Intertemporal income shifting and the taxation of business owner-managers

Helen Miller, Thomas Pope and Kate Smith*

August, 2020

Abstract

Business owner-managers are an important part of the workforce and highly responsive to taxes. We use newly linked tax records to show that the large responses of UK company owner-managers to personal taxes are due to intertemporal income shifting and not to reductions in real business activity. We use a simple model to highlight that understanding why individuals shift income across time, and the constraints they may face in doing so, matter for the efficiency properties of tax policy. Around half of the observed intertemporal shifting is short-term and helps ameliorate the effect of progressive personal taxes on volatile incomes. The remainder reflects systemic retention of profits within a company over long periods, and likely creates efficiency costs by distorting the intertemporal allocation of consumption. We find no evidence that this tax-induced retention increases business investment. Properly accounting for intertemporal shifting reduces the deadweight loss associated with a marginal increase in personal taxes by around 80%.

Keywords: income shifting, elasticity of taxable income, owner-managers, closely held business, dividend taxation, capital gains
JEL classification: H30, H24, H26, D25
Acknowledgements: We thank William Boning, Richard Blundell, Michael Devereux, Eric French, Rachel Griffith, John Eric Humphries, Henrik Kleven, Rory McGee, Costas Meghir, Martin O'Connell, Aureo de Paula, Max Risch, Emmanuel Saez, Joel Slemrod and Eric Zwick for helpful comments. We gratefully acknowledge financial support from the Economic and Social Research Council (ESRC) under the Centre for the Microeconomic Analysis of Public Policy (CPP), grant number RES-544-28-0001 and under the Tax Administration Research Centre, grant number ES/K005944/1. All errors and omissions remained the responsibility of the authors. This work contains statistical data from HMRC which is Crown Copyright. The research datasets used may not exactly reproduce HMRC aggregates. The use of HMRC statistical data in this work does not imply the endorsement of HMRC in relation to the interpretation or analysis of the information.

*Miller is at the Institute for Fiscal Studies, Smith is at the Institute for Fiscal Studies and University College London and Pope is at the Institute for Government. **Correspondence:** helen_m@ifs.org.uk and kate_s@ifs.org.uk.

"*We do not want high tax rates to deter investment. The lower capital gains tax rates introduced by this clause will make it more attractive for people to invest in companies, helping those companies to access the capital to expand and create jobs.*"
– David Gauke, Financial Secretary to the UK Treasury, 2016

1 Introduction

The taxation of business owners is important – they are a growing part of the workforce,[1] and how they respond to tax is key for assessing the efficiency and equity properties of capital taxation. Politicians commonly grant business owner-managers preferential tax treatment as a means to boost entrepreneurship and growth. The policies chosen – for example, favourable capital gains tax rates – often incentivise the shifting of taxable income across time. Such shifting can allow individuals to smooth tax payments when incomes are volatile but can also create efficiency losses and reduce government revenue.

Previous work has shown that business owners are responsive to taxes, and that this is often driven by avoidance, notably through income shifting across tax bases[2] and time.[3] Consistent with this, we use newly linked personal and corporate tax records to show that all of the responsiveness of UK company owner-managers to marginal tax rate changes is due to intertemporal income shifting, and not to reductions in real business activity. We advance the literature in three ways. First, we use a simple model to show how tax motivated intertemporal income shifting can create efficiency losses, *even if real business activity is unaffected.* Notably, welfare is reduced if shifting leads people to consume less today than they would otherwise. Second, informed by this analysis, we quantify the different motivations for shifting. Around half of shifting is short-term, undertaken to ameliorate the effect of progressive personal taxes on volatile incomes, and unlikely to create large efficiency costs. The remainder reflects systemic retention of profits within a company over long periods in order to access lower rates, and is likely to create efficiency losses by distorting the intertemporal allocation of business owners' consumption. Third, we show that this tax-induced systematic profit retention does not increase business

[1] 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)) In the UK, company owner-managers have been the fastest growing part of the labour force since the early 2000s.

[2] This includes tax-motivated incorporation (e.g. Gordon and MacKie-Mason (1994), MacKie-Mason and Gordon (1997), Goolsbee (1998), Gordon and Slemrod (2000)) and the relabelling of labour income as capital income (Gordon and Slemrod (2000), Harju and Matikka (2016)).

[3] e.g. le Maire and Schjerning (2013), Alstadsæter and Fjærli (2009), Alstadsæter et al. (2014).

investment, thus leading neither to the outcome desired by politicians, nor to any potential misallocation of capital.

Understanding how people respond to incentives to shift income intertemporally is key for assessing the efficiency implications of policy. In the UK, as in many European countries, the corporate form is tax-advantaged both because capital income is taxed at lower rates than labour income[4] and because business owners can choose when to withdraw income from the company and pay personal income taxes. We find that properly accounting for the distortions and tax revenue losses caused by shifting in this setting reduces the estimated deadweight loss associated with a marginal increase in personal taxes by 80%. Until recently, US owner-managers have faced a tax incentive to use pass-through S-corporations, which offer limited scope to shift intertemporally because personal taxes are levied on accrual. However, the corporate tax rate 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)); this legal form offers a means to shift income intertemporally and the exemption of qualified small business stock from capital gains tax provides an incentive to do so. Our findings are therefore relevant for studying US business owners, particularly in light of recent reforms, and for other policy settings in which intertemporal shifting is possible. For example, those holding capital assets or receiving remuneration through stock options can choose when to realise taxable income and most people can shift at least some income by saving in a private pension.

We build on previous research that shows that people shift income across time if it is tax advantageous,[5] by developing a simple theoretical framework to analyse the different forms of intertemporal income shifting and their welfare implications. In the model, owner-managers can adjust labour supply, invest in productive capital, and save in both company and personal cash assets. Variation in marginal tax rates, combined with the ability to shift intertemporally, can create distortions in both the intra and intertemporal budget constraints. We show that owner-managers will strategically retain and withdraw income from the company if either (i) the profit flowing into the company fluctuates around a tax kink, or (ii) they are able to access lower tax rates by delaying withdrawal for a longer period. As discussed below, these are likely to have different implications for efficiency.

[4] As in the US (Smith et al. (2019), Smith et al. (2019)), the UK labour share and the share of labour returns in the top 1% of the income distribution is higher than commonly measured due to the tax incentive to take the returns to work in the form of capital income.

[5] In addition to the papers in footnote 3, Goolsbee's (2000) seminal paper shows that corporate executives manipulate the timing of their compensation to avoid taxes; similar findings have been found by Gorry et al. (2018), Gorry et al. (2017), Kreiner et al. (2014). Hanlon and Hoopes (2014) find that firms adjust the timing of their dividend payments in response to tax changes.

To empirically distinguish between the ways that company owner-managers respond to tax changes, we match the personal tax records of individuals who are major shareholders and directors of incorporated businesses to their company's corporate tax records. This allows us to distinguish between the total income created each year by the owner-manager (measured at the business level), personal taxable income paid to the owner-manager and the net retention of profits in the company.

We use two complementary empirical approaches that exploit different forms of tax variation to show that all of the responsiveness of owner-managers to tax rate changes is due to intertemporal income shifting and not reductions in real business activity. First, we use a bunching estimator[6] applied to different income measures around the higher rate threshold, above which the marginal personal income tax rate increases by 20 percentage points. We show that while there is sharp bunching in *taxable (personal) income*, there is no evidence of any bunching in the *total income at the company level*.[7] This indicates that the bunching in taxable income is entirely driven by strategic profit retention and withdrawal. Second, we find similar patterns using a difference-in-differences strategy to assess responses to policy reforms that increased marginal tax rates on incomes above £100,000. There were large responses in taxable income but no evidence of a change in the total amount of income generated, even 5 years after the reforms. Company owner-managers face significantly fewer constraints on their labour supply choices than other types of workers, such that the attenuating effects of adjustment costs on estimated labour supply elasticities are less of a concern.[8] Our findings suggest that higher marginal tax rates do not change their labour supply decisions when income shifting is possible.

We empirically study the different motivations for intertemporal income shifting by exploiting the panel nature of the UK tax records. We argue that those who are smoothing volatile total incomes in the face of tax kinks will not bunch in all years. This is supported by the fact that, on average, net retention is zero for these "sometimes bunchers", and we see them retaining when their incomes are high and withdrawing when their incomes are low. In contrast, we argue that those who bunch consistently are systematically retaining to access lower future rates; in line with this, such individuals accumulate positive net retained profits. We find that around half of the observed bunching at the higher rate threshold is due to shifting

[6] As developed by Saez (2010) and Chetty et al. (2011); see Kleven (2016) for a summary.

[7] 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.

[8] See, for example, Chetty et al. (2011), Kleven and Waseem (2013), Bastani and Selin (2014).

to smooth volatility, and the remainder due to systematic retention to access lower future tax rates. In response to increased dividend tax rates there is evidence of people bringing forward dividend payouts to the year before the reform, followed by a permanent increase in retained income.

