital incomes are poorly targeted at addressing market failures associated with entrepreneurship (Gordon and Sarada (2018)). On some margins, the lower rates do not change investment incentives at all. For example, lower rates of capital gains tax increase the incentive to retain earnings in a company but do not change the incentive to invest in the company's capital stock (see Section 3 for a discussion of this). In other cases, policies change incentives so widely that they can lead to additional start-ups or investment in cases where there are no market failures and thereby lead to a misallocation of resources. The UK's preferential rate of capital gains tax ("Entrepreneurs' Relief") is available to all owners of closely-held businesses and is of greatest benefit to those able to save in a company (i.e. those with fewer constraints) and those who create the largest profits, rather than those (including those who fail) who create the largest externalities.

We find no evidence that the preferential rate of capital gains tax distorts investment decisions of company owner-managers. As such, at the intensive margin (i.e. conditional on company formation), the policy is not correcting any market failures that may exist, but nor it is leading investment capital to be sub-optimally allocated towards investment in the capital stocks of closely held companies. However, the

[42]Ensuring that taxes do not deter marginal investments is best achieved though careful design of the tax base, rather than through lower rates; Mirrlees et al. (2011) sets out how this can be achieved.

policy does lead to distortions (via the intertemporal allocation of consumption). It also raises equity considerations to the extent that lower rates of tax allow some individuals to effectively access a less progressive tax system than similar individuals who are not able to save within a company. Business owners are over represented at the top of the income distribution in many countries, including the UK and US. Smith et al. (2019) find that private business owners who actively manage their businesses are key for top income inequality in the US.

7 Conclusion

We use a new link between personal and corporate UK administrative tax returns to investigate how personal taxes affect the behaviour of company owner-managers. Previous work has shown that owner-managers are very responsive to taxes. By exploiting data that allows us to accurately and separately measure both the total amount of economic activity produced by a business owner and the amount of personal income withdrawn from a company each year, we are able to show that the entire response of owner-managers' taxable income to higher rates of personal tax is driven by intertemporal income shifting.

Accounting for both the presence and nature of intertemporal income shifting is important for calculating the efficiency costs of taxing company owner-managers; the estimated deadweight loss associated with a marginal increase in personal taxes decreases by around 80% once we account for income shifting. We argue that the shifting that business owners do in order to smooth income that fluctuates around a tax kink is costless (or close to it) and therefore unlikely to create large efficiency losses. There is a case for governments extending the ability to smooth taxable income to more individuals so that a progressive income tax system does not weigh more heavily on those with volatile incomes. In contrast, we argue that the systematic retention of income within closely held companies in order to access a lower tax rates in future does create efficiency losses, through inducing business owners to delay their consumption. However, we find no evidence that tax incentives distort the allocation of capital.

The tax features that create the incentive to systematically retain income – notably the preferential rate of capital gains tax – are not equally accessible to all, raising questions over horizontal equity. Company owner-managers are over-represented at the top of the UK's income distribution and, within the closely-held company population, income retention (and therefore access to lower taxes) is skewed towards those with higher average total incomes. Although governments

with different redistributive preferences will vary in their views on the appropriate progressivity of income taxes, it is harder to justify different rates across individuals with the same income levels. Even among high earners, access to lower tax rates will depend on whether they adopt the corporate legal form (rather than work through an employment contract, for example) and, within owner-managers, on how much they are able to save in a company (which will in turn depend on their borrowing constraints and preferences), both of which are harder to justify as characteristics to be used to differentiate tax rates.

All of the results in this paper are conditional on the institutional setting. We argue that the key institutional features – notably the tax advantage associated with the corporate legal form, the significant freedom to decide when income is taxed at the personal level and the preferential rate of capital gains tax for businesses assets – are common across, and therefore of interest in, many tax systems. However, the results cannot be used to conclude that the real activities of owner-managers (which we find are not responsive to higher tax rates) would remain unaffected by personal taxes if the ability to shift income, or the associated tax advantages, were removed. Similarly, if intertemporal income shifting were removed as an option (by, for example, moving to a "pass through" treatment of income), it is possible that company owner-mangers would adopt other avoidance or evasion strategies (such as adding family members as directors in order to shift income across people, or under-reporting total or taxable income). Those working for their own business usually have significant flexibility over their labour supply, making it highly plausible that, absent the ability to avoid or evade taxes, their underlying labour supply would be more responsive to taxes than that of employees.

Understanding how company owner-managers respond to various features of the tax system has become more important as the number of people working through their own businesses has grown. Equally important, given this labour market trend, is understanding how various features of the tax system – including the interaction between corporate and personal taxes and the treatment of volatile incomes and losses – affect who starts a business and their choice of legal form, which we plan to explore in future work.

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Appendix

For Online Publication

Intertemporal income shifting and the taxation of owner-managed businesses

Helen Miller, Thomas Pope and Kate Smith

A Data

This paper uses administrative data from corporate and personal tax records provided by HMRC (the UK tax authority), supplemented by data from company accounts. This section describes the data, including the construction of samples, and provides additional descriptive results.

A.1 Closely-held companies

Company population

The primary dataset on companies is drawn from the CT600 corporation tax return, which must be submitted by companies at least once every twelve months. The data include all tax accounting periods that finish in the tax years 2000-01 to 2014-15 (i.e. between April 6th 2000 and April 5th 2015).

This data is supplemented with information from company accounts from the Financial Accounting Made Easy (FAME) database provided by Bureau van Dijk, also covering the years 2000-01 to 2014-15.[43] These data are from Companies House, the UK company registrar, to which all companies must submit accounts. The accounts data are in two parts. First, the number of directors and number of shareholders are observed at a single point in time – in the most recent year that the company is in the data. This information is matched to the corporate tax record in 98% of cases. Second, information on the company balance sheet is recorded (mostly annually) in company accounts. In 87% of company-years, the corporate tax record is matched to company accounts for the same company with the same start and end date (i.e. in most cases companies file corporate tax records and company accounts that cover the same time period). Those tax records that do not match to company accounts are disproportionately likely to be in the first or last year a company is trading.

The UK tax year runs from April 6th to April 5th. Companies can choose to submit tax returns that cover any period of up to twelve months. In 10% of cases a tax return covers less than twelve months; in the majority of these cases, this is the first or last year a company is trading. Of the remaining 12 month accounts, around 25% begin in April.

In this paper, we take all companies that file at least one corporate tax return ending between April 6th 2012 and April 5th 2015 (i.e. the tax years 2012-13, 2013-14 and 2014-15). There are 2.2 million such companies. We are interested in

[43] The match between CT600 tax records and FAME is based on Company Reference Number (CRN).

annual flows, and so for comparability we drop tax records covering less than 12 months, which leaves 2.0 million companies.

Table A.1 sets out the information provided on the number of directors and number of shareholders that these companies have. In 2% of cases information on the number of directors is missing and in 23% of cases the number of shareholders is missing. This is not random: Table A.2 shows that these companies are disproportionately younger, lower profit and have lower asset values than those with non-missing information. The definition of our company population of interest is based on the number of directors and shareholders. We therefore drop from our analysis companies with missing information on the number of directors or shareholders, leaving us with the 1.6 million companies described as 'All companies' in Table 2.2.

Table A.1: *Distribution of number of directors and shareholders for UK companies*

	Number of shareholders				
Number of directors	1	2	3+	No info.	Total
1	339,504	83,937	18,216	157,625	599,282
2	282,258	387,641	85348	184,596	939,843
3+	125,159	106,128	146,057	94,922	472,266
No info.	2,653	1,426	379	24,397	28,855
Total	749,574	579,132	250,000	461,540	2,040,246

Notes: Includes all companies filing a CT600 tax return covering 12 months in the tax years 2012/13 to 2014/15.
Source: Authors' calculations using HMRC administrative datasets.

Definition of closely held companies

We define our population of interest as companies with (strictly) fewer than 3 directors and (strictly) fewer than 3 shareholders, which is 69% of all companies with non-missing information on the number of directors and shareholders. The purpose of this definition is to capture companies for whom the owners and the managers are the same people. In the FAME database, we do not have information on whether the director and the shareholder are the same person. We therefore use a different dataset (Amadeus), derived from the same underlying accounts data submitted to Companies House, and also provided by Bureau van Dijk, which provides information whether the director is also a shareholder. We find that, among UK companies filing accounts, in over 90% of cases: (i) the director and shareholder of a 1 director 1 shareholder company are the same person; (ii) the directors of 2 director, 2 share-

Table A.2: *Comparison of companies with and without information on number of shareholders*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		No shareholder information				Shareholder information			
Source	Variable	Mean	Median	P10	P90	Mean	Median	P10	P90
FAME	Number of directors	2.3	2.0	1.0	4.0	2.2	2.0	1.0	4.0
FAME	Number of shareholders					2.1	2.0	1.0	3.0
FAME	Firm Age (years)	7.2	4.0	1.0	15.0	9.9	6.0	1.0	22.0
CT600	Turnover (£th)	131.1	47.5	4.0	322.5	576.3	106.2	15.5	1,398.4
CT600	Profit (£th)	12.3	1.6	-6.9	53.0	38.5	16.5	-5.0	115.7
CT600	Profit/Turnover (%)	32.3	23.9	2.1	77.1	30.9	22.4	3.6	73.5
CT600	Ever use capital allowances (%)	48.6				69.9			
CT600	Capital allowances (£th)	4.2	1.1	0.1	13.1	14.0	2.5	0.2	38.6
CT600	Capital allowances/Profit (%)	8.0	0.0	-4.2	43.6	12.6	2.4	-0.9	52.3
FAME	Total assets (£th)	172,200.3	26.3	3.0	545.0	624,561.0	70.1	7.0	1,669.4
FAME	Fixed assets (£th)	64,905.1	5.4	0.6	300.3	225,616.8	14.1	1.0	1,041.5
FAME	Current assets (£th)	58,197.2	19.9	2.0	341.3	280,268.3	45.0	4.5	912.1
FAME	Current/Total assets (%)	78.0	93.8	25.2	100.0	72.9	86.5	18.9	100.0
FAME	Shareholder equity (£th)	32,474.9	1.6	-17.1	118.9	135,420.0	10.2	-11.0	514.6
CT600/FAME	Profit/Total assets (%)	98.3	54.4	3.5	278.8	75.3	40.5	3.1	217.1
	Number of companies	461,540				1,578,706			

Note: Table shows descriptives for two samples. The first sample (columns (3)-(6)) contain all companies that operate at some point between 2013 and 2015, have missing information on the number of shareholders and directors, and file 12 month accounts. The second sample (columns (7)-(10)) contains all companies with non-missing information on the number of shareholders and directors. For each company, we observe the variables (listed in column (2)) annually in the data source listed in column (1). For each company we take the mean of each variable across the period of time they are in the data. The statistics shown in the table are mean, median, 10th and 90th percentiles across companies. Mean calculations (across companies, not when constructing company means) are winsorised at the 1st and 99th percentiles.
Source: Authors' calculations using HMRC administrative datasets.

holder companies are also shareholders; (iii) one of the directors of a 2 director, 1 shareholder company is also the shareholder.

