Capital taxation and entrepreneurship

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Abstract

[PRELIMINARY – PLEASE DO NOT CIRCULATE]

We develop and estimate a dynamic model to study the impact of personal capital tax reforms on small business formation, exit and investment, as well as over the legal form of the business and the shifting of income across tax bases and time. We estimate the model using novel linked administrative data on UK business owners and identify key parameters by exploiting policy variation from tax kinks and reforms. Our estimation procedure explicitly accounts for the rich heterogeneity in small businesses, which range from high investment, entrepreneurial firms, to those whose profit mainly reflects the labour returns of their owners. Removing the UK's preferential capital gains tax rate for business owners leads to switching in business legal form, but no change in the overall number of small businesses. It raises revenue from high income business owners, with only a small fall in aggregate investment. Tax base reforms that reduce the upfront cost of capital investment, such as tax credits for new equity investments, are better targeted at investment than lower capital gains tax rates. Combining base reform with higher rates can boost tax revenue *and* investment.

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1 Introduction

Small businesses and start-ups are widely perceived to be engines of growth.[1] They are a large and increasingly important part of the workforce in many countries.[2] It is common for governments to give them preferential tax treatment, in the hope that this will boost entrepreneurial activity. But these tax breaks are also costly, encouraging tax avoidance through income shifting and tax-motivated incorporation. They create horizontal inequities and limit the ability to redistribute from rich to poor, as business owners are disproportionately at the top of the income distribution.[3] There is, therefore, a desire by some policymakers to raise personal capital income tax rates, but concerns about the impact that this will have on investment and entrepreneurship.

In this paper, we address two questions. First, what is the impact of raising personal capital tax rates on small business outcomes? Second, are there alternative tax policies that are better targeted at entrepreneurial investment? We develop a dynamic model that allows us to study the long-run effects of policy changes and consider counterfactual reforms. We model choices over small business formation, exit, investment and the owner's labour supply, in addition to decisions over the legal form of the business and the shifting of income across tax bases and time. We estimate the model using novel linked administrative data on the universe of small business owners in the UK, and identify key parameters by exploiting policy variation from tax kinks and reforms. Our estimation process explicitly accounts for heterogeneity across types of business, for example, distinguishing between high investment, entrepreneurial firms, and those whose profit mainly reflects the labour returns of their owners.

We find that removing the UK's preferential rate of capital gains tax for business owners leads to switching in business legal form, but no change in the overall number of small businesses. There is a small fall in investment, driven entirely by behaviour on the intensive margin. Tax base reforms that reduce the upfront cost of capital investment, such as tax credits for new equity investments, are better targeted at investment than lower capital gains tax rates. Combining base reform with higher rates can boost tax revenue *and* aggregate investment. High investment small businesses do better under such reforms, while high income business owners receiving predominantly disguised labour income lose out.

[1] Haltiwanger et al. (2013) show that young firms tend to grow faster than incumbents, and Haltiwanger et al. (2017) document that start-ups accounts for about 40% of aggregate growth in total factor productivity.

[2] Small business owners make up more than 1/3 of the UK workforce (Cribb et al. (2019)), and over half of US business income accrues to sole proprietorships, partnerships and S-corporations (Cooper et al. (2016)).

[3] See, Smith et al. (2019).

The UK provides an ideal setting to learn broader lessons about the impact of tax on small businesses due to the combination of policy variation and rich administrative data. There are large and salient differences in the tax treatment of legal forms that business owners can choose. Notably, incorporation (compared with self-employment) offers access to lower tax rates and the ability to shift taxable income intertemporally, however, the tax system discourages new equity investments in incorporated firms. There are also non-tax differences, with incorporation offering limited liability but having higher reporting and compliance requirements. We use administrative tax records on the universe of small business owners in the UK over the period 2001-16. Importantly, we have access to the personal tax records of owner-managers linked to the corporate tax records of their companies, which gives us a full picture of business operation. The number of company owner-managers (incorporated business owners) almost doubled between 2001 and 2014, while the number of self-employed (unincorporated business owners) increased by just under 50% over the same period.

Consistent with findings in the existing literature, we show that small business owners respond to tax at both the extensive and intensive margins. In the early 2000s, there was a 0% starting rate of corporation tax on the first £10,000 of profit. This led to a large increase in the number of new owner-managers, particularly among lower profit businesses, which had the largest proportional gains from incorporating. Around half the increase was from people who were previously self-employed (and therefore already running a business), with the rest from people who were not self-employed in the previous year. Small business owners also respond to marginal tax increases at the intensive margin: there is evidence of bunching at kinks in tax thresholds by owner-managers and the self-employed. The bunching is larger for owner-managers than for the self-employed, reflecting the fact that they can easily shift taxable income across years, as shown by Miller, Pope, and Smith (2020).

We develop a dynamic model that is designed to capture the key dimensions of small business ownership and its interaction with the tax system, including the various margins of response described above. Individuals choose whether to start a business, on the basis of their expected productivity as a business owner, and later have the choice to exit, if they receive a bad productivity shock. Business owners choose how much to invest in productive capital and how much labour to supply. They also choose the legal form of the business i.e. to be incorporated (owner-managers) or not (self-employed). The tax treatment of these legal forms differs and we also allow for there to be non-tax costs (or benefits) associated with

incorporation. Owner-managers have the ability to shift taxable income across time and tax bases. Individuals also choose consumption and saving in a personal cash asset.