Much of the existing literature on intertemporal income shifting focuses on short-run responses; for example, Goolsbee (2000) finds that the taxable income response of executives to tax rises disappears after one year. In these cases, it is often reasonable to assume that this short-run shifting is costless (as in le Maire and Schjerning (2013)). For instance, owner-managers with volatile incomes have a consumption smoothing motive to save (dissave) when incomes are high (low); if this volatility is around a tax kink, then they can simply switch from saving outside the company to inside, leaving consumption unaffected, but conferring a tax saving. The ability to engage in this short-run form of shifting allows individuals with volatile incomes to smooth their tax liability and not be penalised by a progressive tax schedule, relative to individuals with more stable incomes (Meade (1978), Bradford (1982)).

When there are tax incentives to systematically retain profits over the longer run, there can be significant efficiency costs. We find that owner-managers retain substantial sums over several years – among those earning £150,000, half retain in excess of £50,000 each year and 25% retain more than £90,000. However, owner-managers almost never retain to the tax minimising extent, which suggests that there are costs to doing so. Most likely, individuals cannot fully and costlessly borrow at the personal level against income retained in the company for long periods, and, as a result, the intertemporal allocation of consumption is distorted.

The incentive for UK owner-managers to retain over long periods exists largely as a result of "Entrepreneurs' Relief", a 10% rate for capital gains realised on shares owned in closely held companies.[9] One of the aims of this policy is to promote investment. We use our theoretical framework to demonstrate that preferential capital gains tax rates increase the incentive to retain earnings in a company but do not directly change investment incentives; capital investment will only change if higher retained earnings affect the asset portfolio choice within the business. Empirically, we find that retained profits are held in the form of cash and other equivalent assets and lead to no change in a company's capital stock.[10]

[9]Citing the results in this paper, the UK government's March 2020 Budget reduced the lifetime amount of gains eligible for Entrepreneur's Relief from £10 million to £1 million and renamed it Business Asset Disposal (BAD) relief.

[10]This is consistent with 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))) and evidence that the 2003 US dividend tax cut did not led to increased investment (Yagan (2015)).

Policy makers often perceive a trade-off when setting capital taxes: because capital incomes accrue disproportionally to high earners, higher rates are desirable for redistributive reasons, but they can generate large efficiency losses if they reduce savings and investments (Chetty and Saez (2005)). Reduced headline rates are not well targeted at removing distortions to investment (Mirrlees et al. (2011)), nor are they well targeted at any of the potential market failures associated with entrepreneurship (Gordon and Sarada (2018)). They also create the potential for capital misallocation, for example, towards the small business sector. Our results suggest that taxing dividends and the capital gains income of business owners at lower rates than labour income does not boost investment at the intensive margin of UK owner-managed businesses. It thus neither increases activity that may have positive spillovers, nor leads to capital misallocation.[11] At the same time, these policies are costly in terms of foregone revenue and provide disproportionate benefit to the highest income business owners: among owner-managers claiming Entrepreneurs' Relief, mean capital gains are £500,000, corresponding to a tax saving (relative to taxation on accrual) of £75,000 over the company's life.[12] Smith, Zidar, and Zwick (2019) highlight the importance of private business income at the top of the US wealth distribution; tax policies that encourages the long-run retention of income within businesses contribute to private business wealth accumulation.

We show that failing to properly account for the nature and costs associated with intertemporal income shifting can lead to significant misestimation of the deadweight loss associated with raising taxes on business owners. We use our theoretical framework to derive the sufficient statistics for evaluating the deadweight loss of a marginal tax change.[13] When we account for the the fact that shifting to smooth volatility likely does not generate efficiency losses, and that some tax is paid on all shifted income (both over the short and long run), the estimated deadweight loss falls by around 80%, relative to the estimate that assumes that all shifting is costly and no tax is paid on shifted income.

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-

[11] We do not study business entry in this paper, but note that the policies are similarly poorly targeted on this margin and lead to tax motivated incorporation (Crawford and Freedman (2010)).

[12] Advani and Summers (2020) show that preferential rates of tax on capital incomes lead to average tax rates falling at the very top of the UK income distribution.

[13] 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 break down if there are spillovers to other tax bases (Slemrod (1995), Slemrod and Yitzhaki (2002)). In our setting there are spillovers across time and bases; in an application of Chetty (2009a), we derive statistics that account for this.

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 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 available. 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. The majority (68%) 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.[14]

Table 2.1 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 cash equivalents), investments and any stock of products yet to be sold, account,on average, for over 75% of total assets.[15] Fixed assets measure a company's stock of

[14]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.

[15]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.

Table 2.1: *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 companies	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.

"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 profits 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.[16]

Consistent with this heterogeneity, there are systematic differences in the activities and returns across industries. Table 2.2 lists the top 15 industries 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

[16] 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.

managers operating in construction, retail, health and social work (e.g. doctors), and land transport (e.g. taxi drivers).

Table 2.2: *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.

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.[17] 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

[17]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.

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.

Company owner-managers

Table 2.3 presents summary statistics for directors of closely held companies. 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.

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.[18] 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) and 10-15% of the top 1% are owner-managers in any given year. 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.

Table 2.3: *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.

Variable construction

We observe company f's post corporate 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. Let $\mathcal{F}_f$ denote the set of owner-managers belonging to company f. We define the total income of company f in year t ($z_{ft} = \pi_{ft} + \sum_{i \in \mathcal{F}_f} y_{it}^w$) as corporate profit minus corporate tax paid, plus any wage income paid to the owner-managers.[19] 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 ($y_{it} = y_{it}^w + y_{it}^d$) is measured directly from the individual's tax returns as the sum of dividend and wage income.

The flow of retained profits of company f are the difference between the total post-corporate tax income of the company and what is withdrawn as taxable income by the company's owner-managers, $r_{ft} = z_{ft} - \sum_{i=\in \mathcal{F}_f} y_{it}$. For a subset of our

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

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

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 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%.[20] 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 paid out, 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.[21] 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 in Appendix

[20] 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.

[21] 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.

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 lower rates and do not attract social security contributions. The tax minimising way to take income out of the company in all years we study involves taking a salary equal to the point at which personal taxes become payable and withdrawing the remainder as dividend income. This is the most commonly used strategy by owner-managers.[22] 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 use "director's loans" to borrow against the income in their company in order to smooth an income stream.[23]

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 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 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

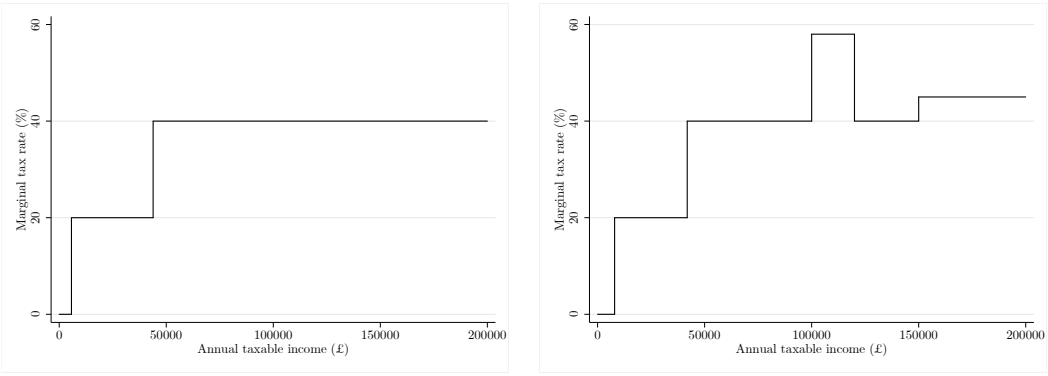
[22] Owner-managers can also reduce their tax liability by making a spouse a shareholder and paying them dividends. These will be included in our sample of companies with at most two directors and two shareholders.

[23] 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.

over time. Since the 2010-11 tax year, there have been additional marginal tax rate bands at £100,000 and £150,000, illustrated in the right hand panel.[24]

Figure 3.1: *Marginal personal tax rate schedules*

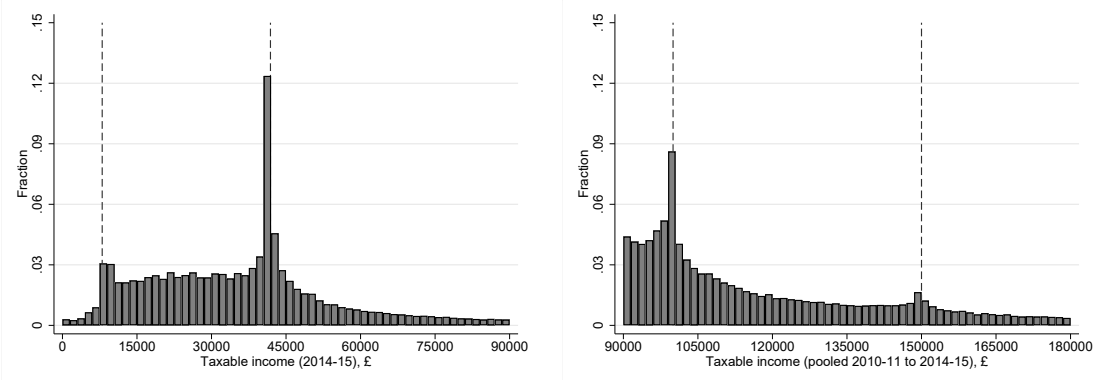
(a) Tax year 2009-10 (b) Tax year 2014-15



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.