A.2 Variables

Here we provide definitions of the variables used from corporate tax records and company accounts:

Number of shareholders The number of people that own shares in the company. Dividends are paid out to shareholders.

Number of directors The number of people who are appointed or elected members of the board of the company.

Turnover The total trading turnover (or sales) from any source for the company during the period covered by the tax return.

Profit Turnover net of allowable (for tax purposes) costs including material and salary costs and allowable deductions for plant and machinery investment (capital allowances – see next).

Capital allowance Allowable deductions for plant and machinery investment. See Appendix B for details.

Total assets The total cash value of assets recorded on the company's balance sheet at the end of the accounting period. Includes fixed and current assets.

Fixed assets A fixed asset is defined as a long-term piece of property that a company owns and uses in its operation to generate income, and that is not expected to be consumed or converted into cash in the next year. This includes tangible (e.g. buildings or machinery such as laptops) and intangible assets (e.g. patents). Fixed assets are measured at historic book value (i.e. the price at acquisition net of ongoing accounting depreciation).

Current assets Current assets represent all the assets of a company that are expected to be sold, consumed, utilized or exhausted through the standard business operations, which can lead to their conversion to a cash value over the next one year period. It includes, among other categories, unsold stock, cash on hand and money owed to the company. In principle, these different components could be observed separately, but in practice they are mostly missing for closely held companies as they are not a mandatory reporting requirement.

Shareholder equity Also known as shareholders' funds. This measures total assets net of liabilities, which include outstanding debt and other money owed to third parties or employees.

A.3 Industries

Table 2.3 in the main paper shows statistics for the top 15 industries in which closely held companies are based.

Table A.3 shows the number of closely held companies (including the subset with one director and one shareholder) in each industry, as well as the share of companies in that industry that are closely held. This shows that one director, one shareholder companies are disproportionately based in the same industries as the wider set of all closely held companies.

Table A.4 provides further statistics on the closely held companies in the top 15 industries, while Table A.5 does the same for the subset of closely held companies with one director and one shareholder.

Table A.3: *Number and share of closely held companies in different industries*

(1)	(2)	(3)	(4)	(5)	(6)
	All companies	$\leq$ 2 directors, $\leq$ 2 shareholders		1 director, 1 shareholder	
Industry (SIC code)	Number	Number	Share of industry	Number	Share of industry
Other business activities (74)	329,736	245,592	74.5	81,044	24.6
Construction (45)	145,103	109,556	75.5	29,814	20.5
Computer & related (72)	96,844	79,544	82.1	25,987	26.8
Retail trade (52)	82,992	59,320	71.5	17,649	21.3
Real estate (70)	103,195	55,165	53.5	11,407	11.1
Other service activities (93)	61,081	48,110	78.8	18,254	29.9
Health & social work (85)	47,015	36,413	77.4	13,943	29.7
Hotels & Restaurants (55)	49,447	34,498	69.8	11,728	23.7
Wholesale trade (51)	56,080	32,658	58.2	8,209	14.6
Rec., culture & sport (92)	37,506	26,502	70.7	8,396	22.4
Vehicle sale & repair (50)	29,648	20,831	70.3	5,529	18.6
Land transport (60)	23,650	17,910	75.7	7,582	32.1
Publishing & printing (22)	20,740	13,429	64.7	3,742	18.0
Financial intermediation (65)	19,309	10,509	54.4	3,234	16.7
Manufacture NEC (36)	17,643	10,240	58.0	2,276	12.9
Agriculture & Hunting (01)	17,092	10,200	59.7	2,188	12.8
Education (80)	12,576	9,204	73.2	3,030	24.1
Travel support (63)	12,349	7,738	62.7	2,435	19.7
Metal manufacture (28)	14,075	7,566	53.8	1,392	9.9
Post & telecoms (64)	8,628	6,122	71.0	2,162	25.1
Machinery rental (71)	8,191	5,104	62.3	1,317	16.1
Auxiliary finance (67)	6,924	4,408	63.7	1,591	23.0
Sewage & waste (90)	4,365	3,248	74.4	1,034	23.7
Food & drink manufacture (15)	6,844	3,231	47.2	828	12.1
Equipment manufacture (29)	6,438	2,953	45.9	495	7.7
Electric, gas, steam (40)	4,870	2,136	43.9	585	12.0
Oil & Gas (11)	3,423	2,099	61.3	449	13.1
Wood manufacture (20)	3,095	1,912	61.8	387	12.5
Insurance & pensions (66)	5,152	1,863	36.2	348	6.8
Rubber + plastic manufacture (25)	3,967	1,789	45.1	327	8.2
Research & development (73)	3,271	1,716	52.5	451	13.8
Clothes manufacture (18)	2,476	1,705	68.9	526	21.2
Textile manufacture (17)	2,683	1,671	62.3	421	15.7
Electrical manufacture (31)	3,168	1,516	47.9	282	8.9
Forestry & logging (02)	1,898	1,390	73.2	367	19.3
Chemical manufacture (24)	3,108	1,141	36.7	216	6.9
Other transport manufacture (35)	1,819	1,114	61.2	329	18.1
Fishing (05)	1,723	1,112	64.5	181	10.5
Air transport (62)	1,713	1,101	64.3	297	17.3
Public administration (75)	1,500	1,090	72.7	352	23.5
Precision manufacture (33)	2,532	1,047	41.4	186	7.3
Mineral manufacture (26)	1,972	1,035	52.5	225	11.4
Motor vehicle manufacture (34)	1,487	828	55.7	212	14.3
Membership activity NEC (91)	1,751	794	45.3	230	13.1
Recycling (37)	1,298	775	59.7	218	16.8
Communication manufacture (32)	1,635	766	46.9	151	9.2
Paper manufacture (21)	1,561	727	46.6	134	8.6
Water transport (61)	1,442	623	43.2	118	8.2
Basic metal manufacture (27)	1,298	584	45.0		
Water (41)	704	382	54.3	88	12.5
Leather manufacture (19)	542	324	59.8	89	16.4
Computer manufacture (30)	584	303	51.9	54	9.2
Household as employer (95)	345	276	80.0	111	32.2
Services for household use (98)	387	243	62.8	74	19.1
Other mining (14)	515	186	36.1	35	6.8
Extra-territorial (99)	272	171	62.9	43	15.8
Missing	298,595	200,710	67.2	66,602	22.3

Notes: Firms classified based on 2-digit SIC code (2003-based). Table includes all companies that operate at some point between 2013 and 2015 and have non-missing director and shareholder information. Share of industry (columns (4) and (6)) is the share of all companies in that industry that fit the relevant criteria for the number of directors and shareholders. For basic metal manufacture (27), 1 director 1 shareholder information is blank for reasons of disclosivity.
Source: Authors' calculations using HMRC administrative datasets.

Table A.4: *Closely held companies in different industries*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Industry	Company distribution		Profit (£th)		Turnover (£th)		Total assets (£th)		Current/total assets	Use capital allowances
	Number	Share	Mean	Med.	Mean	Med.	Mean	Med.	(%)	(%)
Other business activities (74)	245,592	22.5	36.7	21.7	149.7	68.0	132.4	33.5	83.9	68.1
Construction (45)	109,556	10.0	27.9	15.8	265.5	108.9	153.1	37.5	76.8	83.2
Computer & related (72)	79,544	7.3	42.7	35.1	115.3	77.2	79.3	32.5	89.4	72.7
Retail trade (52)	59,320	5.4	20.0	5.9	342.6	173.8	174.2	56.8	76.7	77.0
Real estate (70)	55,165	5.0	21.5	4.9	132.8	45.0	566.8	239.4	45.8	48.8
Other service activities (93)	48,110	4.4	21.8	8.1	152.2	64.4	110.7	23.3	71.2	70.7
Health & social work (85)	36,413	3.3	43.0	24.4	198.3	64.6	168.0	25.4	75.1	68.6
Hotels & Restaurants (55)	34,498	3.2	14.4	3.4	303.7	157.3	201.9	45.7	52.8	78.0
Wholesale trade (51)	32,658	3.0	31.7	8.9	536.8	232.6	353.2	104.5	85.4	75.1
Rec., culture & sport (92)	26,502	2.4	24.3	9.3	159.0	61.3	138.7	27.4	73.8	74.4
Vehicle sale & repair (50)	20,831	1.9	26.1	12.3	448.7	204.9	212.9	70.0	70.7	85.2
Land transport (60)	17,910	1.6	17.0	7.4	266.2	60.1	193.7	28.4	66.3	69.7
Publishing & printing (22)	13,429	1.2	21.5	4.9	197.5	66.8	144.8	31.4	77.2	72.4
Financial intermediation (65)	10,509	1.0	36.4	17.3	172.2	73.6	210.5	39.6	83.0	60.9
Manufacture NEC (36)	10,240	0.9	26.0	8.6	389.8	165.0	274.5	75.1	75.0	82.8
Total (top 15 industries)	800,277	73.2								

Notes: Firms classified based on 2-digit SIC code (2003-based). For around 20% of closely held companies, industry is missing. Of the remainder, 90% are based in the industries shown in the table. Moments are calculated based on one observation per company (with the value for each company calculated as the mean across all 12-month accounts filed by that company between 2005-06 and 2014-15). All monetary values are in 2014-15 prices. Mean calculations are winsorised at the 1st and 99th percentiles.
Source: Authors' calculations using HMRC administrative datasets.