There is substantial heterogeneity in the small business population, a fact also documented by Humphries (2017) and Levine and Rubinstein (2017). Some businesses make considerable investments and engage in innovative activity, but many do not.[4] There are a substantial number that operate as vehicles through which their owners sell their own labour. Gordon and Sarada (2018) emphasise that understanding the nature of the market failures underpinning the underprovision of entrepreneurial activity is crucial to the effective policy design. We allow for flexible heterogeneity in the model parameters, in order to study how policy reforms affect different business types. We follow the approach of Bonhomme et al. (2021) and use a k-means clustering approach to group business owners into latent "types", based on average profit and investment choices. This gives a parsimonious grouping that captures key dimensions of variation. For example, at one extreme are low profit, self-employed business owners who invest little. At the other extreme are high profit, low investment businesses, who are predominantly owner-managers and are concentrated in business services. In the middle are the individuals who do the most investment, and are more likely to be in manufacturing and agriculture.

We estimate the model using a two-step procedure. In the first step, we calibrate a number of parameters using data and existing evidence. In the second step, we use the simulated method of moments to identify the remaining parameters. We use variation in tax environments to help identify different features of the model. For example, we match the changes in incorporation rates associated with the 0% starting rate of corporation tax to identify the distribution of incorporation costs. The model is able to match reduced-form evidence on the responsiveness of small businesses to tax changes. For instance, the model generates bunching at the higher rate threshold, and the increase in retained profits for owner-managers earning profits beyond this point.

We use the model to assess the impact of policy reforms and to study the channels through which they operate. We first consider a reform that removes the lower rate of capital gains tax for business owners, which currently provides them with an incentive to retain profits within their company until they liquidate it.[5] Removing this tax break reduces the number of owner-managers, particularly at higher profit levels, but this is entirely offset by a corre-

[4] Evidence from survey data suggests that small businesses that plan on investing are much more likely to launch new products or services.

[5] "Entrepreneur's Relief" allowed people to claim a lower 10% rate of capital gains tax on the disposal of business assets from 2008 through to 2020. In the March 2020 Budget it was renamed "Business Asset Disposal Relief"

sponding increase in the number of self-employed. This is because, for the vast majority of owner-managers, they prefer running an unincorporated business to not running a business at all. Thus, reducing the tax advantages associated with being an owner-manager affects the margin between incorporation and not, but does not affect the incentive to start a small business. There is a small fall in aggregate small business investment, driven by reductions on the intensive margin by existing owner-managers. Removing this preferential rate increases the tax revenue raised from small businesses by 3.2%, 39% of which comes from the top 1% of business owners making more than £100,000 in profit.

We then consider reforms to the capital tax base that are designed to target investment directly. Specifically, we consider the impact of tax credits for new equity investments made by company owner-managers.[6] We find that a 10% tax credit leads to an increase in aggregate small business investment of almost 4%, with a decline in tax revenue of 0.55%. The fact that the credit is provided upfront acts to relax the capital constraint faced by some businesses owners: we find larger increases in investment for those businesses who were previously capital constrained. Reforms to the capital tax rates and base can be combined to more effectively target small business investment. For example, removing the preferential rate of capital gains tax and accompanying this with a 5% tax credit for new equity investment leads to a 3% increase in tax revenue and a 1.2% increase in aggregate investment. Individuals who run high investment small businesses are better off under such a reform, while high income business owners receiving predominantly disguised labour income lose out. This illustrates how lower personal capital tax rates for business owners are poorly targeted at investment and are costly in revenue terms. Removing this preferential treatment raises significant revenue, and the small decline in investment can be more than offset by tax base reforms that make investment cheaper.

Related literature

There are a large number of papers that study the effect of the tax system on businesses and their owners. This includes the impact on avoidance behaviours, such as tax-motivated incorporation (MacKie-Mason and Gordon (1997), Goolsbee (1998), Tazhitdinova (2016)) and income shifting (Gordon and Slemrod (2000), Alstadsæter and Fjærli (2009), le Maire and

(BADR), which limited the total amount of lifetime gains to £1 million. We consider reforms to the system in place over 2002-14, and do not account for the implications of the new lifetime limit introduced by BADR.

[6]The current tax system discourages new equity investments by owner-managers; under certain conditions therefore, this reform moves the tax system towards a neutral treatment of new equity investments.

Schjerning (2013), Harju and Matikka (2016), Miller et al. (2020)), as well as on investment and risk-taking (Gentry and Hubbard (2000), Cullen and Gordon (2007), Devereux and Liu (2015), Yagan (2015), Moon (2020)). We develop a model that allows for these different responses to tax, using reduced-form evidence to help identify the parameters of the model.[7] We use the model to assess the impact of reforms to personal capital taxes. The model allows us to estimate the effect of the long-run effects of such reforms, which are particularly important in this setting, and can be challenging to estimate using quasi-experimental variation and reduced-form techniques (Sarin et al. (2021)).