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.

[24]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.

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 (the distributions are similar across tax years). 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.

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 profits) 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, over 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.[25] 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.[26] 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 earnings retained in a company can be used for investment or withdrawn at any time, pension pots

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

[26]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).

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.

3.2 Investment incentives

The incentive to use retained profits to invest in productive capital does not change across personal tax thresholds.[27] The parts of the corporate tax system that determine investment incentives – notably the corporate tax rate and capital allowances[28] – 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.[29]

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.

[27] 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.

[28] 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

[29] A potential exception to this is if owner-managers purchase assets for personal use but claim them as 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.

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 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

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

We consider an owner-manager, who chooses consumption, c_t, and labour supply, l_t in each period, t, to maximise the expected net present value (discounted at rate β) of lifetime utility. They produce total income, $z_t = f(k_t, l_t, \eta_t)$, using their own labour supply 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 profits within the company cash asset, a_t, and investment in capital, i_t. Consumption, c_t, 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. The cash assets attract rate of return, r. Owner-managers are subject to borrowing constraints at both the personal and company level. Maximisation of lifetime utility subject to the period budget constraints, the laws of motion for the

different assets, and the borrowing constraints yields a set of first order conditions that describe optimal behaviour. Here we present an overview of our analysis, with further details provided in Appendix C.

4.1 The effect of taxation on behaviour

If 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. The intertemporal allocations are unaffected: the owner-manager is indifferent between saving (or borrowing) in the company or at the personal level, and does so to smooth the marginal utility of consumption over time. Owner-managers invest such that the net return on capital equals the return on cash investments.

However, 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. For example, consider a piecewise linear tax function, with taxable income up to the kink point, y^K, 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). We let choice variables superscripted by * denote those that are optimal under the constant linear tax, and those superscripted ** denote those that are optimal under the kinked tax function. Owner-managers may respond to the kinked function with lower future rate in a variety of ways.

Shifting to smooth volatile incomes. For owner-managers whose total income fluctuates around the kink, there is an incentive to retain and withdraw to smooth volatility in total income, which does not create any deadweight loss. 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. For example, 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 $c^* < y^K$. If their total income exceeds the kink in a given period, they can simply switch from saving in their personal asset to the company asset, leaving consumption unaffected. Labour

supply is also unaffected because they never face the higher rate of tax. A similar argument applies to owner-managers with average total income above the kink.[30]

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.

Shifting to take advantage of a lower future tax rate. Owner-managers with average total income above the kink, $\bar{z}^* \geq y^K$ have an incentive to shift taxable income across time in order to access the 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 at the personal level, 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, some owner-managers may be borrowing constrained 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. In this case, owner-managers who are borrowing constrained face a kink in their intertemporal budget constraint; the optimal amount owner-managers choose to retain depend on their marginal rate of substitution between today and the future (for further discussion see Appendix C).

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

[30]These owner-managers may adjust their labour supply and hence total income in the face of the higher tax rate, 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 heterogeneity in responses, which we expect to be linked to personal borrowing constraints, varies with the age of owner-managers.

Labour supply. The higher rate of tax, τ_1, may also lead to labour supply reductions, and therefore reductions in total income, which also create deadweight loss. The extent to which this occurs 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. Owner-managers who systematically retain income face a choice of whether to hold retained profits as cash (or investments in third parties) in the company or to invest in their business capital stock. Personal taxes do not directly affect the incentive to use retained profits to invest in productive capital. In Appendix C we show that this can be derived by analysing the first order conditions for the different asset choices: although some owner-managers are willing to consume less today than tomorrow (because of the kink in the intertemporal budget constraint), this does not distort the asset choice within the company.

However, this result rests critically 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 profits 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 personal 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 profits may lead some agents to alter their asset portfolio and increase investment in capital rather than saving in cash.[31] Second, if investment is lumpy (such that the marginal product of capital

[31] 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

may be above r) then the probability of investing would be increasing in retained profits 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 profits (i.e. not because taxes directly change investment incentives but because portfolio allocations vary with the size of retained profits). We investigate empirically whether there is any evidence of changes to investment decisions as a result of changes in marginal personal tax rates.

4.2 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 implications 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:

$$\frac{dW}{d\tau_1} = \frac{\mathbb{E}[\bar{\mu}_t]}{1-\beta}\left[\epsilon_y \mathbb{E}[y_t]\frac{(\tau_1 - \tau_k)}{1-\tau_1} + \epsilon_z \mathbb{E}[z_t]\frac{\tau_k}{1-\tau_1}\right] \tag{4.1}$$

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.3.

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[32]), 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.

and dropped below the marginal product of capital at some point. 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.

[32]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.

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 profits 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 rates by reducing the total income generated or by intertemporal income shifting of different forms. First, we analyse 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

Figure 3.2 shows that there is large bunching in annual (personal) taxable income around the higher rate threshold. 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.[33]

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, $[x_-, x_+]$.

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, and in Appendix A to the distribution for all closely held company directors. 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 5.2(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.[34] 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

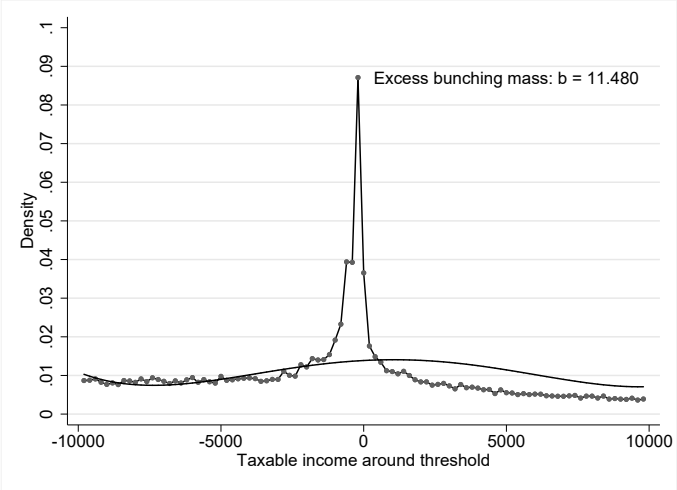
[33] We group owner-managers into income bins indexed by j; c_j is the number of owner-managers in bin j, x_j is the income level in bin j, $[x_-, x_+]$ is the excluded range and p is the order of the polynomial. We use an iterative procedure to estimate the counterfactual distribution, $\hat{c}_j = \sum_{i=0}^{p} \hat{\beta}_i (z_j)^i$ 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_+: $\hat{b}_x = \frac{\hat{B}_N}{\sum_{i=x_-}^{x_+} \hat{c}_j / (x_+ - x_-)}$

[34] 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.

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.

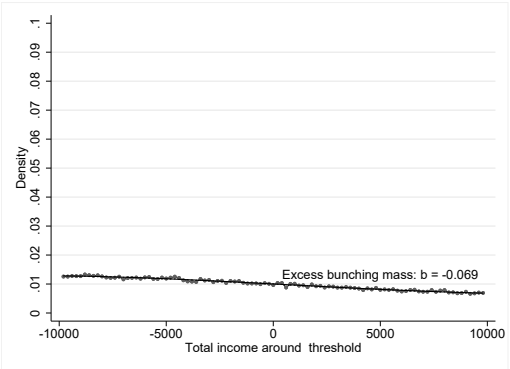
Figure 5.1: *Bunching in annual taxable around the higher rate threshold*



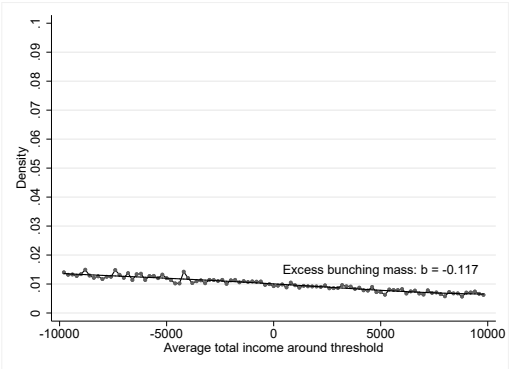
Notes: Method for estimating the counterfactual density described in the text. Bin width is £200. The distribution is drawn for the sample of owner-managers of one director one shareholder companies who are present in the data for at least 3 years. Details on sample definition are provided in Appendix 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: *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.

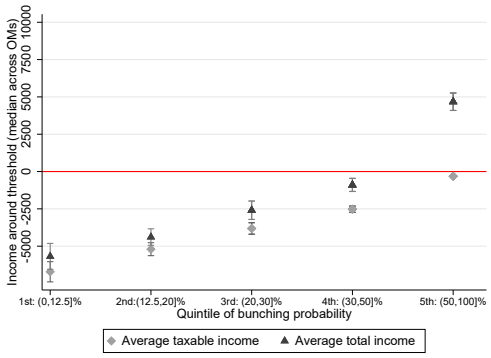
We expect owner-managers who shift to smooth income volatility to: (i) only bunch at the threshold intermittently (e.g. when their total income temporarily goes above the threshold); (ii) to not systematically retain income (i.e. on average their total incomes equal their taxable incomes). For the set 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 ("bunching probability"), and use this to proxy whether they are bunching to smooth volatility or to systematically retain income and access lower future rates. We group owner-managers into quintiles on the basis of their bunching probability.