Table A.5: *One director one shareholder companies in different industries*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Industry	Company distribution		Profit (£th)		Turnover (£th)		Total assets (£th)		Current/total assets	Use capital allowances
	Number	Share	Mean	Med.	Mean	Med.	Mean	Med.	(%)	(%)
Other business activities (74)	81,044	23.9	28.9	18.4	92.7	53.0	67.2	22.0	86.0	56.6
Construction (45)	29,814	8.8	18.2	11.5	148.8	70.5	69.2	21.3	76.4	72.0
Computer & related (72)	25,987	7.7	37.9	30.1	81.0	64.4	52.2	26.0	89.8	60.4
Other service activities (93)	18,254	5.4	14.5	5.3	91.0	51.8	51.7	14.2	72.1	59.5
Retail trade (52)	17,649	5.2	9.7	2.5	207.6	110.4	86.1	32.5	79.4	64.1
Health & social work (85)	13,943	4.1	25.9	17.1	96.7	44.8	63.2	12.0	80.8	54.7
Hotels & Restaurants (55)	11,728	3.5	6.3	1.6	191.3	103.7	78.5	22.3	58.6	65.9
Real estate (70)	11,407	3.4	13.7	2.4	103.7	41.3	283.2	106.5	54.0	42.5
Rec., culture & sport (92)	8,396	2.5	19.8	10.8	94.9	50.6	63.5	19.3	76.2	67.0
Wholesale trade (51)	8,209	2.4	14.6	2.6	281.6	117.6	159.5	46.7	86.1	60.8
Land transport (60)	7,582	2.2	9.4	5.8	104.2	32.4	60.8	7.1	74.3	48.2
Vehicle sale & repair (50)	5,529	1.6	13.2	5.4	248.7	121.5	102.6	38.6	71.0	72.9
Publishing & printing (22)	3,742	1.1	13.0	2.8	107.3	44.7	64.2	17.2	77.4	59.6
Financial intermediation (65)	3,234	1.0	27.6	16.7	108.0	55.0	102.7	23.2	86.4	47.6
Education (80)	3,030	0.9	15.3	5.0	88.4	37.3	52.3	13.2	78.1	63.7
Total (top 15 industries)	249,548	73.6								

Notes: Firms classified based on 2-digit SIC code (2003-based). For around 20% of one director, one shareholder , industry is missing. Of the remainder, 90% are based in the industries shown in the table. Moments are calculated based on one observation per company (with the value for each company calculated as the mean across all 12-month accounts filed by that company between 2005-06 and 2014-15). All monetary values are in 2014-15 prices. Mean calculations are winsorised at the 1st and 99th percentiles.
Source: Authors' calculations using HMRC administrative datasets.

A.4 Personal income tax data

Information on the owner-managers of closely held companies is taken from the universe of self–assessment income tax records, available from 1997-98 to 2015-16. Most UK adults are not required to complete a self–assessment tax return (between 9 and 10 million did so each year, out of an adult population of more than 40 million). All company directors are required to submit a self–assessment tax return.[44]

This data includes information on the taxable incomes of the individuals, the source of that income (e.g. whether it is from employment, dividends or capital gains) and some basic demographic characteristics (age and gender).

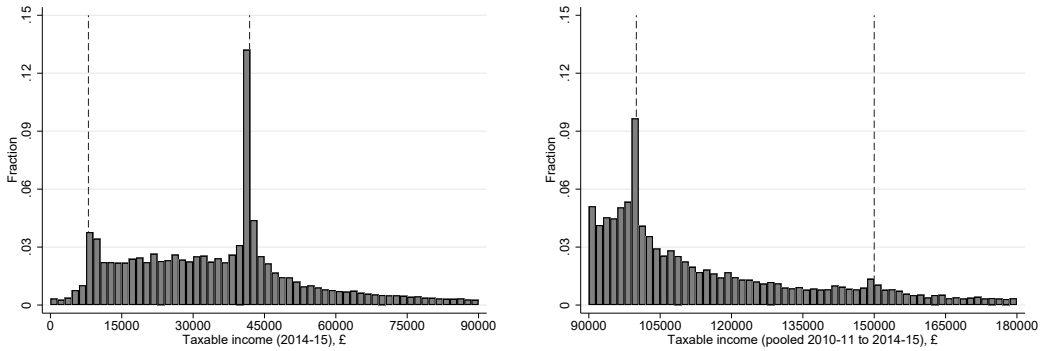
Taxable income distribution in different samples and years

Figure 3.2 in the main paper presents the taxable income distribution for matched directors of all closely held companies in 2014-15 up to £90,000, and pooled between 2010-11 and 2014-15 above £90,000. Figure A.1 shows the distributions for matched directors of the subset of closely held companies that have only one director and one shareholder. A.2 presents the distributions of taxable income (up to £90,000) in each tax year for directors of all closely held companies from 2008-09 (due to data disclosure requirements, we cannot draw these distributions with the same fine bin width for the years before 2008-9). In both samples, and over time, there is evidence of pronounced bunching at kinks in the tax schedule.

[44]Other groups required to submit tax returns include those with income from an unincorporated business, those with substantial dividend, property or foreign income and those with incomes above £100,000.

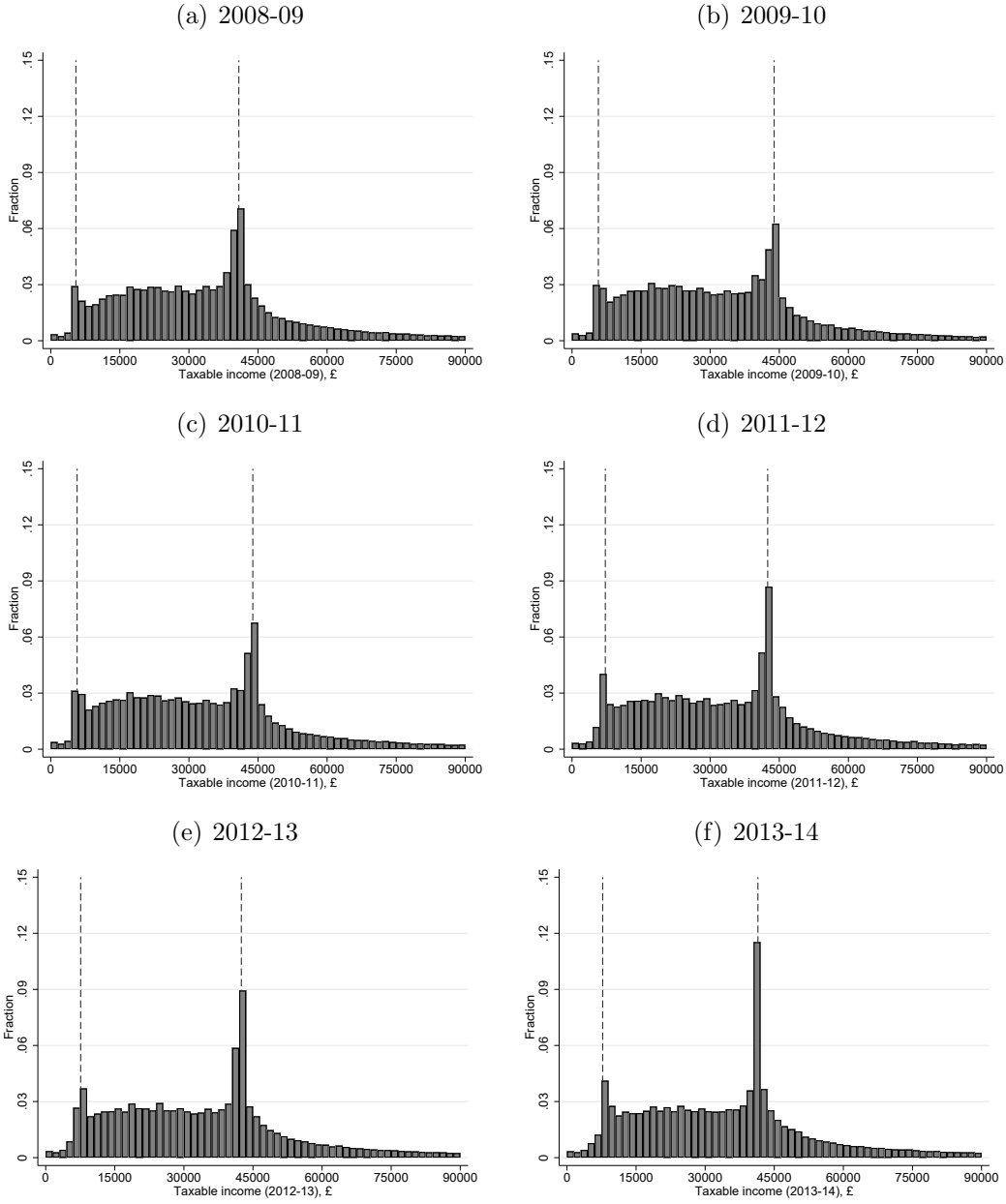
Figure A.1: *Distribution of taxable income for company owner-managers of 1 director, 1 shareholder companies*

(a) Income $\leq$ £90,000 (2014-15) (b) Income $>$ £90,000 (2010-11–2014-15)



Notes: Black dotted lines indicate increases in marginal rates at the primary threshold and the higher-rate threshold. More details on the tax system are provided in Appendix B. Due to disclosure requirements, we truncate the annual distributions at £90,000, and panel (b) pools observations above £90,000 over the tax years 2010-11 to 2014-15. Bin width is £1500.
Source: Authors' calculations based on HMRC administrative datasets.

Figure A.2: *Distribution of taxable income for closely held company owner-managers (2008-09 to 2013-14)*



Notes: Black dotted lines indicate increases in marginal rates at the primary threshold and the higher-rate threshold. More details on the tax system are provided in Appendix B. Due to disclosure requirements, we truncate the distributions at £90,000. Bin width is £1500.
Source: Authors' calculations based on HMRC administrative datasets.