We also contribute to the literature that develops and estimates structural models of entrepreneurship and business ownership, including Evans and Jovanovic (1989), Cagetti and De Nardi (2006, 2009), Catherine (2017), Humphries (2017), Hamilton et al. (2019) Jones and Pratap (2020), . Relative to these papers, our model is designed to focus on the interaction between the choices made by small business owners (and potential owners) and the tax system, accounting not only for "real" responses but also avoidance behaviours. In doing so, we allow for the fact that small businesses range from "entreprenerial" firms, which may be the desired target of policymakers, to others that may benefit from broadly applied tax breaks. We do not attempt to label some firms "entrepreneurial" and others not, but instead study on the effect of tax on choices, such as investment, which may be more subject to market failures e.g. liquidity constraints and uninsured risk.

The rest of the paper is structured as follows. In the next section, we describe our data on small businesses, and in Section 3 we describe how they are taxed and present descriptive evidence on how they respond to taxation. In Section 4 we set out a dynamical model of business ownership, and in Section 5 we present our estimation results. In Section 6 we conduct a series of counterfactual experiments, and a final section concludes. Several appendices provide further detail.

[7] For example, we use the 0% starting rate of corporation tax in the early 2000s, a reform also studied by Tazhitdinova (2016). We use this variation to help pin down the distribution of incorporation costs in a dynamic model, explicitly accounting for volatility in profits, the importance of retained profits and the forward looking nature of business owners' choices.

2 Data on small businesses

We study small businesses in the UK over the period 2001-16. We use data from three main sources: personal tax records, corporate tax records, and company accounts.[8] We supplement this with information on the attitudes and constraints of small businesses in the Longitudinal Small Business Survey, collected by the UK's Department for Business, Energy and Industrial Strategy.

2.1 Data sources

Small businesses in the UK are either unincorporated (the self-employed) or incorporated (company owner-managers). We focus on the 90% of the self-employed who are sole proprietorships (i.e. excluding partnerships) and the 70% of incorporated businesses that have fewer than two directors and two shareholders. This is to avoid the complications of modelling more complex ownership structures.[9] There are significant differences in the tax treatment of these two forms, which we discuss below. For both types of business owner, the personal tax records contain information on: taxable income (amount and whether it is from salary, self-employment, dividends, or capital gains), whether the individual is self-employed or a director of a close company, age and sex. All self-employed individuals and company directors are required to submit a self-assessment tax return; these data therefore cover the universe of people running their own business for the period the business is active.

We get also have information on business operations. For the self-employed, the personal tax records record information on business expenses, such as the use of capital allowances for investment spending. For owner-managers, the corporate tax records provide information turnover, profits and use of capital allowances. These data are linked to the company accounts, which provides information on company age, the number of directors and shareholders, industrial classification, and assets and liabilities listed on companies' balance sheet. The corporate tax records are matched to the personal tax records for directors of companies active in at least one year between 2013 and 2015. This match allows us to simultaneously observe income and activities at the company and individual level, which provides a more

[8] The personal ("self-assessment data") and corporate tax records ("CT600") are filed at the UK tax authority (HM Revenue & Customs (HMRC)), and the company accounts data is provided by Bureau van Dijk, specifically *Financial Accounting Made Easy* (FAME).

[9] We include companies with two or fewer directors and shareholders because, until 2006, there was a requirement that companies have a company secretary, who was often also a director. There are also strong incentives to use the company to split income with a spouse – for around 2/3 of two director-shareholder companies, the shareholders share the same last name.

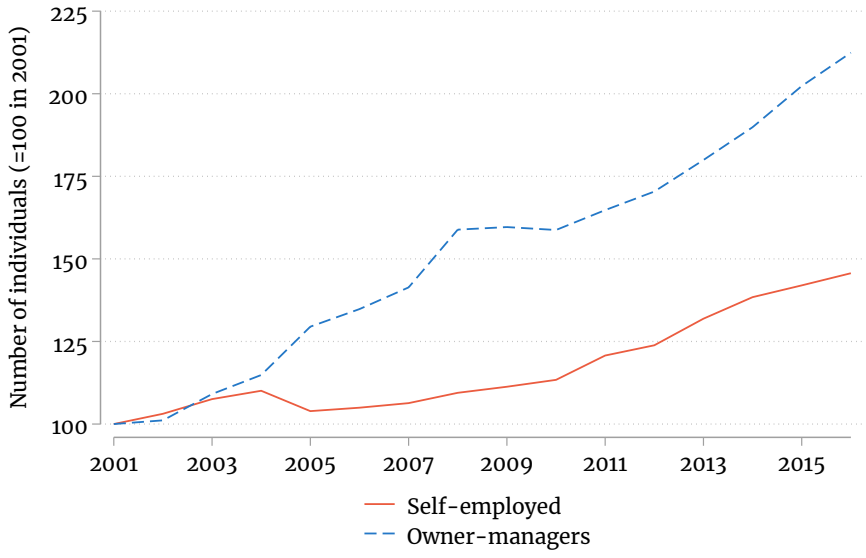
complete picture of the behaviour of owner-managers than has previously been possible. For further details of the match, see Appendix A and Miller, Pope, and Smith (2020).

2.2 Growth in small business ownership

In each tax year, we define the self-employed as individuals who submit at least one self-employment tax page and report positive sales,[10] and owner-managers as those who report being the director of a close company. Over the period 2001-16, there are 8.8 million people who are self-employed in at least one year and never owner-managers, 1.3 million who are owner-managers in at least one year and never self-employed, and 1.1 million people who are both self-employed and an owner-manager over the period.