Figure 5.3(a) shows that owner-managers who bunch in fewer than 50% 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 50% 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.[35]

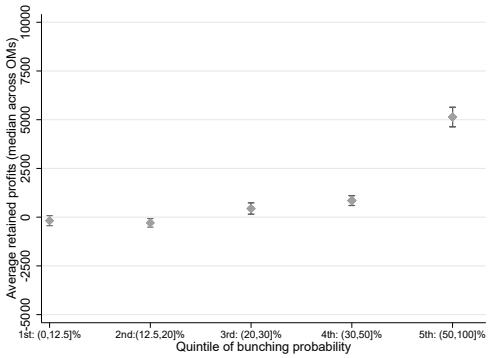
[35]Figure 5.3 uses the fraction of years that an owner-manager bunches regardless of how many years an owner-managers appears in the sample. The results – including estimates of the share of responsiveness accounted for by smoothing volatility shown in Figure 5.4 below – are robust to conditioning on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

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

(a) Total and taxable income



(b) Retained earnings



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 quintiles based on this fraction, 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.

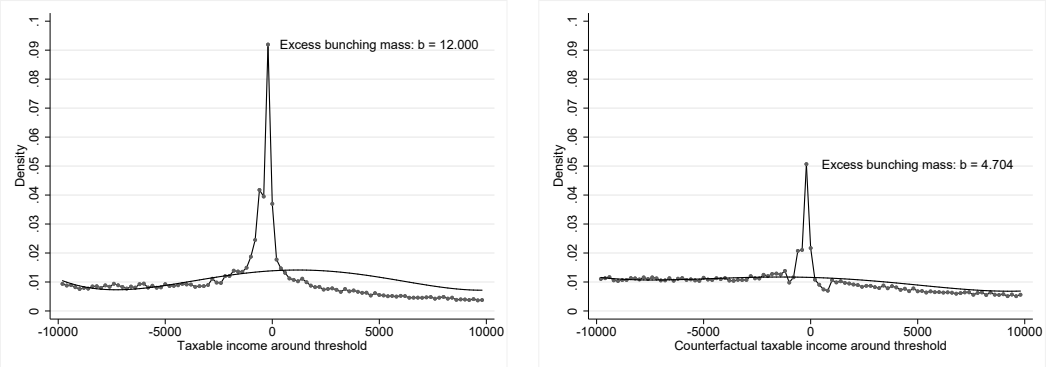
We define "sometimes bunchers" as owner-managers who bunch at the threshold less than or equal to half of the time we observe them in the sample and "consistent bunchers" as those who bunch at the threshold more than half of the time we observe them. The bunching behaviour of "sometimes bunchers" is 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).

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.[36] 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.

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.

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

[36] In Appendix D.2, we show how the amount of excess mass explained by "sometimes bunchers" varies when we define these as those who bunch less than 25%, 50% and 75% of the time.

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.[37] 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' equity to proxy retained profits [38], 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 is 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.

[37] 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.

[38] 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 profits (conditional on a level of liabilities) will appear as a one-for-one change in shareholder equity.

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

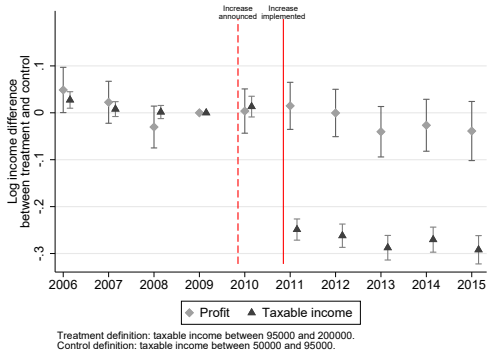
Figure 5.5(a) shows the estimated coefficients from equations (5.1) and (5.2); these are relative to 2009, the omitted year. Taxable income evolves similarly for the treatment and control group in the pre-reform period; for profit, there is some evidence of a decline in the treatment relative to the 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 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

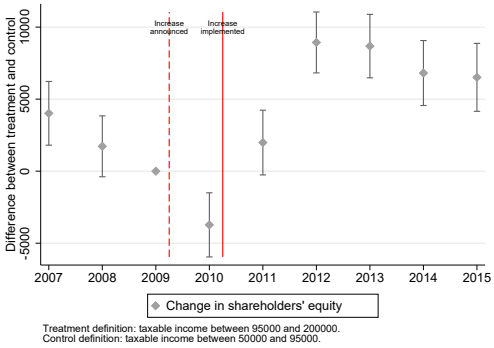
future tax rates), owner managers persistently retained more income within their company. The estimated negative coefficient in 2010 is consistent with bringing forward dividend payments, and thus reducing shareholder equity, in anticipating of the reform. This is a form of short run shifting of taxable income in order to avoid a higher marginal tax rate.

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.

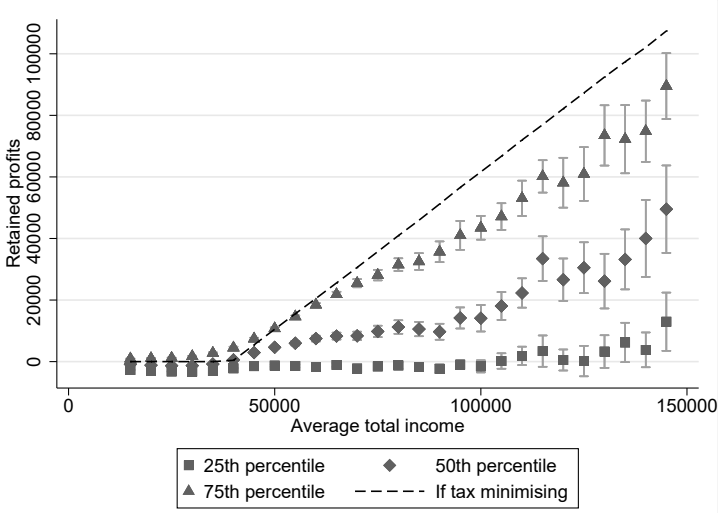
5.2 Who retains profits and how do they invest them?

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 the threshold retain substantial amounts, even if they are not "fully retaining". Figure 5.6 shows that 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.

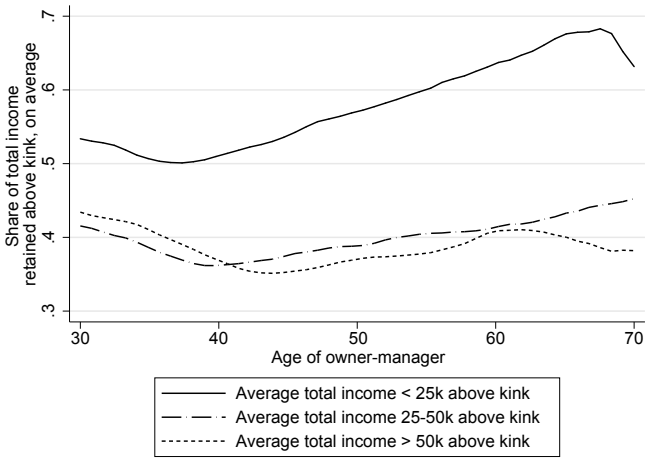
Figure 5.6: *Retained profits across the total income distribution*



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.

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. Figure 5.7 shows 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.

Figure 5.7: *Retained profits, by age*



Notes: For each owner-manager we calculate the the share of total income above the higher rate threshold that each owner-manager retains, on average, over the period that we observed them in the data. The figure 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.

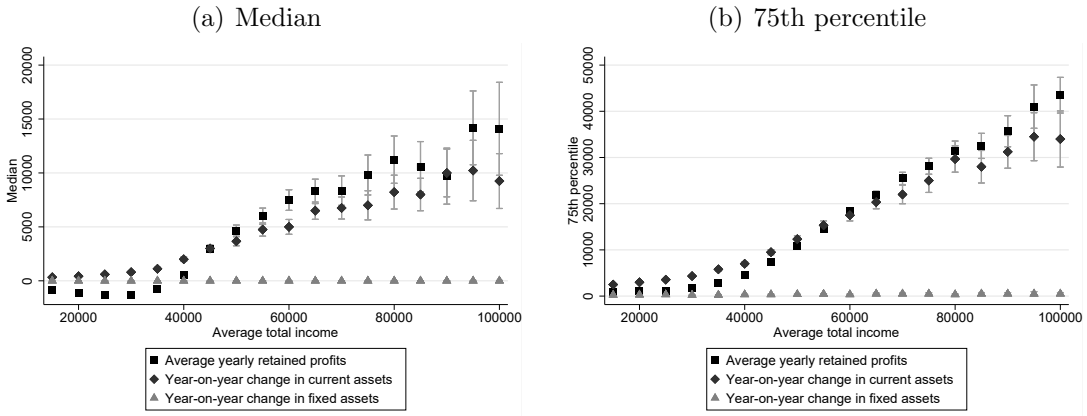
Policy makers often support lower capital gains tax rates (relative to taxes on salaries or dividends) as a mechanism to encourage business owners to invest in their own enterprises.[39] Here we provide evidence that tax induced increases in retained profits do not lead to higher business investment. 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 profits 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 profits 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 profits (and therefore portfolio choices distorted) if the rate of return on investment relative to a cash asset is increasing in the size of retained profits. 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.