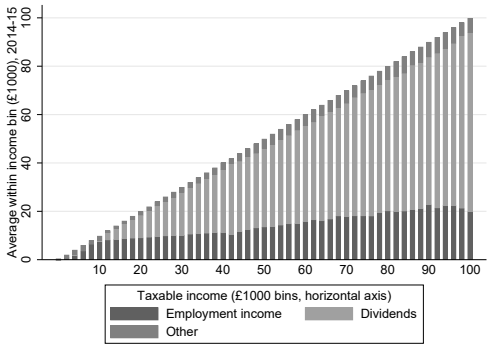
Composition of owner-manager taxable income

Figure A.3 shows the composition of taxable income at different income levels for closely held company owner-managers in 2014-15. The increase in taxable income across the distribution is almost entirely driven by increases in income from div-

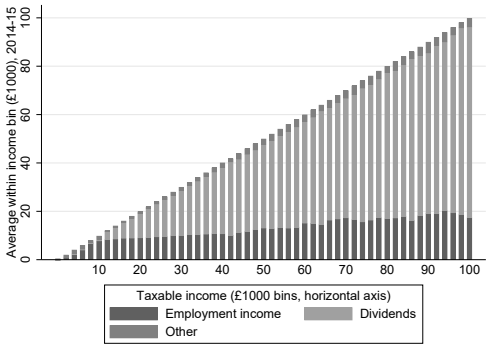
idends, which is consistent with the within-year tax minimizing way to withdraw income from the company described in Section 3.

Figure A.3: *Composition of owner-manager taxable income at different income levels, 2014-15*

(a) ≤2 directors, ≤2 shareholders



(b) 1 director, 1 shareholder



Notes: Owner-managers are split into £1,000 bins of taxable income in 2014–15. Figure shows the average of wages, dividends and other income within each bin. Figure (a) does this for all company owner-managers, while (b) does this for the subset whose company has 1 director and 1 shareholder.
Source: Authors' calculations based on HMRC administrative datasets.

A.5 Matching personal and company information

This paper relies on a match between the personal income tax records of company directors and the company's corporate tax returns and accounts.

Details of the match

The match was undertaken by HMRC, the tax authority. They took all directors listed on company accounts in 2013-14 (4.5 million directors), and attempted to match these directors (based on name, date of birth and address) to self-assessment tax records. All company directors are required to submit a tax return, which means that all directors should be in both datasets.

This match was undertaken for directors active at a particular point in time (2013-14). We are able to link both company and personal tax records over time, and so we have the full histories of these directors and their companies from 2005-06.

Of the 4.5 million directors, 3.3 million had non-missing information on date of birth and address. Of these, 2.2 million were successfully matched to their self-assessment tax record, giving a match rate of 49% of all directors listed, and 67% of those with non-missing date of birth and address.

Matched companies

Table A.6 compares the sample of all closely held companies (which we define as companies that operate at some point between 2013 and 2015, have non-missing information on the number of shareholders and directors, file 12 month accounts and have $\leq$ two directors and $\leq$ two shareholders) with the subset for which at least one director is successfully matched, and that director has only one directorship (of matched closely held company directors, 10% had more than one active directorship in 2013–14). We note that the sample of all closely held companies is not the set of companies that HMRC tried to match (we do not have the list of companies included in that exercise), but the "matched" companies all fall within this full sample. Table A.6 provides the same comparison for the subset of companies with 1 director and 1 shareholder. 49% of closely held companies and 41% of one director, one shareholder companies have at least one director successfully matched.

The matched companies are similar in terms of company age, have lower (at the mean) turnover and assets, but higher profits. Figure A.4 shows that this is because directors of companies with very low or negative profit are less likely to be successfully matched. Above £5,000, the distribution of profit in the full and matched company samples look similar.

Table A.6: *Comparison of matched closely held companies and the full population*

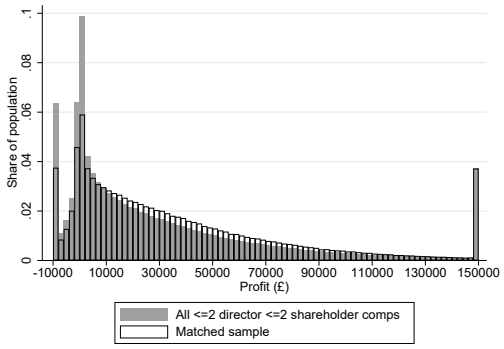
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
		≤ 2 directors, ≤ 2 shareholders								1 director, 1 shareholder							
		Full sample				Matched sample				Full sample				Matched sample			
Source	Variable	Mean	Median	P10	P90	Mean	Median	P10	P90	Mean	Median	P10	P90	Mean	Median	P10	P90
FAME	Number of directors	1.6	2.0	1.0	2.0	1.7	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FAME	Number of shareholders	1.4	1.0	1.0	2.0	1.5	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FAME	Firm Age (years)	7.6	5.0	1.0	16.0	8.0	6.0	1.0	16.0	4.0	3.0	1.0	9.0	4.2	3.0	1.0	9.0
CT600	Turnover (£th)	223.6	82.0	14.4	599.1	196.4	87.2	19.3	515.2	123.4	60.7	11.5	303.8	107.1	63.2	15.9	242.4
CT600	Profit (£th)	30.4	16.8	-2.5	88.8	36.7	25.1	-0.4	94.8	21.7	11.7	-2.8	66.9	27.9	19.5	-0.7	74.6
CT600	Profit/Turnover (%)	33.8	27.3	4.4	74.9	36.2	31.4	5.8	75.6	36.5	32.2	4.2	77.3	40.7	39.9	6.2	78.7
CT600	Ever use capital allowances (%)	70.4				79.3				58.7				66.0			
CT600	Capital allowances (£th)	6.3	1.7	0.2	18.4	5.1	1.5	0.2	14.6	4.3	1.3	0.2	13.2	3.3	1.1	0.2	9.9
CT600	Capital allowances/Profit (%)	11.3	2.0	-0.0	46.7	10.5	2.5	0.0	40.6	10.5	0.9	0.0	45.8	9.1	1.1	0.0	37.0
FAME	Total assets (£th)	190.4	42.8	5.7	495.8	117.8	41.6	7.1	320.6	81.6	23.5	3.5	199.8	56.0	24.1	4.5	142.3
FAME	Fixed assets (£th)	90.9	7.2	0.7	244.0	43.6	6.0	0.6	125.6	33.9	4.0	0.6	84.3	17.4	3.1	0.5	45.9
FAME	Current assets (£th)	110.2	30.0	3.7	272.5	75.7	30.6	4.7	200.6	51.8	17.9	2.5	131.2	40.8	19.0	3.0	106.9
FAME	Current/Total assets (%)	75.3	88.7	24.7	100.0	77.1	88.9	32.5	100.0	78.5	93.2	29.8	100.0	80.7	93.9	37.6	100.0
FAME	Shareholder equity (£th)	55.1	6.0	-8.2	152.8	42.5	8.2	-4.1	128.6	17.6	2.2	-7.1	59.0	18.0	3.9	-4.0	61.2
CT600/FAME	Profit/Total assets (%)	92.3	56.7	7.0	249.1	101.1	67.9	11.9	257.4	117.6	78.9	11.0	300.3	128.4	92.6	17.9	306.0
	Number of companies	1,093,340				532,072				339,504				139,362			

Note: Table shows descriptives for four samples. The first sample (columns (3)-(6)) contain all companies that operate at some point between 2013 and 2015, have non-missing information on the number of shareholders and directors, file 12 month accounts and have ≤ two directors and ≤ two shareholders. The second sample (columns (7)-(10)) is a subset of the first column where at least one of the director's tax records is matched to the company records. The third sample (columns (11)-(14)) is a subset of the first sample that have only one director and one shareholder. The fourth sample (columns (15)-(18)) is the subset of the third sample where the director's tax record is matched to the company. For each company, we observe the variables (listed in column (2)) annually in the data source listed in column (1). For each company we take the mean of each variable across the period of time they are in the data. The statistics shown in the table are mean, median, 10th and 90th percentiles across companies. Mean calculations (across companies, not when constructing company means) are winsorised at the 1st and 99th percentiles.

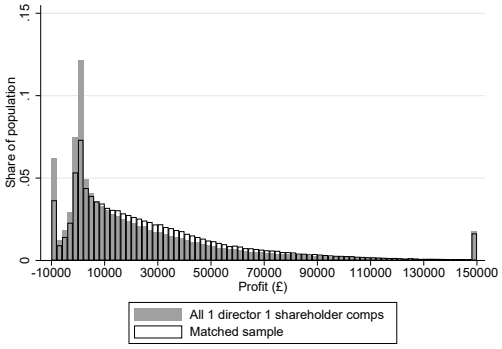
Source: Authors' calculations using HMRC administrative datasets.

Figure A.4: *Distributions of turnover, profits and assets between company populations and matched samples*

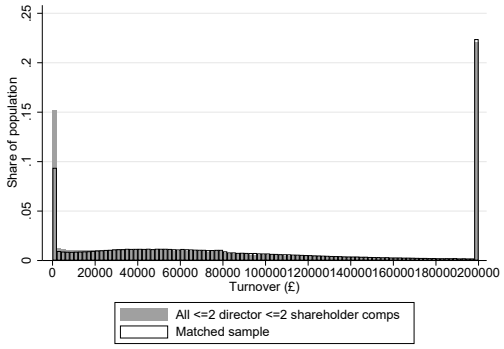
(a) Profit, ≤2 directors, ≤2 shareholders



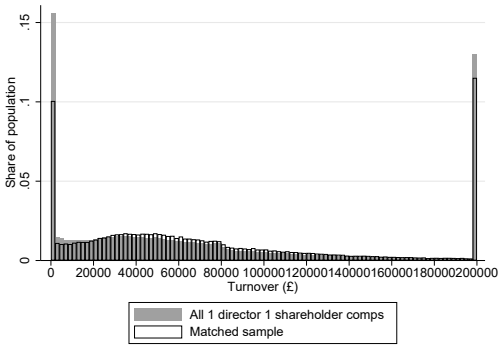
(b) Profit, 1 director, 1 shareholder



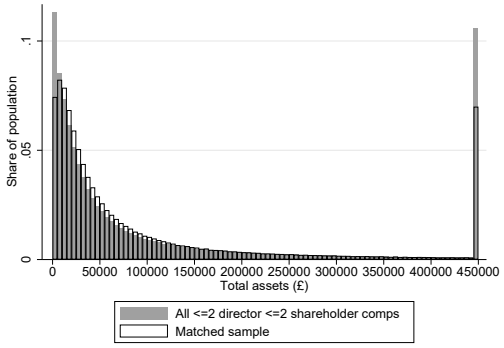
(c) Turnover, ≤2 directors, ≤2 shareholders