Figure 2.1 shows the number of self-employed and owner-managers in each year relative to 2001. The number of owner-managers has more than doubled since 2001, while the number of self-employed has increased by almost 50%. In 2014, owner-managers constituted around 20% of the small business population. Over the same period, the number of employees grew by only 10% – small business owners are therefore an increasingly important part of the workforce.

Figure 2.1: *Growth in closely held business ownership, 2001-16*



Notes: The figure shows the numbers of self-employed and owner-managers in each tax year relative to 2001.
Source: Authors' calculations based on HMRC administrative datasets.

[10] This does not require that self-employment is their only, or even their main, source of income. It does however, exclude partnerships.

2.3 Profits, incomes and investment

Table 2.1 presents descriptive statistics for different samples of small business owners. We distinguish between individuals who are always self-employed, individuals who are always owner-managers, and those who are self-employed for a period before becoming an owner-manager (which we refer to as "incorporation").[11]

The top panel presents descriptives for individuals who were self-employed or an owner-manager in at least one year from 2001 to 2016. Around 10% have a period of self-employment followed by incorporation. Among this group, people spend, on average, 3.5 years in self-employment, with a further 4.1 years as an owner-manager. The exclusively owner-manager group have the highest taxable income, receiving £39,400 per year, on average, with the exclusively self-employed making substantially less, receiving only £11,200, on average.[12] Those that transition from self-employment to incorporation have lower taxable income than those that are exclusively owner-managers, but have higher year-on-year growth in both legal forms. Self-employed individuals who go on to incorporate grow at 10.3% per year, compared with 7.3% for the self-employed who never incorporate. Once they incorporate, these individuals continue to have higher growth, at 5.8%, than owner-managers who were never previously self-employed. This suggests that fast growth early in the business lifecycle may play a role in determining incorporation decisions.

The bottom panel describes the sample of small business owners active in 2014. We further distinguish between the sample of owner-managers whose personal tax records are matched to the corporate tax records of their companies – this match allows us to observe the profits and investment decisions of small incorporated businesses, which otherwise would not be observable from the owner-manager's personal tax record.[13] The number of years in self-employment or as an owner-manager are similar across the matched and unmatched samples, as are the mean and standard deviation of annual taxable income. In line with higher taxable income, the annual profit of owner-managers is substantially higher than for the self-employed. In addition, profits are more volatile than taxable income for owner-managers, partly reflecting the fact that they can retain profits in the company to smooth out volatile incomes in the face of a progressive tax system. On average, investment is low, with

[11] Only a small fraction of business owners move from incorporation to self-employment; we therefore focus on moves only from self-employment to incorporation.

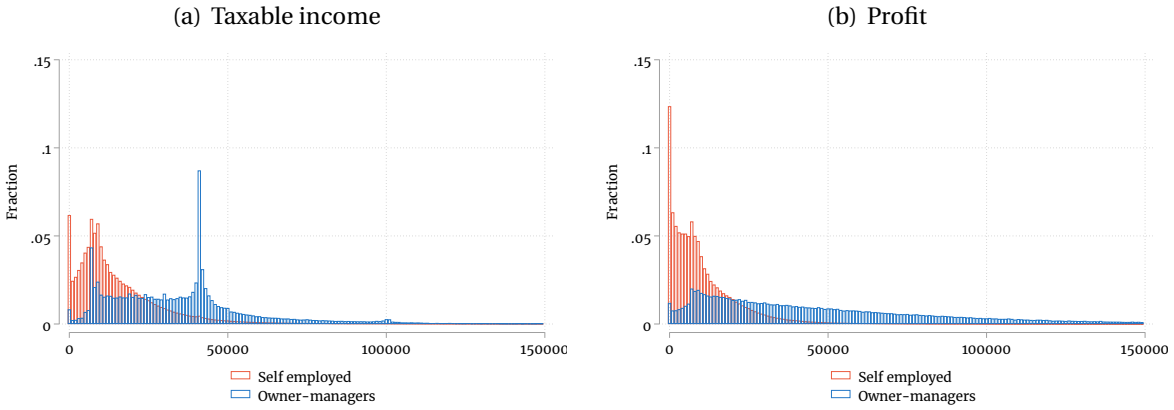
[12] Taxable income includes income from all sources, not just profits from business ownership.

[13] We also require that they are directors of companies that have 2 or fewer shareholders and directors, which we are only able to observe for the matched owner-managers.

the median exclusive self-employed individual investing nothing, and the owner-manager making capital investments equal to 1% of mean profits. The highest rates of investment are for individuals who spend time both self-employed and as an owner-manager.

Figure 2.2 shows the distributions of profit and taxable income for the self-employed and owner-managers (matched sample) in 2014. Two things are apparent from these figures. First, the distributions of profit and taxable income for the self-employed are to the left of those for owner-managers. Second, there is pronounced bunching in taxable income for owner-managers at the higher rate threshold, and some bunching in both profit and taxable income for the self-employed at the lower profit limit. We describe this bunching behaviour further in Section 3.3, and use this to help identify parameters of the model in Section 4.

Figure 2.2: *Distributions of taxable income and profit in 2014*



Notes: The left-hand panel shows the distribution of taxable income for individuals self-employed or an owner-manager in 2014. The right hand panel shows the distribution of business profit for individuals self-employed or an owner-manager in 2014.
Source: Authors' calculations using HMRC administrative datasets.