[39]Part of the rationale often relates to encouraging new start-ups, which are outside the scope of this analysis.

First, we construct, for each owner-manager, the average year-on-year change in current and fixed assets. Figure 5.8 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.[40] This suggests that retained profits are held as cash, or cash equivalents, and not invested in the company's productive capital.

Figure 5.8: *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.[41] That is, we consider whether tax induced increases in retained profits make it more

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

[41] 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" 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.

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 5.9(a) shows that there is no difference in the capital investment of the treatment compared with the control group following the reform for the full sample of companies. Figure 5.9(b) shows that for a sub-sample of "high fixed asset companies", which are defined as those with an average fixed asset holding of above £100,000 over our sample period, the year immediately preceding the reform, 2009, had lower levels of investment than either the pre- (2007-8) or post- (2011-15) period, likely capturing depressed investment during the Great Recession. This is consistent with evidence that the large fall in UK investment following the financial crisis happened in 2009 and was driven by large firms reducing the number of investment projects they undertook (Disney et al. (2019)). The fact that we see little to 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.

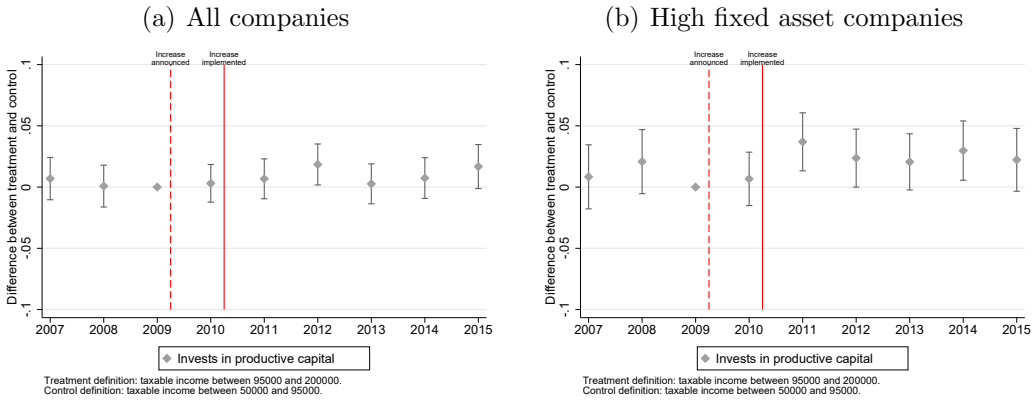
Finally, there is evidence that owner-managers retain income in their companies in cash or equivalent assets for long periods in order to access lower tax rates (accountants in the UK refer to this practice as "moneyboxing"). Those owner-managers with average total income above the higher rate threshold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

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.[42] This rises to almost half for those with shareholders' equity that exceeds £100,000 during our sample period. There is a strong positive, close to one-for-one, relationship between the level of eligible capital gains on which relief was claimed and the value of shareholders'

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

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

Figure 5.9: *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. The left hand panel shows the estimates for all companies, and the right hand panel shows the estimates for "high fixed asset companies", which are defined to be those with an average fixed asset holding of above £100,000 over our sample period.
Source: Calculations based on HMRC administrative datasets.

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

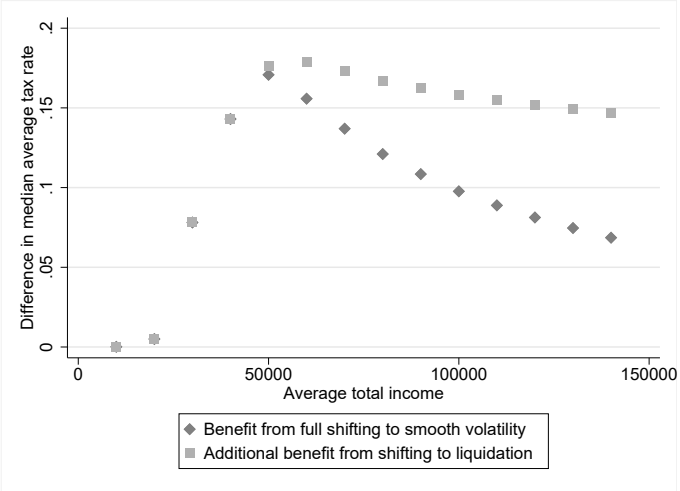
Around half of the observed responsiveness of owner-managers' taxable income to the kink at the higher rate threshold can be attributed to intertemporal shifting that allows volatility in total income to be smoothed. The benefits of "tax smoothing" have been widely discussed, particularly in the context 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 especially 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. Figure 6.1 shows the benefits (expressed in terms of average tax rates) from different shifting strategies at different levels of average total income. Owner-managers with incomes close to the kink benefit the most from shifting to smooth volatility, while those with higher incomes benefit proportionately more from the ability to shift income to liquidation.

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 available to the UK self-employed (those running unincorporated businesses) nor to owner-managers operating in tax systems that tax business 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.[43] 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.

[43] 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)).

Figure 6.1: *Benefits of different intertemporal income shifting strategies*



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 (mean across years) average tax rate that they would pay if they withdrew annual total income earned each year. We also calculate average tax rates under the assumption that they fully shifted to account for income volatility, and if they additionally shifted any income to liquidation. The figure shows the difference between the ATR under shifting only to smooth volatility and no shifting, and the additional reduction in ATR achieved by shifting to liquidation, for different income levels.
Source: Calculations based on HMRC administrative datasets.

6.2 Efficiency cost of taxation

Our theoretical analysis suggests that shifting to smooth income volatility around tax kinks likely does not lead to large distortions but that the systematic retention of profits may do so. 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. This 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.3 – 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).[44] 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 smooth volatility) and total income – see equation (4.1), 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 (4.1) 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 (4.1) 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

[44] 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.

-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 institutional context. In 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 to minimise tax avoidance, avoid distorting choices and limit post-tax inequality.

Reduced headline rates are not well targeted at removing distortions to investment – they reduce but do not remove taxation of the normal rate of return and also apply to excess returns.[45] Using taxes to encourage investment (as opposed to having a tax system that is neutral with regard investment decisions) 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

[45] Ensuring that taxes do not deter marginal investments is best achieved through careful design of the tax base, rather than through lower rates, see Mirrlees et al. (2011).

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 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. 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 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.

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 and this is often driven by avoidance behaviour. By accurately measuring 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. We build on the prior literature by theoretically and empirically distinguishing between different motivations for shifting and their efficiency implications, and studying the effects on business investment.

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, 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. Those working for their own business usually have significant flexibility over their labour supply, making it highly plausible that, absent the ability to shift intertemporally or engage in other forms of avoidance and evasion, 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.

References

Adam, S., H. Miller, and T. Pope (2017). Tax, legal form and the gig economy. In *Green Budget 2017*, Volume 2017. London: IFS.

Advani, A. and A. Summers (2020). How much tax do the rich really pay? New evidence from tax microdate in the UK. *CAGE Policy Briefing no.27*.

Alstadsæter, A. and E. Fjærli (2009, August). Neutral taxation of shareholder income? Corporate responses to an announced dividend tax. *International Tax and Public Finance 16*(4), 571–604.

Alstadsæter, A., W. Kopczuk, and K. Telle (2014). Are Closely Held Firms Tax Shelters? *Tax Policy and the Economy 28*(1).

Auerbach, A. J. (1979). Wealth maximization and the cost of capital. *Quarterly Journal of Economics 93*(3), 433–446.

Bastani, S. and H. Selin (2014, January). Bunching and non-bunching at kink points of the Swedish tax schedule. *Journal of Public Economics 109*, 36–49.

Blomquist, S. and W. K. Newey (2017). The bunching estimator cannot identify the taxable income elasticity. *Uppsala Center for Fiscal Studies, mimeo*.

Bradford, D. (1982). The choice between income and consumption taxes. *Tax Notes 16*, 715–723.

Bradford, D. F. (1981). The incidence and allocation effects of a tax on corporate distributions. *Journal of Public Economics 15*(1), 1–22.

Brockmeyer, A. (2014). The investment effect of taxation: Evidence from a corporate tax kink. *Fiscal Studies 35*(4), 477–509.

Caballero, R. J. (1999). Aggregate investment. *Handbook of Macroeconomics 1*, 813–862.

Chetty, R. (2009a, August). Is the Taxable Income Elasticity Sufficient to Calculate Deadweight Loss? The Implications of Evasion and Avoidance. *American Economic Journal: Economic Policy 1*(2), 31–52.

Chetty, R. (2009b). Sufficient Statistics for Welfare Analysis: A Bridge Between Structural and Reduced-Form Methods. *Annu. Rev. Econ. 1*(1), 451–488.

Chetty, R., J. N. Friedman, T. Olsen, and L. Pistaferri (2011, May). Adjustment Costs, Firm Responses, and Micro vs. Macro Labor Supply Elasticities: Evidence from Danish Tax Records. *Quarterly Journal Of Economics 126*(2), 749–804.

Chetty, R. and E. Saez (2005). Dividend Taxes and Corporate Behavior: Evidence from the 2003 Dividend Tax Cut. *Quarterly Journal of Economics 120*(3), 791–833.