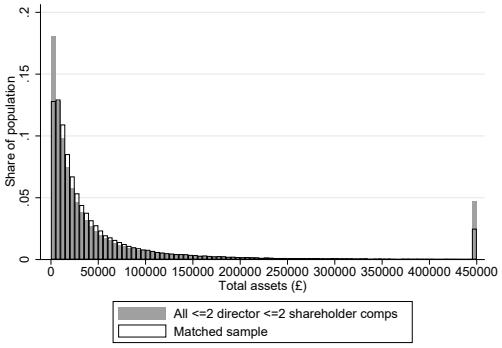
(d) Turnover, 1 director, 1 shareholder



(e) Total assets, ≤2 directors, ≤2 shareholders



(f) Total assets, 1 director, 1 shareholder



Notes: Shows the distributions of mean profit ((a) and (b)), mean turnover ((c) and (d)) and mean total assets ((e) and (f)). Means are calculated at the company level across all years that closely held company is observed. These distributions are based on the subset of companies where at least one director's self-assessment income tax record is matched to the company. Panels (a), (c) and (e) show distributions for all companies with strictly less than 3 directors and strictly less than 3 shareholders, while panels (b), (d) and (f) show the subset with one director and one shareholder. Profit, turnover and assets are truncated at -£10000 and £150,000, £200,000 and £450,000 respectively. Source: Authors' calculations using HMRC administrative datasets.

A.6 Permanent-transitory income decomposition

We study the extent to which income variation of owner-managers is explained by permanent or transitory components using a simple income decomposition. For the matched sample of one director, one shareholder company owner-managers that are present for at least 5 years, we decompose log total income into a permanent (α) and transitory (ε) component as follows:

$$\ln z_{it} = \alpha_i + \varepsilon_{it} \tag{A.1}$$

where i indexes owner-manager, and t year. Table A.7 displays the results. 64% of the variation in log total income is due to the transitory component.

Table A.7: *Income decomposition*

$var(\ln z_{it})$	1.481
$var(\alpha_i)$	0.847
$var(\varepsilon_{it})$	0.637
$\frac{var(\varepsilon_{it})}{var(\ln z_{it})}$	64%

Notes: The table shows the variance of the permanent and transitory components of income estimated using the matched sample of one director, one shareholder company owner-managers (present for at least 5 years) and following equation (A.1).

We get a similar result if we follow the approach in Kopczuk et al. (2010), who calculate the average variance of log earnings, the variance of five-year average log earnings, and the variance of log earnings deviations (in our case replacing earnings with total income). In comparison, they find that the transitory component explains a much smaller fraction (10%) of overall log earnings variation for all workers in the US.

B Tax system

Rates and thresholds

Tables B.1, B.2 and B.3 set out, for each year that our analysis covers, the relevant thresholds and statutory tax rates for the corporate, personal income and capital gains tax systems respectively. Table B.4 sets out computed marginal (combined) corporate and personal tax rates for different forms of income.

The marginal (combined) effective tax rates calculate the amount of tax paid if the owner-manager earns an extra £(at the company level) and pays it out either as salary, dividends, or capital gains. In all years, the marginal effective tax rate on capital gains income is above (below) that on dividend income if taxable income is below (above) the higher rate threshold.

Table B.1: *Statutory corporate tax thresholds and rates*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Thresholds (£)				Marginal rate (%)				
Tax year	Lower rate threshold ($\pi 1$)	Lower rate marginal relief end ($\pi 2$)	Small profits rate threshold ($\pi 3$)	Small profits marginal relief end ($\pi 4$)	$\pi < \pi 1$	$\pi 1 \leq \pi < \pi 2$	$\pi 2 \leq \pi < \pi 3$	$\pi 3 \leq \pi < \pi 4$	$\pi \geq \pi 4$
2005-06	10,000	50,000	300,000	1,500,000	0.0	23.8	19.0	32.8	30.0
2006-07			300,000	1,500,000	19.0	19.0	19.0	32.8	30.0
2007-08			300,000	1,500,000	20.0	20.0	20.0	32.5	30.0
2008-09			300,000	1,500,000	21.0	21.0	21.0	29.8	28.0
2009-10			300,000	1,500,000	21.0	21.0	21.0	29.8	28.0
2010-11			300,000	1,500,000	21.0	21.0	21.0	29.8	28.0
2011-12			300,000	1,500,000	20.0	20.0	20.0	27.5	26.0
2012-13			300,000	1,500,000	20.0	20.0	20.0	25.0	24.0
2013-14			300,000	1,500,000	20.0	20.0	20.0	23.8	23.0
2014-15			300,000	1,500,000	20.0	20.0	20.0	21.3	21.0

Note: Table sets out the relevant thresholds for pre-tax corporate profit, π, (columns 2-5) and the marginal corporation tax rate on profits that apply on profits between these thresholds. The starting rate of corporation tax (applying below the lower-rate threshold) was abolished after 2005–06, and only applied to profits that were not distributed to shareholders in that tax year.
Source: Authors' calculations using HMRC administrative datasets.

Table B.2: *Statutory personal tax thresholds and rates*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Thresholds (£)				Dividend tax rates		
Tax year	Primary threshold (PT)	Higher-rate threshold (HRT)	PA withdrawal	Additional-rate threshold (ART)	Below HRT	HRT to ART	Above ART
2005-06	4,888	37,295			0.0	25.0	25.0
2006-07	5,044	38,335			0.0	25.0	25.0
2007-08	5,200	39,825			0.0	25.0	25.0
2008-09	5,460	40,835			0.0	25.0	25.0
2009-10	5,720	43,875			0.0	25.0	25.0
2010-11	5,720	43,875	100,000 - 112,950	150,000	0.0	25.0	36.1
2011-12	7,228	42,475	100,000 - 114,950	150,000	0.0	25.0	36.1
2012-13	7,592	42,475	100,000 - 116,210	150,000	0.0	25.0	36.1
2013-14	7,748	41,450	100,000 - 118,880	150,000	0.0	25.0	30.6
2014-15	7,956	41,865	100,000 - 120,000	150,000	0.0	25.0	30.6

Note: Table sets out statutory thresholds (columns 2-5) and tax rates (6-8) that are relevant for calculating the marginal tax rates faced by an owner-manager pursuing the optimal withdrawal strategy. Primary threshold is the point at which National Insurance Contributions begin to be paid. PA withdrawal is the point at which the tax-free income tax personal allowance begins to be withdrawn (an individual loses 50p of their personal allowance for every pound they earn until their personal allowance is zero).
Source: Authors' calculations using HMRC administrative datasets.

Table B.3: *Statutory capital gains thresholds and rates*

(1) Tax year	(2) Capital gains allowance (£)	(3) Marginal rate (%) if taxable income is:	(4)
		Below HRT	Above HRT
2005-06	8,500	5.5	10.0
2006-07	8,800	5.5	10.0
2007-08	9,200	5.5	10.0
2008-09	9,600	10.0	10.0
2009-10	10,100	10.0	10.0
2010-11	10,100	10.0	10.0
2011-12	10,600	10.0	10.0
2012-13	10,600	10.0	10.0
2013-14	10,900	10.0	10.0
2014-15	11,000	10.0	10.0

Note: This table shows the statutory capital gains threshold (column 2) and rates (columns 3 and 4) in each year, assuming that the asset is a business asset that qualifies for taper relief (before 2008-09) and Entrepreneurs' Relief (2008-09 onwards) respectively. An amount equal to the allowance can be taken as capital gains tax free. Before 2008-09, capital gains above the allowance were taxed at marginal income tax rates, but taper relief meant that only a fraction of the tax rate applied so long as the asset had been held for long enough. This table assumes that the asset has been held for at least 2 years. An individual is above the higher-rate threshold if her taxable (for income tax purposes) income plus capital gains is above the higher-rate threshold. From 2008–09, owners of business assets faced a flat 10% capital gains tax rate (called Entrepreneurs' Relief). This relief is applied to the first £1 million (extended up to £10 million by 2011) of qualifying lifetime gains. Source: Authors' calculations using HMRC administrative datasets.

Table B.4: *Calculated combined effective marginal tax rates*

(1) Tax year	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Combined marginal effective tax rate (%)											if taxable income in range:		
	Below PT			PT - HRT			HRT - ART			PA withdrawal		Above ART		
	Salary	Dividends	Cap. gain	Salary	Dividends	Cap. gain	Salary	Dividends	Cap. gain	Salary	Dividends	Salary	Dividends	Cap. gain
2005-06	0.0	19.0	19.0	40.6	19.0	23.5	47.7	39.2	27.1	47.7	39.2	47.7	39.2	27.1
2006-07	0.0	19.0	19.0	40.6	19.0	23.5	47.7	39.2	27.1	47.7	39.2	47.7	39.2	27.1
2007-08	0.0	20.0	20.0	40.6	20.0	24.4	47.7	40.0	28.0	47.7	40.0	47.7	40.0	28.0
2008-09	0.0	21.0	28.9	38.8	21.0	28.9	47.7	40.8	28.9	47.7	40.8	47.7	40.8	28.9
2009-10	0.0	21.0	28.9	38.8	21.0	28.9	47.7	40.8	28.9	47.7	40.8	47.7	40.8	28.9
2010-11	0.0	21.0	28.9	38.8	21.0	28.9	47.7	40.8	28.9	65.4	50.6	56.6	49.5	28.9
2011-12	0.0	20.0	28.0	40.2	20.0	28.0	49.0	40.0	28.0	66.6	50.0	57.8	48.9	28.0
2012-13	0.0	20.0	28.0	40.2	20.0	28.0	49.0	40.0	28.0	66.6	50.0	57.8	48.9	28.0
2013-14	0.0	20.0	28.0	40.2	20.0	28.0	49.0	40.0	28.0	66.6	50.0	53.4	44.4	28.0
2014-15	0.0	20.0	28.0	40.2	20.0	28.0	49.0	40.0	28.0	66.6	50.0	53.4	44.4	28.0

Note: This table sets out the combined (personal and corporate) marginal tax rate for an owner-manager earning an extra £at the corporate level and paying it out either as salary, dividends or capital gains. Table assumes that company has annual profits below £300,000 (and therefore faces the small profits rate). The combined marginal tax rate on salary is computed as the tax due from an extra £paid by an employer (including income tax, employee NICs and employer NICs). Combined marginal tax rate on dividends and capital gains are calculated as corporate tax rate $+ (1 -$ *corporate tax rate)* $*$ *dividend tax rate and corporate tax rate* $+ (1 -$ *corporate tax rate)* $*$ *capital gains tax rate respectively. Over the range of income where the personal allowance is being withdrawn, the marginal tax rate is higher because, for every £earned, 50p of personal allowance is withdrawn so an extra 50p of income is taxed at the higher rate. Source: Various government documents. Authors' calculations.*

Capital allowances

Current expenditure (such as wages and material inputs) is directly deductible from turnover in the calculation of (corporate) taxable profits. For capital expenditure (such as on buildings and machinery that depreciate over time), companies can claim capital allowances.