2.4 Industries

Table 2.2 shows the distribution of small business owners across industries. Just under half operate in either the construction or business services sectors. Almost 1 in 5 people in the business service sector are owner-managers, compared with under 0.5% of those in domestic services. In all industries, owner-managers have higher profits than the self-employed, with the most profitable business owners those in business services and the medical sectors. Investment is highly skewed, with the median self-employed owner-manager in all industries reporting zero investment, and only owner-managers in the retail, transport, manufacturing, and agriculture sectors having positive median profits. Mean investment is higher, although

Table 2.1: *Descriptive statistics for business owners, 2001-16*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Annual taxable income						
	Num.	Num. years:				Growth (%) when:		Annual profit		Mean investment
	individuals	SE	OM	Mean	s.d.	SE	OM	Mean	s.d.	/mean profit
Full sample, 2001-16										
SE only	8804011	4.5		11206	4120	7.3				
OM only	1277739		4.3	39383	9160		4.5			
SE and OM	1107649	3.5	4.1	26532	7871	10.3	5.8			
Active in 2014										
SE only	3592189	6.6		12238	4815			8053	4356	0.000
OM only (matched)	359812		5.0	41018	12240			47571	22642	0.011
OM only (unmatched)	182769		5.5	39172	10974					
SE and OM (matched)	190025	4.0	4.4	30954	12529			30201	18050	0.031
SE and OM (unmatched)	108047	3.2	4.7	26741	11857					

Notes: The top panel shows descriptive statistics for all individuals who were self-employed or owner-managers at some point over the period 2001-16 and the bottom panel for those who were business owners in 2014. Columns (2) and (3) show the mean number of years for which individuals were either self-employed or owner-managers. For each period of business ownership, we calculate the mean and standard deviation of annual taxable income, as well as the year-on-year growth rate when the individual was either self-employed or an owner-manager. Columns (4)–(7) show the median of these statistics across periods of business ownership. Columns (8) and (9) show analogous statistics for the mean and standard deviation in annual business profit; this can only be calculated for the self-employed and owner-managers with matched corporate and personal tax returns. Column (10) shows the median (across periods of business ownership) ratio of mean investment to mean profit. Financial variables are expressed in 2014 pounds.
Source: Authors' calculations using HMRC administrative datasets.

there is still a great deal of variation across sectors – mean investment is 25% of median profit for those owner-managers in agriculture, compared with 2.5% for those owner-managers in business services. We explicitly incorporate the importance of this heterogeneity in the model by using a clustering approach to allow for variation in the model parameters.

Table 2.2: *Top 10 industries*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	% of	% within		Median		Investment			
	business	industry		profit		Median		Mean	
	owners	SE	OM	SE	OM	SE	OM	SE	OM
Construction	23.8	93.4	6.6	11749	30872	0	0	367	3020
Business services	23.2	81.5	18.5	4954	50987	0	0	302	1321
Retail	9.1	93.7	6.3	5157	27442	0	334	265	2769
Domestic services	6.8	99.7	0.3	5579	19778	0	0	197	2111
Medical	6.5	94.8	5.2	6095	51757	0	42	420	2226
Transport	5.9	90.8	9.2	7735	28366	0	303	648	3806
Wholesale	5.0	99.2	0.8	5776	21869	0	0	581	2180
Manufacturing	3.1	91.9	8.1	6078	34035	0	589	514	4213
Agriculture, mining, utilities	2.5	94.6	5.4	6303	26066	0	2354	1947	6545
Other/missing	14.0	67.7	32.3	5000	35039	0	0	431	2270

Notes: Column (1) shows the percentage of business owners in each industry. Columns (2) and (3) show the percentage of business owners that are self-employed or owner-managers within each industry. Columns (4) and (5) show the median annual profit for the self-employed and owner-managers within each industry. Columns (6)-(9) show the median and mean annual investment spending for the self-employed and owner-managers.
Source: Authors' calculations using HMRC administrative datasets.

2.5 Investment and innovation

What does it mean to be an "entrepreneur"? The tax records provide detailed and accurate information on the activities of closely held businesses relevant for the tax authorities. However, they do not provide information on other activities, such as the degree of "innovative" activity in which the business engages, nor their sources of financing. These are important for thinking about what it means to be an entrepreneur. There is no perfect way to measure entrepreneurial activity in the data – different measures will capture different aspects of behaviour that might be considered "entrepreneurial". Of more use from a policy perspective is to try to identify behaviour that is more likely to suffer from market failures, and which policy could therefore usefully target. For example, there may be underprovision of small business investment because of credit constraints and the inability to completely insure risky investments. Another possibility is that the trial of new products and services create positive spillovers, which may mean that they are underprovided.

We use data from the Longitudinal Small Business Survey (LSBS) to further describe these elements of small business activity. We use the LSBS for the years 2015-17 for the sample of businesses that are self-employed or companies with fewer than 2 owners (i.e. a comparable sample of firms to those we study using the administrative tax records). The survey asks questions aiming to elicit businesses plans over the next three years. In Appendix A, we show that less than 1/4 of firms who do not plan on investing, also have no plans to launch new products or services in the next three years; in comparison, more than half of those planning to invest also plan on launching new products. This suggests that capital investment is correlated with innovative activity.