Cooper, R. and J. Haltiwanger (1993). The Aggregate Implications of Machine Replacement: Theory and Evidence. *American Economic Review 83*(3), 360–82.

Cooper, R., J. Haltiwanger, and L. Power (1999). Machine Replacement and the Business Cycle: Lumps and Bumps. *American Economic Review 89*(4), 921–946.

Cooper, R. W. and J. C. Haltiwanger (2006). On the nature of capital adjustment costs. *Review of Economic Studies 73*(3), 611–633.

Crawford, C. and J. Freedman (2010). Small Business Taxation. In *Dimensions of Tax Design*.

Cribb, J., H. Miller, and T. Pope (2019). Who are business owners and what are they doing? *IFS Report*.

de Mooij, R. A. and G. Nicodème (2008, August). Corporate tax policy and incorporation in the EU. *International Tax and Public Finance 15*(4), 478–498.

DeBacker, J. M. and R. Prisinzano (2015). The rise of partnerships. *Tax Notes 147*(13), 1563–75.

Disney, R., H. Miller, and T. Pope (2019). Firm-level Investment Spikes and Aggregate Investment over the Great Recession. *Economica*.

Doms, M. and T. Dunne (1998). Capital Adjustment Patterns in Manufacturing Plants. *Review of Economic Dynamics 1*(2), 409–429.

Feldstein, M. (1995). The Effect of Marginal Tax Rates on Taxable Income: A Panel Study of the 1986 Tax Reform Act. *Journal of Political Economy 103*(3), 551–572.

Feldstein, M. (1999). Tax Avoidance and the Deadweight Loss of the Income Tax. *Review of Economics and Statistics 81*(4), 674–680.

Goolsbee, A. (1998). Taxes, organizational form, and the deadweight loss of the corporate income tax. *Journal of Public Economics 69*(1), 143–152.

Goolsbee, A. (2000). What Happens When You Tax the Rich? Evidence from Executive Compensation. *Journal of Political Economy 108*(2), 352–378.

Gordon, R. and Sarada (2018). How should taxes be designed to encourage entrepreneurship? *Journal of Public Economics 166*, 1–11.

Gordon, R. H. and J. K. MacKie-Mason (1994). Tax distortions to the choice of organizational form. *Journal of Public Economics 55*(2), 28.

Gordon, R. H. and J. B. Slemrod (2000). Are" Real" Responses to Taxes Simply Income Shifting Between Corporate and Personal Tax Bases? *Does Atlas Shrug?: The Economic Consequences of Taxing the Rich*, 240.

Gorry, A., K. A. Hassett, R. G. Hubbard, and A. Mathur (2017, July). The response of deferred executive compensation to changes in tax rates. *Journal of Public Economics 151*, 28–40.

Gorry, A., R. G. Hubbard, and A. Mathur (2018). The Elasticity of Taxable Income in the Presence of Intertemporal Income Shifting. Working Paper 24531, National Bureau of Economic Research.

Hanlon, M. and J. L. Hoopes (2014, October). What do firms do when dividend tax rates change? An examination of alternative payout responses. *Journal of Financial Economics 114*(1), 105–124.

Harju, J. and T. Matikka (2016, August). The elasticity of taxable income and income-shifting: What is "real" and what is not? *International Tax and Public Finance 23*(4), 640–669.

Humphries, J. E. (2017). *The Causes and Consequences of Self-Employment over the Life Cycle*. PhD Thesis, The University of Chicago.

Kleven, H. J. (2016). Bunching. *Annual Review of Economics 8*(June).

Kleven, H. J. and M. Waseem (2013, May). Using Notches to Uncover Optimization Frictions and Structural Elasticities: Theory and Evidence from Pakistan. *Quarterly Journal of Economics 128*(2), 669–723.

Kopczuk, W., E. Saez, and J. Song (2010, February). Earnings Inequality and Mobility in the United States: Evidence from Social Security Data since 1937 *. *Quarterly Journal of Economics 125*(1), 91–128.

Kreiner, C. T., S. Leth-Petersen, and P. E. Skov (2014, May). Year-End Tax Planning of Top Management: Evidence from High-Frequency Payroll Data. *American Economic Review 104*(5), 154–158.

le Maire, D. and B. Schjerning (2013). Tax bunching, income shifting and self-employment. *Journal of Public Economics 107*, 1–18.

Looney, A. (2017). The next tax shelter for wealthy Americans: C-corporations. *Brookings*.

MacKie-Mason, J. K. and R. H. Gordon (1997). How much do taxes discourage incorporation? *Journal of Finance 52*(2), 477–506.

Meade, J. (1978). *The Structure and Reform of Direct Taxation: Report of a Committee Chaired by Professor J.E. Meade for the Institute for Fiscal Studies*. London: George Allen & Unwin.

Mirrlees, J., S. Adam, T. Besley, R. Blundell, S. Bond, R. Chote, M. Gammie, P. Johnson, G. Myles, and J. M. Poterba (2011). *Tax by Design*. Oxford University Press.

Nilsen, Ø. A. and F. Schiantarelli (2003). Zeros and lumps in investment: Empirical evidence on irreversibilities and nonconvexities. *Review of Economics and Statistics 85*(4), 1021–1037.

Piketty, T., E. Saez, and S. Stantcheva (2014, February). Optimal Taxation of Top Labor Incomes: A Tale of Three Elasticities. *American Economic Journal: Economic Policy 6*(1), 230–271.

Saez, E. (2010). Do Taxpayers Bunch at Kink Points? *American Economic Journal: Economic Policy 2*(3), 180–212.

Slemrod, J. (1995). Income Creation or Income Shifting? Behavioral Responses to the Tax Reform Act of 1986. *American Economic Review 85*(2), 175–180.

Slemrod, J. and S. Yitzhaki (2002). Tax Avoidance, Evasion, and Administration. *Handbook of Public Economics 3*, 1423–1470.

Smith, M., D. Yagan, O. Zidar, and E. Zwick (2019). Capitalists in the Twenty-First Century. *Quarterly Journal of Economics*.

Smith, M., D. Yagan, O. Zidar, E. Zwick, and C. Booth (2019). The Rise of Pass-Throughs and the Decline of the Labor Share. pp. 27.

Smith, M., O. Zidar, and E. Zwick (2019). Top Wealth in the United States: New Estimates and Implications for Taxing the Rich. pp. 68.

Yagan, D. (2015, December). Capital Tax Reform and the Real Economy: The Effects of the 2003 Dividend Tax Cut. *American Economic Review 105*(12), 3531–3563.

Zodrow, G. R. (1991). On the "Traditional" and "New" views of dividend taxation. *National Tax Journal* (4), 13.

Appendix

For Online Publication

Intertemporal income shifting and the taxation of business owner-managers

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. 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. There are 2.2 million such companies. We are interested in annual flows, and so for comparability we drop tax records covering less than 12 months, which leaves 2.0 million companies.

Table A.1 shows that in 2% of cases information on the number of directors is missing and in 23% of cases the number of shareholders is missing. 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 2.1.

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

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.

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 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.

A.4 Personal income tax data

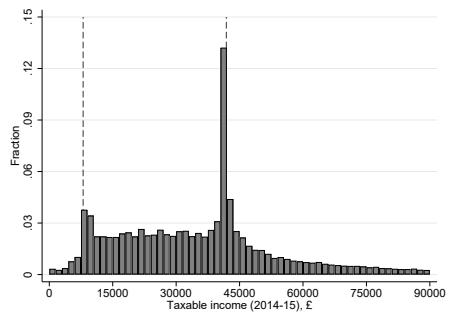
Information on the owner-managers of closely held companies is taken from the universe of self–assessment income tax records, available from 1997-98 to 2015-16. All company directors are required to submit a self-assessment tax return. This data includes information on the taxable incomes of the individuals, 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

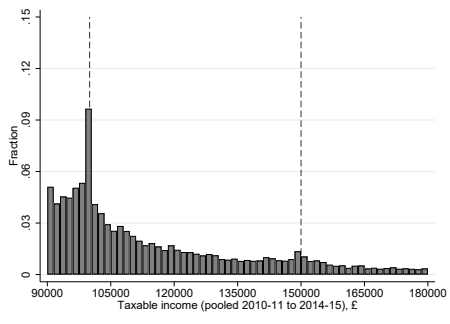
Figure 3.2 in the main paper presents the taxable income distribution for matched directors of all closely held companies in 2014-15 up to £90,000, and pooled between 2010-11 and 2014-15 above £90,000. Figure A.1 shows the distributions for matched directors of the subset of closely held companies that have only one director and one shareholder. The distributions do not change markedly across years.

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.