From 2008-09, the UK has operated an Annual Investment Allowance (AIA), which provides 100% upfront deduction for plant and machinery investment up to an annual cap (which varied between £25,000 and £500,000 across years). Plant and machinery expenditure above this allowance is written down on a (currently 18%) declining-balance basis. In practice most closely held companies are able to deduct 100% of their plant and machinery investments using the AIA (i.e. in the year the expenditure is incurred).

Prior to 2008, the capital allowances regime was less generous than the AIA but small and medium-sized companies still tended to get allowances that were greater than economic depreciation. Most closely-held businesses would have been able to claim a 50% first year allowance for all of their plant and machinery investments, meaning that half of the expenditure could be deducted in the calculation of corporate profit in the year the investment was made, while the remainder would be deducted on a declining balance basis (25%). As an example, for an investment of £100, £50 would be deducted in the first year, £12.50 in the second year (25% of £50), £9.38 (25% of £37.50) in the third year and so on.

C Sufficient statistics derivation

We perform the following thought experiment: what is the welfare loss from a marginal increase in the higher rate of tax, τ_1, assuming revenue is redistributed lump sum back to individuals?

In the theoretical analysis, to ease the exposition, we assumed that the corporate tax rate, τ_c, was zero. In practice, there is a constant linear rate, which we account for in the following derivation. Let $\tau_1 = \tau_c + (1 - \tau_c)\tau_{p1}$ denote the combined effective marginal rate on income above y^K, where τ_{p1} denotes the higher rate of tax on dividend income; and let $\tau_0 = \tau_c + (1 - \tau_c)\tau_{p0}$ denote the combined effective marginal rate on income below y^K, where τ_{p0} denotes the lower rate of tax on dividend income. Let $\tilde{z}_t = f(k_t, l_t) = \frac{z_t}{1-\tau_c}$ denote total income before deducting corporate tax, where we use z_t to denote total income after deducting corporate tax (which is consistent with the variable definition in Section 2).

To derive the sufficient statistics we follow the approach in Chetty (2009b). Let $x_{it} = \{l_{it}, A_{it+1}, S_{it+1}, k_{it+1}\}$ denote the vector of choice variables for individual i in period t, let $U_i(x_{it}) = u(c_{it}) - \psi(l_{it})$ denote the per period utility, and let $G_m(x_{it}, \tau_{p1}, R_t)$ for $m = 1, \ldots, M$ denote the M constraints facing individual i at time t; these depend on the tax rate τ_{p1}, and the lump sum transfer of any revenue raised, R_t. An increase in τ_1 (via an increase in τ_{p1}) only affects owner-managers who are already paying τ_1, let $\mathcal{I}$ denote the set of these owner-managers. The social welfare function is:

$$W(\tau_1) = \int_{i \in \mathcal{I}} \max_{\{x_{it}\}_{t=1}^{\infty}} \mathbb{E} \sum_{t=1}^{\infty} \beta^t [U_i(x_{it}) + \sum_{m=1}^{M} \lambda_m G_m(x_{it}, \tau_{p1}, R_t)] di \tag{C.1}$$

where λ_m denotes the Lagrange multiplier on constraint m.

The envelope theorem implies that the owner-managers' behavioural responses are second order, so the change in the social welfare function with respect to the tax rate, τ_{p1} is given by:

$$\frac{dW}{d\tau_1} = \int_{i \in \mathcal{I}} \mathbb{E} \sum_{t=1}^{\infty} \beta^t \left[\sum_{m=1}^{M} \lambda_m \left(\frac{\partial G_m}{\partial R_t} \frac{dR_t}{d\tau_{p1}} + \frac{\partial G_m}{\partial \tau_{p1}} \right) \right] di \tag{C.2}$$

The tax rate and rebate affect only the per period budget constraint:

$$G_1(x_{it}, \tau_{p1}, R_t) = c_{it} - y_{it}(1 - \tau_{p1}) - s_{it} + \phi_{it} R_t$$

where ϕ_{it} denotes the share of the aggregate tax revenue raised in period t rebated to individual i.

Government revenue in each period t is given by:

$$R_t = \tau_{p1} \int_{i \in \mathcal{I}} y_{it} di + \tau_{pk} \left(\int_{i \in \mathcal{I}} z_{it} di - \int_{i \in \mathcal{I}} y_{it} di \right) + \frac{\tau_c}{1 - \tau_c} \int_{i \in \mathcal{I}} z_{it} di \tag{C.3}$$

$$= \tau_{p1} \bar{y}_t + \tau_{pk} (\bar{z}_t - \bar{y}_t) + \frac{\tau_c}{1 - \tau_c} \bar{z}_t \tag{C.4}$$

where we assume that any shifted income is taxed at the lower personal tax rate τ_{pk}. Substituting in the expressions for $\frac{dR_t}{d\tau_{p1}}$, $\frac{\partial G_1}{\partial R_t}$ and $\frac{\partial G_1}{\partial \tau_{p1}}$ into (C.2) gives:

$$\frac{dW}{d\tau_1} = \int_{i \in \mathcal{I}} \mathbb{E} \sum_{t=1}^{\infty} \beta^t \left[\mu_{it} \left(\phi_{it} \left(\bar{y}_t + \tau_1 \frac{\partial \bar{y}_t}{\partial \tau_1} + \tau_k \left(\frac{\partial \bar{z}_t}{\partial \tau_1} - \frac{\partial \bar{y}_t}{\partial \tau_1} \right) + \frac{\tau_c}{1 - \tau_c} \frac{\partial \bar{z}_t}{\partial \tau_{p1}} \right) - y_{it} \right) \right]$$

if we let $\phi_{it} = \frac{y_{it}}{\bar{y}_t}$ denote individual i's share of aggregate taxable income in period t, then we have:

$$\frac{dW}{d\tau_1} = \mathbb{E} \sum_{t=1}^{\infty} \beta^t \left[\bar{\mu}_t \left(\tau_{p1} \frac{\partial \bar{y}_t}{\partial \tau_{p1}} + \tau_{pk} \left(\frac{\partial \bar{z}_t}{\partial \tau_{p1}} - \frac{\partial \bar{y}_t}{\partial \tau_{p1}} \right) + \frac{\tau_c}{1 - \tau_c} \frac{\partial \bar{z}_t}{\partial \tau_{p1}} \right) \right]$$

where $\bar{\mu}_t = \int_{i \in \mathcal{I}} \mu_{it} \phi_{it} di$ denotes the average marginal utility of consumption in period t.

If we assume that there are no aggregate shocks that induce a correlation (across t) between the average marginal utility of consumption $\bar{\mu}_t$ and aggregate total and taxable income, then we have the following:

$$\frac{dW}{d\tau_{p1}} = \sum_{t=1}^{\infty} \beta^t \left[\mathbb{E}[\bar{\mu}_t] \left((\tau_{p1} - \tau_{pk}) \mathbb{E} \left[\frac{\partial \bar{y}_t}{\partial \tau_{p1}} \right] + \left(\tau_{pk} + \frac{\tau_c}{1 - \tau_c} \right) \mathbb{E} \left[\frac{\partial \bar{z}_t}{\partial \tau_{p1}} \right] \right) \right]$$

$$= \frac{\mathbb{E}[\bar{\mu}_t]}{1 - \beta} \left[(\tau_1 - \tau_k) \mathbb{E} \left[\frac{\partial \bar{y}_t}{\partial \tau_1} \right] + \tau_k \mathbb{E} \left[\frac{\partial \bar{z}_t}{\partial \tau_1} \right] \right]$$

where we have expressed the final expression in terms of the effect of the combined tax rates, τ_1 and τ_k.

Let $\epsilon_y = \frac{\partial \bar{y}_t}{\partial \tau_1} \frac{(1 - \tau_1)}{y_t}$ and $\epsilon_z = \frac{\partial \bar{z}_t}{\partial \tau_1} \frac{(1 - \tau_1)}{z_t}$ denote the elasticities of total and taxable income; substituting these in yields the final expression:

$$\frac{dW}{d\tau_{p1}} = \frac{\mathbb{E}[\bar{\mu}_t]}{1 - \beta} \left[\epsilon_y \mathbb{E}[y_t] \frac{(\tau_1 - \tau_k)}{1 - \tau_1} + \epsilon_z \mathbb{E}[z_t] \frac{\tau_k}{1 - \tau_1} \right]$$

We can interpret the term in square brackets as the annual flow of deadweight loss in money metric units, due to a marginal permanent increase in τ_{p1}. We note that if taxable income equals total income (i.e. $y_t = z_t$ in every period) then the expression in the square brackets collapses to $\epsilon_z \mathbb{E}[z_t] \frac{\tau_1}{1 - \tau_1}$, which is the standard result (Chetty (2009a). Similarly, if $\tau_k = 0$, then it collapses to $\epsilon_y \mathbb{E}[y_t] \frac{\tau_1}{1 - \tau_1}$, which is the standard

sufficiency of the elasticity of taxable income formula. This is because, if $\tau_k = 0$, then there are no spillovers to other tax bases, and so we do not need to distinguish between labour supply and shifting responses to evaluate the efficiency cost of tax in this setting.