3 Tax variation and its effects

Over our period of study, there have been substantial tax changes that have altered incentives at both the extensive margin – whether to start a business and whether to incorporate – and the intensive margin – how much to work and how much profit to retain. In this section, we summarise the key features of the tax system as they relate to small businesses and describe the impact of this tax variation on behaviour.

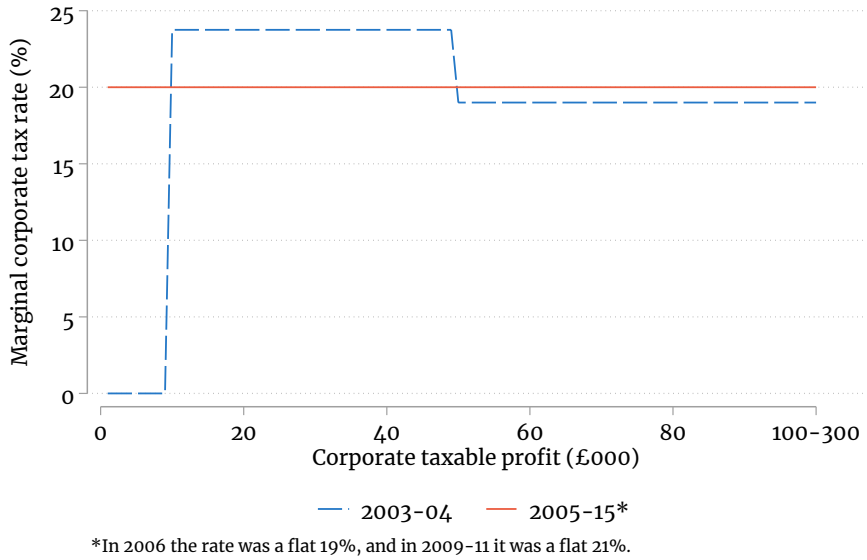
3.1 The taxation of small businesses

The self-employed (SE) and company owner-managers (OM) are taxed differently. The self-employed are subject to personal income taxes, and owner-managers are subject to both corporate and personal income taxes. Owner-managers are able to retain profits within their companies, allowing them to easily shift personal taxable income across tax years; this mechanism is not available to the self-employed. The effective marginal tax rates at different income levels also vary across the two legal forms, and the differences between them has changed over the past two decades. More details of the tax system are provided in Appendix B.

Corporate tax. Profits made by company owner-managers are 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 net of allowable deductions e.g. employee costs, materials, and capital allowances. Figure 3.1 shows the marginal corporate tax rate at different levels of

profit over the period 2003-16.[14] In 2003 and 2004 profits up to £10,000 were taxed at a lower 0% starting rate.[15] This lower rate increased the incentives for lower income business owners to incorporate. From 2007 onwards, companies with profit below £300,000 (i.e. 97% of companies with 2 or fewer directors and shareholders) faced a flat and stable "small companies" corporation tax rate of between 19% and 21%.

Figure 3.1: *Marginal corporate tax rate schedules*



Notes: The figure shows the marginal corporate tax rate applied to profits between £0 and £300k over the period 2001-16. This assumes profits were distributed to shareholders.
Source: Various government sources and authors' calculations. Exact rates and thresholds provided in Appendix B.

Personal income taxes. While the company is active, an owner-manager can choose to pay herself either in salary 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)). Figure 3.2 plots the marginal personal income tax rates applied to salary and dividend income over the period 2001-16. There were two reforms in 2011 that affected higher incomes: (i) the 60% marginal rate for incomes between £100,000 and approximately £120,000 is due to the withdrawal of the tax free allowance, and (ii) there was also the introduction of the additional 50% rate (later reduced to 45% on incomes above

[14] In the UK, tax years run from 1 April to 31 March. We refer to the tax year by the year in which it ends e.g. 2002/3 is referred to as 2003.

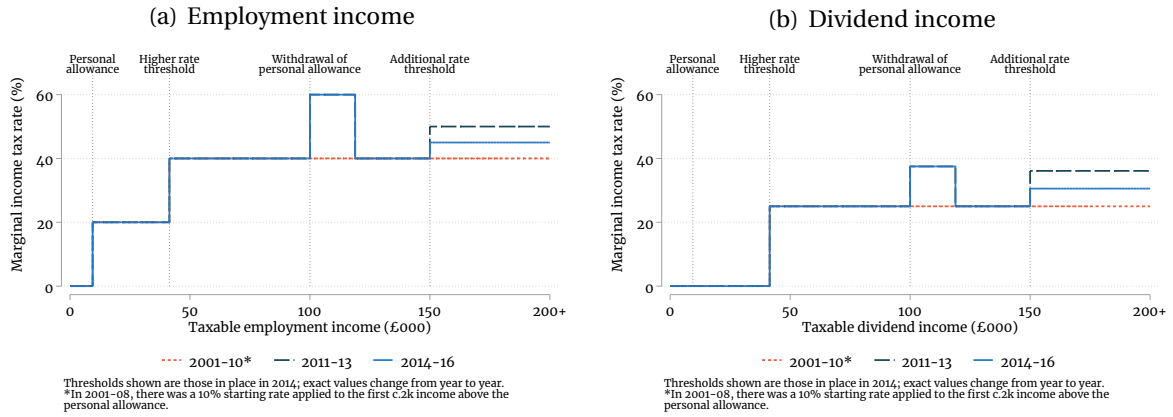
[15] The 0% rate remained in place until 2006, but only on profits not paid out to shareholders. The higher marginal rate between £10,000 and £50,000 ensures that the average corporate tax rate equals the marginal rate at £50,000).