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

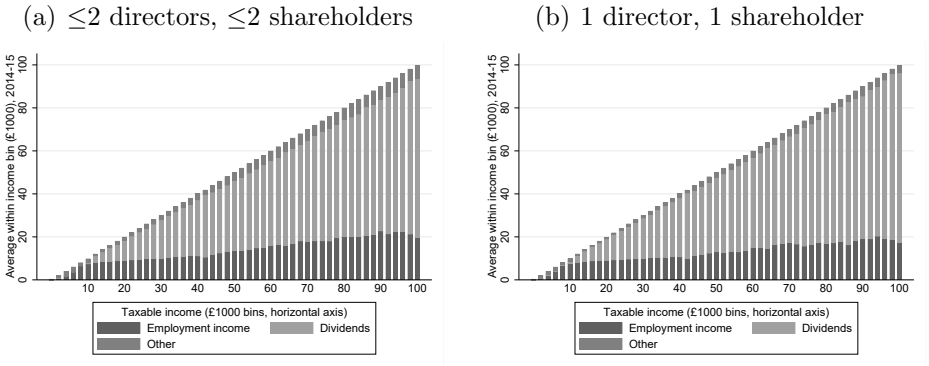
(1)	(2)	(3)	(4)	(5)	(6)
	All companies	$\leq$ 2 directors, $\leq$ 2 shareholders		1 director, 1 shareholder	
Industry (SIC code)	Number	Number	Share of industry	Number	Share of industry
Other business activities (74)	329,736	245,592	74.5	81,044	24.6
Construction (45)	145,103	109,556	75.5	29,814	20.5
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.

Composition of owner-manager taxable income

Figure A.2 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 dividends, which is consistent with the within-year tax minimizing way to withdraw income from the company described in Section 3.

Figure A.2: *Composition of owner-manager taxable income at different income levels, 2014-15*



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.4 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.4 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.3 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.

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.

We estimate $var(\ln z_{it}) = 1.481$, and the share of the variation in log total income is due to the transitory component, $\frac{var(\varepsilon_{it})}{var(\ln z_{it})} = 0.43$. 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

Table A.4: *Comparison of matched closely held companies and the full population*

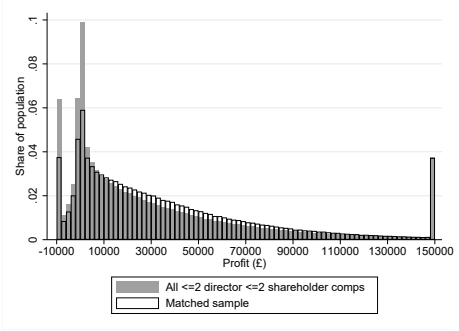
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
		≤ 2 directors, ≤ 2 shareholders								1 director, 1 shareholder							
		Full sample				Matched sample				Full sample				Matched sample			
Source	Variable	Mean	Median	P10	P90	Mean	Median	P10	P90	Mean	Median	P10	P90	Mean	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.

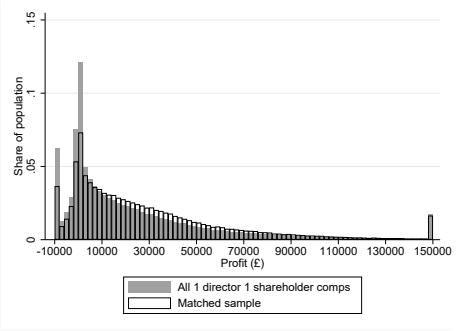
Source: Authors' calculations using HMRC administrative datasets.

Figure A.3: *Distributions of turnover, profits and assets between company populations and matched samples*

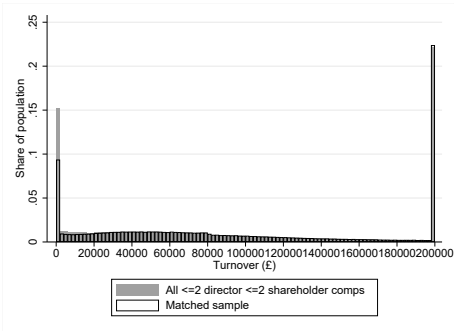
(a) Profit, ≤2 directors, ≤2 shareholders



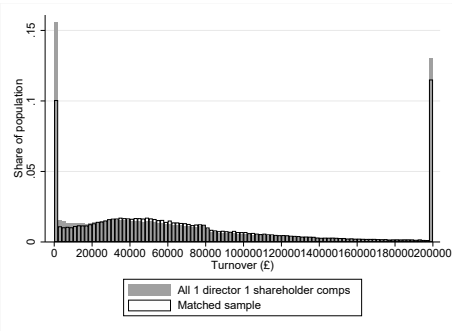
(b) Profit, 1 director, 1 shareholder



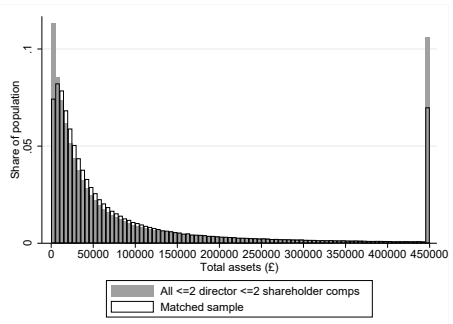
(c) Turnover, ≤2 directors, ≤2 shareholders



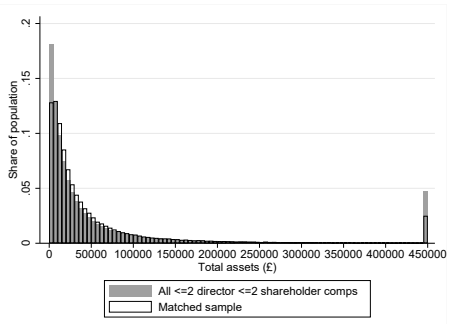
(d) Turnover, 1 director, 1 shareholder



(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.

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

Table B.1 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.

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 Theoretical analysis

Here we provide further details on the analysis summarised in Section 4.

Table B.1: *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.*

C.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:

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t[u(c_t)-\psi(l_t)], \tag{C.1}$$

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: $y_t = z_t - a_t - i_t$. [46] 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: $c_t = y_t - \mathcal{T}(y_t) - s_t$.

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:

$$k_{t+1} = (1-\delta)k_t + i_t \tag{C.2}$$

$$A_{t+1} = (1+r)(A_t + a_t) \tag{C.3}$$

$$S_{t+1} = (1+r)(S_t + s_t) \tag{C.4}$$

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.[47] 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 (C.1) subject to the period budget constraints, the laws of motion (C.2) – (C.4), and the borrowing

[46] 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.

[47] 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).

constraints. The first order conditions are:

$$u_{ct} \cdot f_{lt} \cdot (1 - \mathcal{T}'_t) = \psi'_t \tag{C.5}$$

$$u_{ct} \cdot (1 - \mathcal{T}'_t) = \beta \mathbb{E}[u_{ct+1} \cdot (f_{kt+1} - (1 - \delta)) \cdot (1 - \mathcal{T}'_{t+1})] \tag{C.6}$$

$$u_{ct} \cdot (1 - \mathcal{T}'_t) = \beta(1 + r)\mathbb{E}[u_{ct+1} \cdot (1 - \mathcal{T}'_{t+1})] + \lambda^A_t \tag{C.7}$$

$$u_{ct} = \beta(1 + r)\mathbb{E}[u_{ct+1}] + \lambda^S_t \tag{C.8}$$

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^A_t and λ^S_t denote the Lagrange multipliers on the borrowing constraints.

C.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 (C.5)). The tax rate drops out of conditions (C.6) – (C.8) i.e. intertemporal allocations are unaffected. The owner-manager is indifferent between saving (or borrowing) in the company or 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 (C.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:

$$\mathcal{T}(y_t) = \tau_0 \min(y_t, y^K) + \tau_1 \max(y_t - y^K, 0) \tag{C.9}$$

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 take advantage of a lower future tax rate

As discussed in the main text, 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.

Investment

As highlighted in Section 3, personal taxes do not directly affect the incentive to use retained profits 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 (C.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.[48] 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. As discussed further in the main text, 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.

C.3 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:

$$W(\tau_1) = \int_{i \in \mathcal{I}} \max_{\{x_{it}\}_{t=1}^{\infty}} \mathbb{E} \sum_{t=1}^{\infty} \beta^t [U_i(x_{it}) + \sum_{m=1}^{M} \lambda_m G_m(x_{it}, \tau_{p1}, R_t)] di \tag{C.10}$$

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

[48] 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 $\mathbb{E}[u_{ct+\bar{T}}(1-\tau_k)\big((1+r)^{\bar{T}} - (f_{kt+\bar{T}} - (1-\delta))^{\bar{T}}\big]$.

tax rate, τ_{p1} is given by:

$$\frac{dW}{d\tau_1} = \int_{i\in\mathcal{I}} \mathbb{E} \sum_{t=1}^{\infty} \beta^t \left[\sum_{m=1}^{M} \lambda_m \left(\frac{\partial G_m}{\partial R_t} \frac{dR_t}{d\tau_{p1}} + \frac{\partial G_m}{\partial \tau_{p1}} \right) \right] di \tag{C.11}$$

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:

$$\begin{aligned} R_t &= \tau_{p1} \int_{i\in\mathcal{I}} y_{it} di + \tau_{pk} \left(\int_{i\in\mathcal{I}} z_{it} di - \int_{i\in\mathcal{I}} y_{it} di \right) + \frac{\tau_c}{1-\tau_c} \int_{i\in\mathcal{I}} z_{it} di & \text{(C.12)} \\ &= \tau_{p1} \bar{y}_t + \tau_{pk} (\bar{z}_t - \bar{y}_t) + \frac{\tau_c}{1-\tau_c} \bar{z}_t & \text{(C.13)} \end{aligned}$$