D Empirical analysis

D.1 Data samples

In this paper we take as our starting point all companies who file a 12 month corporate tax account finishing between 2012-13 and 2014-15 with non-missing information on directors and shareholders (we refer to this as the "full company population"). The data cover tax years 2005-06 to 2014-15. Our population of interest are the owner-managers of closely-held companies, which we define as those with $\leq$2 directors and $\leq$ 2 shareholders.

In the empirical analysis in section 5 we study those companies for which we have matched (at least one of) the directors' personal tax records and where the director is the director of only one company (we refer to this as the "matched sample").

For a subset of the empirical analysis, we use only one director, one shareholder companies as this allows us to attribute total income of the company to the owner-manager. In our bunching analysis, we consider the set of matched one director one shareholder companies observed for at least three years.

Table D.1 shows the number of companies, number of directors and number of observations in various samples, including those used as a basis for our analysis. The samples listed in italics are those used as a basis of the analysis in Section 5: $\leq$ 2 directors, $\leq$2 shareholder sub-samples refer to the years in which a company is observed: we demonstrate the sensitivity of our diff-in-diff results to this in Appendix D.3. Note that the samples on which the regressions are estimated (Table D.3) are smaller than those listed here, as they condition on the director or company being either in the treatment or control group.

Table D.1: *Samples used in analysis*

(1)	(2)	(3)	(4)
Sample	Companies	Directors	Observations
Full company population	1,578,706	-	9,374,793
≤ 2 directors ≤ 2 shareholders	1,093,340	-	7,268,792
Matched sample	532,072	636,676	3,671,484
Observed 2009–2014	245,789	300,195	2,641,688
Observed 2008–2014	207,778	254,980	2,347,250
Observed 2007–2014	175,234	215,638	2,048,410
Observed 2006–2014	128,823	158,239	1,546,452
Balanced panel	108,020	131,642	1,316,420
1 director, 1 shareholder	339,504	-	1,201,526
Matched sample	139,362	139,362	520,064
Observed 3+ years	81,792	81,792	430,035

Note: The table shows the number of companies, number of directors (where applicable) and number of observations in different samples used in this paper.
Source: Authors' calculations using HMRC administrative datasets.

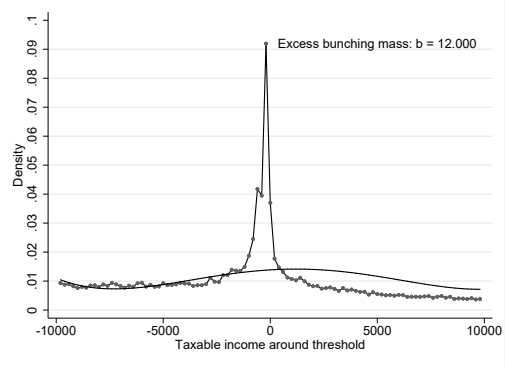
D.2 Bunching estimation

Sample

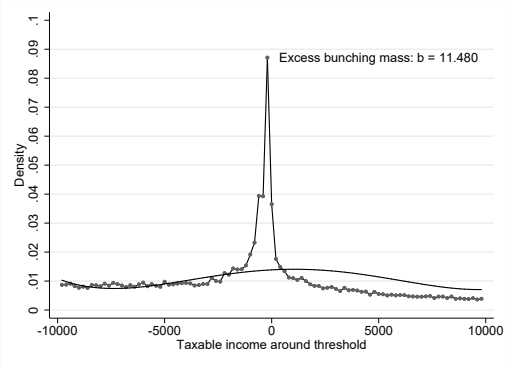
In our bunching analysis in Section 5.1 we use the sample of one director, one shareholder companies that are present in the data for at least three years. This is so we can analyse their average total income, and also calculate the fraction of years that we observe them bunching, in order to distinguish between different motivations for intertemporal shifting. Figure D.1 shows that the distributions of taxable income for the full sample (present for any number of years), and the sample of those present for at least three years is very similar.

Figure D.1: *Bunching in annual taxable around the higher rate threshold, one director one shareholder companies*

(a) Present for at least one year



(b) Present for at least three years



Notes: Method for estimating the counterfactual density described in the main paper. Bin width is £200. The left hand panel shows the distribution of annual taxable income for the owner-managers of one director one shareholder companies present for any number of years; the right hand panel shows the distribution for the sample of owner-managers of one director one shareholder companies who are present in the data for at least 3 years; more details on sample definition are provided in Appendix D.1.
Source: Calculations based on HMRC administrative datasets.

Counterfactual distribution

In our main bunching results, to construct the counterfactual distribution, we fit a polynomial of degree 4 through the observed distribution, excluding a window of 7 bins (i.e. £1400) either side of the threshold. Table D.2 shows the robustness of our estimates to varying the size of the excluded window and degree of polynomial; differences in the estimated bunching mass and corresponding elasticities are small, and the 95% confidence intervals overlap.

Table D.2: *Robustness to the parametrization of the counterfactual distribution*

	(1)	(2)	(3)	(4)	(5)	(6)
		Excluded window			Polynomial degree	
	Baseline	£700	£2000	5	6	7
Annual taxable income						
Bunching mass	11.480	11.440	10.600	11.390	9.832	9.796
Elasticity	0.199	0.199	0.184	0.198	0.171	0.170
	[0.178,0.220]	[0.180,0.218]	[0.154,0.214]	[0.179,0.217]	[0.153,0.189]	[0.154,0.186]
Annual total income						
Bunching mass	-0.069	-0.010	0.088	-0.071	-0.151	-0.153
Elasticity	-0.001	-0.000	0.002	-0.001	-0.003	-0.003
	[-0.006,0.003]	[-0.004,0.004]	[-0.004, 0.007]	[-0.006,0.003]	[-0.008,0.002]	[-0.008,0.002]
Average total income						
Bunching mass	-0.012	-0.065	-0.009	-0.106	-0.044	-0.036
Elasticity	-0.002	-0.001	-0.000	-0.002	-0.001	-0.001
	[-0.012,0.008]	[-0.010, 0.007]	[-0.013, 0.013]	[-0.012,0.009]	[-0.013,0.011]	[-0.013,0.011]

Notes: Method for estimating the counterfactual density described in the main paper. Bin width in all specifications £200. Each column shows a different parametrization of the counterfactual density. Column (1) shows the baseline specification, which has an excluded window of 7 bins, or £1400, and uses a polynomial of degree 4. Columns (2)-(3) show the results when the excluded window is varied; and columns (4)-(6) show the results when the degree of polynomial is varied. All specifications use the sample of one director one shareholder companies who are present in the data for at least 3 years. Elasticities are constructed as described in Section 6.2, and 95% confidence intervals (shown in square brackets) are estimated using bootstrap methods.
Source: Calculations based on HMRC administrative datasets.

D.3 Differences-in-differences analysis

Table D.3 shows the coefficient estimates underlying Figures 5.5 and 5.8.

Table D.3: *Differences-in-differences coefficient estimates*

(1)	(2) $\ln y_{it}$	(3) $\ln \pi_{ft}$	(4) $A_{ft} - A_{ft-1}$	(5) i_t
Pre-reform				
Treatment*2006	0.0274	0.0487		
	(0.0090)	(0.0246)		
Treatment*2007	0.0079	0.0225	4016.5	0.00690
	(0.0081)	(0.0228)	(1128.5)	(0.00880)
Treatment*2008	0.0016	-0.0303	1725.6	0.00079
	(0.0071)	(0.0228)	(1078.6)	(0.00871)
Treatment*2009	0.0000	0.0000	0.0	0.00000
	–	–	–	–
Reform announced				
Treatment*2010	0.0132	0.0037	-3727.6	0.00305
	(0.0113)	(0.0241)	(1135.6)	(0.00785)
Reform implemented				
Treatment*2011	-0.2489	0.0148	1986.6	0.00674
	(0.0115)	(0.0256)	(1146.0)	(0.00831)
Treatment*2012	-0.2620	-0.0004	8935.7	0.01846
	(0.0127)	(0.0258)	(1078.8)	(0.00854)
Treatment*2013	-0.2876	-0.0403	8682.8	0.00265
	(0.0134)	(0.0274)	(1124.6)	(0.00831)
Treatment*2014	-0.2704	-0.0265	6812.6	0.00733
	(0.0136)	(0.0282)	(1149.5)	(0.00848)
Treatment*2015	-0.2920	-0.0389	6512.5	0.01675
	(0.0154)	(0.0322)	(1203.4)	(0.00917)
Year effects	Yes	Yes	Yes	Yes
Fixed effects	Director	Company	Company	Company
Number of directors	32,847			
Number of companies		28,843	29,224	29,224
Number of observations	318,254	235,023	256,014	257,182

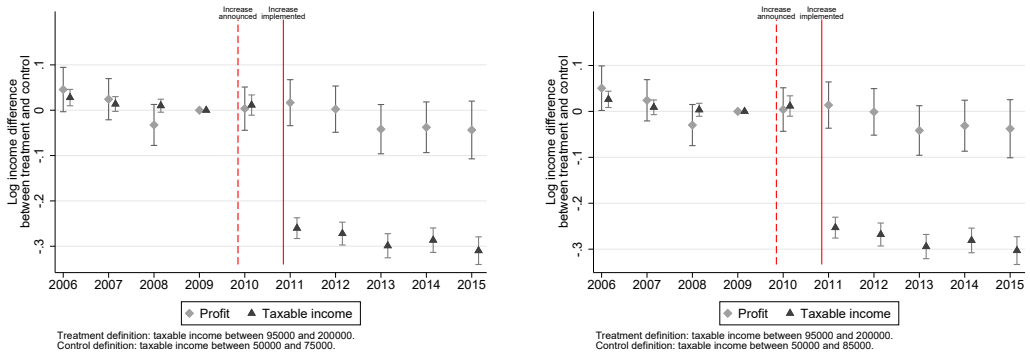
Notes: Table shows the coefficient estimates from the estimated equations (5.1)-(5.3) (columns (2)–(4)) and (5.4) column (5). Robust standard errors are show in parentheses. There are more directors than companies because some companies have two directors. $\ln \pi_{ft}$ *is missing if* π_{ft} *is negative. The dependent variable in columns (4) and (5) are changes from the previous year, so the interaction with the first year is not identified.*
Source: Calculations based on HMRC administrative datasets.