£150,000). Income paid as dividends is taxed first at the corporate level (in the year profits arise) at the rate described above, and then attracts personal taxes in the year dividends are paid out. Dividends are subject to the same thresholds as salary income but are taxed at lower rates and do not attract social security contributions. The 2011 reforms described above also increased the marginal tax rates on dividend income.

The tax minimising way to take income out of the company in a given year, and in all years we study, involves taking a salary equal to the point at which personal taxes become payable (i.e. after exhausting tax free allowances) and withdrawing the remainder as dividend income.[16] This is the most commonly used strategy by owner-managers.[17]

Self-employed business profit is calculated as annual revenue (turnover) net of allowable deductions. The self-employed pay income tax on any profits earned above the personal allowance, at the same rates as employment income (as shown in Figure 3.2). The self-employed are also required to pay social security contributions (although at a lower rate than employees) on business profits earned above a lower profit limit. In comparison to owner-managers, who are taxed at the personal level in the year they withdraw income from the company, the self-employed are taxed at the personal level *in the year that profits are made*. This gives them much less scope to shift personal taxable income across tax years.

Figure 3.2: *Marginal personal income tax rate schedules*



Notes: The figure shows the marginal personal income tax rate applied to employment income between £0 and £200k over the period 2001-16. Source: Various government sources and authors' calculations. Exact rates and thresholds provided in Appendix B.

[16] 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.

[17] See Miller et al. (2020) for further details.

Capital gains taxes. 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. Capital gains are calculated as the difference between the current value of the shares (which is the net value of all assets, including accumulated retained earnings) and the value of the shares when the company was started (which is the initial shareholder equity if the whole company is being sold or dissolved). From 2008, the capital gains of owner-managers is eligible for a reduced 10% rate of capital gains tax under "Entrepreneurs' Relief",[18] which makes it more heavily taxed than dividend income withdrawn below the higher rate threshold, but more lightly taxed than dividend income above the higher rate threshold.

The self-employed are also subject to capital gains tax on the disposal of business assets, which, for the majority of businesses, is at the lower 10% Entrepreneurs' Relief rate. These assets are only subject to capital gains tax, and not corporation or income tax, which makes this treatment more generous than that available to owner-managers. However, it is much more difficult for the self-employed to shift income across tax years, which gives fewer opportunities to take advantage of this tax break.

Tax base and capital allowances. Spending on variable inputs, such as wages and materials, is directly deductible from turnover in the calculation of taxable profits. For capital expenditure, such as on buildings and machinery that depreciates over time, businesses can claim capital allowances. Since 2009, the UK has operated an Annual Investment Allowance (AIA), which provides 100% upfront deduction for plant and machinery investment up to an annual cap.[19] In practice most small businesses 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 small 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%).

[18] Prior to 2008, business owners could access taper relief on business assets held above a certain number of years. This rate was less generous than Entrepreneurs' Relief, but more generous than the dividend rate at the time.

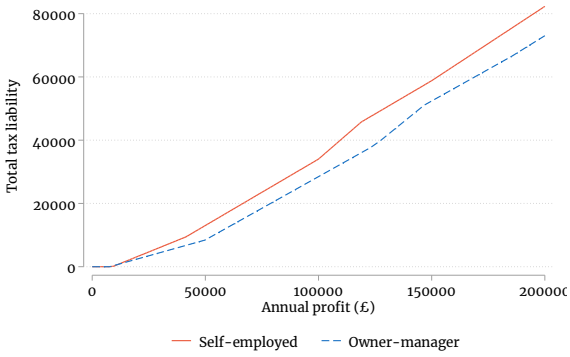
[19] This cap varies between £25,000 and £500,000 across years. Plant and machinery expenditure above this allowance is 'written down' on a (currently 18%) declining-balance basis.

3.2 The effect of tax at the extensive margin

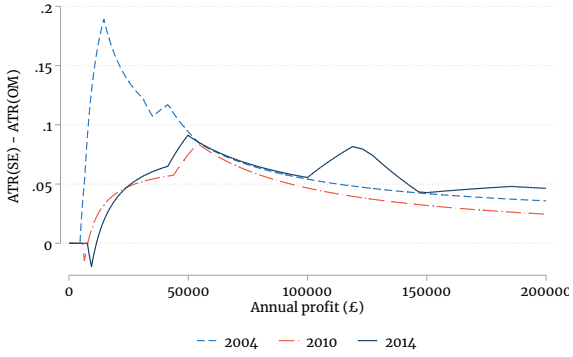
Figure 3.3(a) shows the total tax liability at different profit levels for a self-employed individual and owner-manager in 2014. This combines social security contributions, personal and corporate income taxes, and assumes that the owner-manager does not retain any income in the company. At all profit levels, the owner-manager pays less tax than a self-employed individual, and this difference is larger, in levels, at higher profit levels. Figure 3.3(b) shows the difference in average tax rates (total tax/profit) for a self-employed individual and owner-manager at various profit levels in 2004, 2010, and 2014. The average tax rate for a self-employed individual is around 5 percentage points higher than for an owner-manager over this period. However, this difference exceeds 10 percentage points for relatively low profit levels in 2004, due to the 0% starting rate of corporation tax. The withdrawal of the personal allowance for those earning more than £100,000 from 2011 onwards increased the difference in average tax rate at higher profit levels.