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.11) 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:

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

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

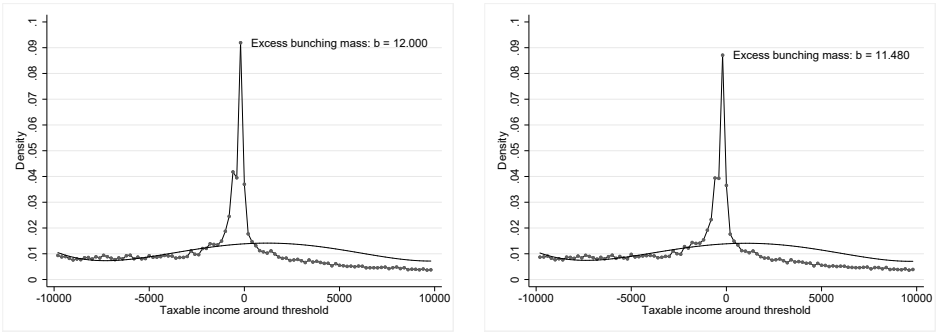
In our bunching analysis in Section 5.1 we use the sample of one director, one shareholder companies that are present in the data for at least three years. This is so we can analyse their average total income, and also calculate the fraction of years that we observe them bunching, in order to distinguish 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.

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.

Figure D.2 shows how the estimated mass at the higher rate threshold changes when we remove those that bunch less than 25%, 50%, and 75% of the time.

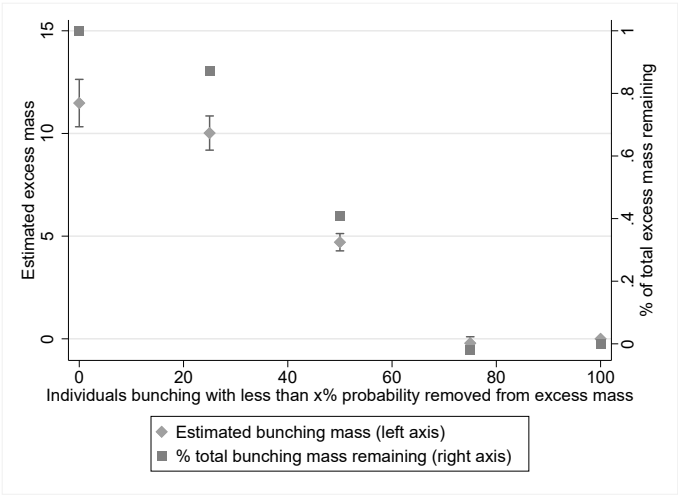
Figure D.1: *Bunching in annual taxable around the higher rate threshold, one director one shareholder companies*

(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.

Figure D.2: *Bunching mass explained by different types of bunchers*



Notes: The figure shows the excess bunching mass once we remove those that bunch less than 25%, 50%, and 75% of the time, as well as the share of total excess mass accounted for by those who bunch less than 25%, 50%, and 75%. Method to estimate the bunching mass is described in the text.
Source: Calculations based on HMRC administrative datasets.

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 5.9.

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

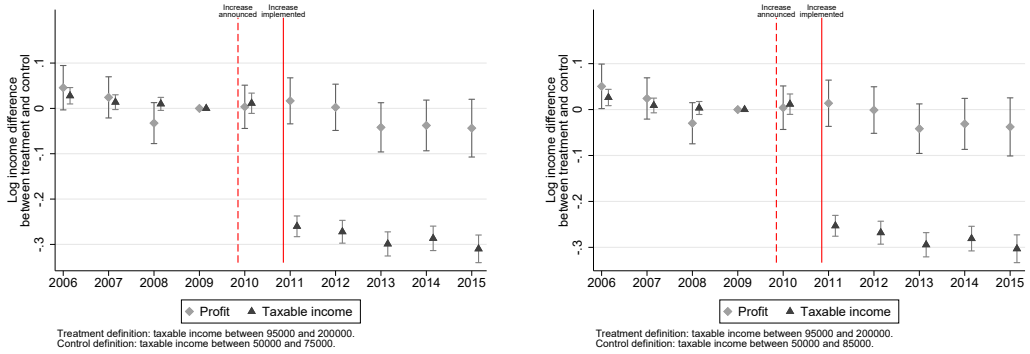
Notes: Table shows the coefficient estimates from the estimated equations (5.1)-(5.3) (columns (2)–(4)) and (5.4) column (5). Robust standard errors are show in parentheses. There are more directors than companies because some companies have two directors. $\ln \pi_{ft}$ *is missing if* π_{ft} *is negative. 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

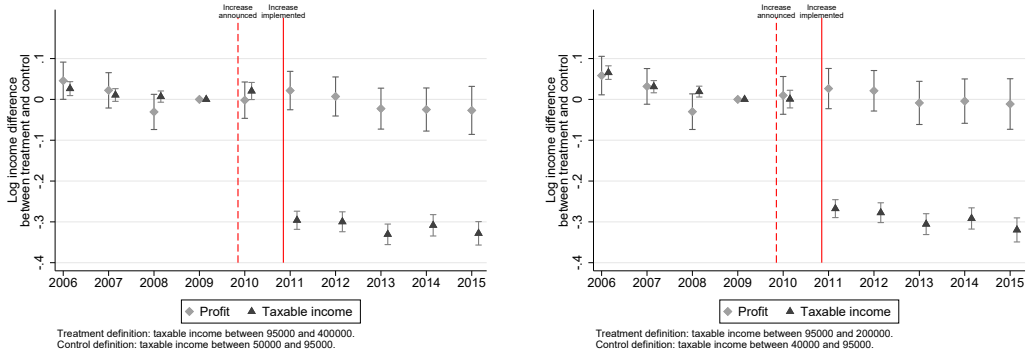
We define the treatment and control groups on the basis of the taxable income of owner-managers in the pre-reform period. Figure D.3 shows robustness to alternative income cutoffs used to define the treatment and control groups.

Figure D.3: *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



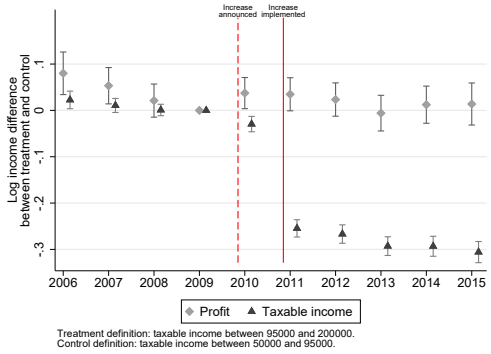
Notes: Each panel shows the estimated $\beta_s^{taxable}$ coefficients from equation (5.1); grey markers show the estimated β_s^{profit} coefficients from equation (5.2) using different income cutoffs to define the treatment and control groups. In all cases, the treatment and control groups are defined 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

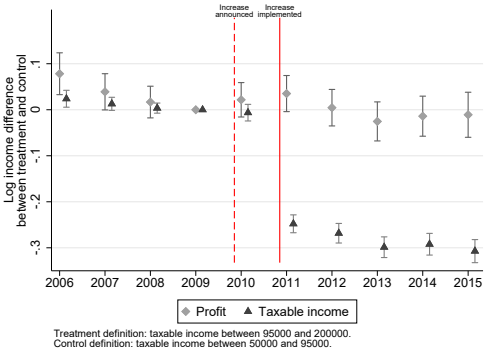
In our baseline estimate we require that we observe owner-managers for the full pre-reform period (i.e. over 2005/6 to 2008/9 tax years) to construct the treatment and control groups. Panels (a)–(c) of Figure D.4 show that our results are robust to relaxing this requirement to only observing owner-managers in at least 1, 2, and 3 years of the pre-reform period. Finally, panel (d) of D.4 shows that we get similar results when we use a balanced panel.

Figure D.4: *Robustness to alternative treatment and control group definitions*

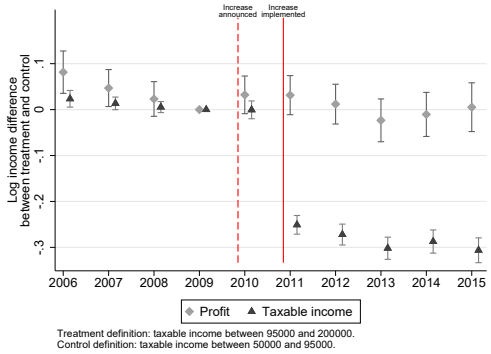
(a) At least 1 year in pre-reform period



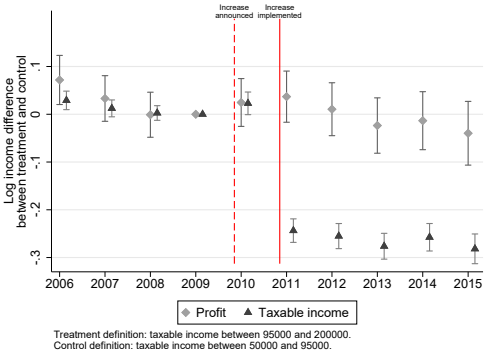
(b) At least 2 years in pre-reform period



(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.