Income cutoffs

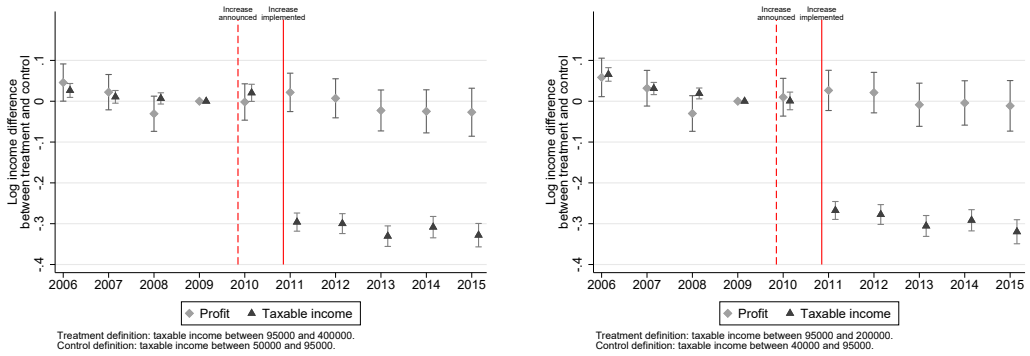
We define the treatment and control groups on the basis of the taxable income of owner-managers in the pre-reform period. In our baseline estimation, we define the control group as those owner-managers with incomes always in the range £50,000–95,000, and the treated group as those owner-managers with incomes always in the range £50,000–95,000. Figure D.2 shows robustness to alternative income cutoffs used to define the treatment and control groups.

Figure D.2: *Robustness to alternative treatment and control group definitions*

(a) Control: £50–75k. Treatment: £95–200k (b) Control: £50–85k. Treatment: £95–200k



(c) Control: £50–95k. Treatment: £95–400k (d) Control: £40–95k. Treatment: £95–200k



Notes: Each panel shows the estimated $\beta_s^{taxable}$ coefficients from equation (5.1); grey markers show the estimated β_s^{profit} coefficients from equation (5.2) using different income cutoffs to define the treatment and control groups. In all cases, the treatment and control groups are defined as owner-managers with incomes always within the specified ranges during the pre-reform period (2006-2009). The omitted year in all cases is 2009. Error bars show 95% confidence intervals. Years on the horizontal axis refer the calendar year in which the tax year ends i.e. 2007 refers to the tax year starting in April 2006 and ending in March 2007.
Source: Calculations based on HMRC administrative datasets.

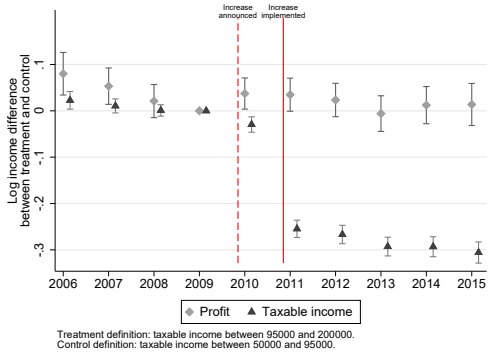
Balanced and unbalanced panels

In our baseline estimate we require that we observe owner-managers for the full pre-reform period (i.e. over 2005/6 to 2008/9 tax years) to construct the treatment

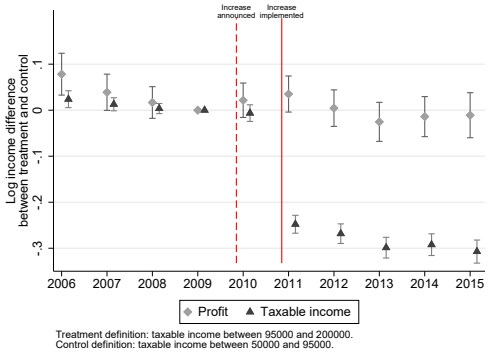
and control groups. Panels (a)–(c) of Figure D.3 show that our results are robust to relaxing this requirement to only observing owner-managers in at least 1, 2, and 3 years of the pre-reform period. Finally, panel (d) of D.3 shows that we get similar results when we use a balanced panel.

Figure D.3: *Robustness to alternative treatment and control group definitions*

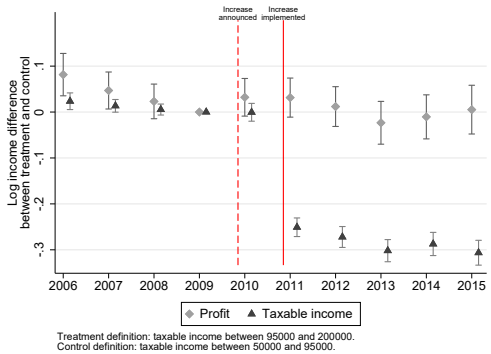
(a) At least 1 year in pre-reform period



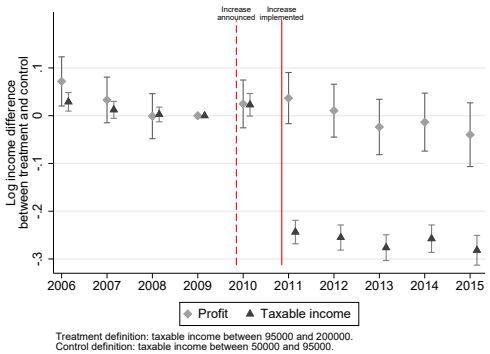
(b) At least 2 years in pre-reform period



(c) At least 3 years in pre-reform period



(d) Balanced panel

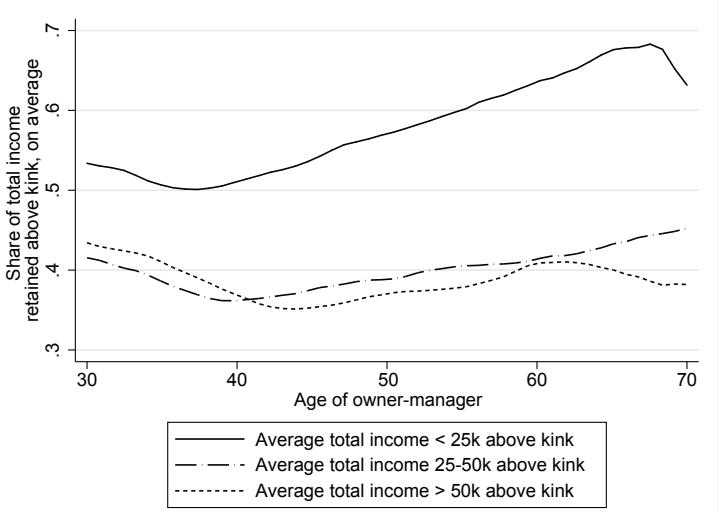


Notes: Each panel shows the estimated $\beta_s^{taxable}$ coefficients from equation (5.1); grey markers show the estimated β_s^{profit} coefficients from equation (5.2) varying the requirements to be in the sample. In all cases, the treatment and control groups are defined as in the baseline case (treatment: £95–200k, and control: £50–95k). Error bars show 95% confidence intervals. Years on the horizontal axis refer the calendar year in which the tax year ends i.e. 2007 refers to the tax year starting in April 2006 and ending in March 2007.
Source: Calculations based on HMRC administrative datasets.

D.4 Additional empirical results

Figure D.4 the average retained profits by age of the owner-manager, by banded average total income. Retained profits increases with age, particularly for those with average total income within £25,000 of the kink.

Figure D.4: *Retained profits, by age*

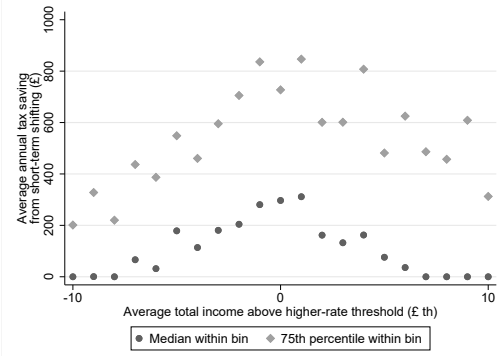


Notes: For each owner-manager we calculate their average retained profits and average total income over the period that we observe them in the data. We also calculate the share of total income above the higher rate threshold that each owner-manager retains, on average. The right hand panel shows the conditional mean of this variable at ages of the owner-manager, by banded average total income.
Source: Calculations based on HMRC administrative datasets.

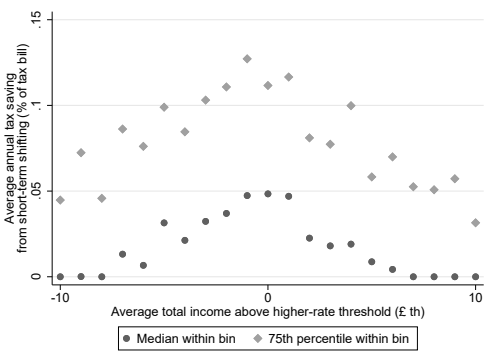
In Section 6.1, we note that some owner-managers use the flexibility afforded by retaining income in the company wrapper to smooth volatility in taxable income around tax kinks. Figure D.5 shows the relationship between the amount of tax saved and owner-managers' average total income around the higher-rate threshold. The tax saving is calculated by comparing the amount of tax that would be paid on the total income earned each year (i.e. if there was no ability to retain) with the actual amount of tax paid. For each owner-manager we take the average across years in which we observe them, and the figure shows the median and 75th percentile across owner-managers within binned average total income.

Figure D.5: *Benefits of short-term shifting*

(a) Cash



(b) Percent of tax paid



Notes: Calculated by comparing the amount of tax that would be paid if taxable income was equal to total income each period (i.e. if there were no ability to retain) and the actual amount of tax paid on taxable income. Panel a shows the median and 75th percentile within each total income bin in cash terms, while panel b shows the median and 75th percentile within each total income bin as a share of (corporate and personal) tax paid. Includes only those owner-managers with average retained profit below £1,500 so as to make tax paid on taxable and total income comparable.
Source: Authors' calculations based on HMRC administrative datasets.