Figure 3.3: *Effective tax liabilities by profit level and tax year*

(a) Total tax liability, 2014



(b) ATR of SE – ATR of OM



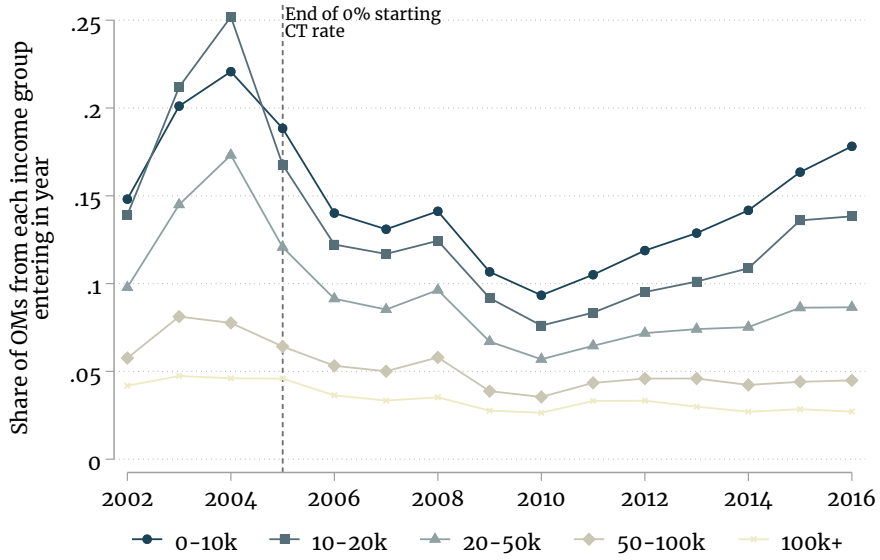
Notes: The left-hand panel shows the total tax liability for a self-employed individual (solid line) and owner-manager (dotted line) at different profit levels in 2014. This includes social security contributions, personal and corporate income taxes. The right-hand panel shows the average tax rate (total tax/profit) for a self-employed individual minus the average tax rate for an owner-manager at different profit levels for 2004, 2010 and 2014. Source: Various government sources and authors' calculations. Exact rates and thresholds provided in Appendix B.

0% starting rate of corporation tax

The 0% starting rate of corporation tax (on profits of up to £10,000) in the years 2003-4 provided a strong and salient incentive for new business owners to enter as owner-managers,

and for the existing self-employed to incorporate.[20] These incentives were strongest for less profitable businesses, as is evident in Figure 3.3(b): for those with profits of £10,000, the average tax rate was 18 percentage points higher for the self-employed compared with owner-managers. After the end of the 0% starting rate, this tax advantage dropped to less than 5 percentage points (for an individual making £10,000).

Figure 3.4: *Entry of owner-managers, 2002-16*



Notes: The panel shows the share of owner-managers within each taxable income band that are newly present in the year shown on the horizontal axis.
Source: Authors' calculations using HMRC administrative datasets.

In Figure 3.4 we show the impact this had on entry of owner-managers. We group owner-managers operating in each year into five groups based on their taxable income in that year.[21] The figure shows the share of owner-managers within each income group that entered in the year shown on the horizontal axis. There was a clear increase in incorporation rates in 2003 and 2004, which was primarily driven by those receiving up to £50,000 in taxable income, the group who benefited most from the corporate tax cut. In the Appendix, we show that around half of this increase was from new entrants to business ownership, and the remainder from people moving from self-employment into incorporation. Our model of business ownership is able to match these patterns in the data.

[20] The 0% starting rate of corporate tax remained until 2006, but only on profits not distributed to shareholders. The relevant rate for the small businesses we study is that on profits distributed to shareholders which, from 2005 onwards, were taxed at the small company rate (ranging between 19 and 21%).

[21] We use taxable income, as opposed to profit, because this allows us to use the full sample of business owners operating over the 2001-16.

Increased personal taxes on incomes above £100,000

There was also a greater incentive for higher income business owners (those earning in excess of £100,000) to operate as owner-managers from 2011 onwards, due to changes in personal income tax rates. This is because owner-managers have the option to retain profits within their companies, which they can then withdraw as more lightly taxed capital gains income. The increased income tax rates could thus be avoided by incorporating and retaining profit in the companies. Figure B.2 shows the share of owner-managers newly incorporated in each year that made profits in excess of £100,000 (in real terms), relative to 2001. There was 1.5 percentage point increase in the share of new owner-managers that had high profit levels in 2011, following the introduction of higher rates.

3.3 The effect of tax at the intensive margin

Taxes affect not only the decision to start a business and whether to incorporate, but also ongoing choices made while running a business. Business owners have to choose how much labour to supply to produce profit – higher effective marginal rates could reduce their labour supply. Owner-managers also have to choose how much taxable income to take out of their business each year. If they expect to face lower (higher) tax rates in the future, they have an incentive to retain (withdraw) profits in the current year. We use variation in marginal rates created by kinks and policy reforms to study these intensive margin decisions.

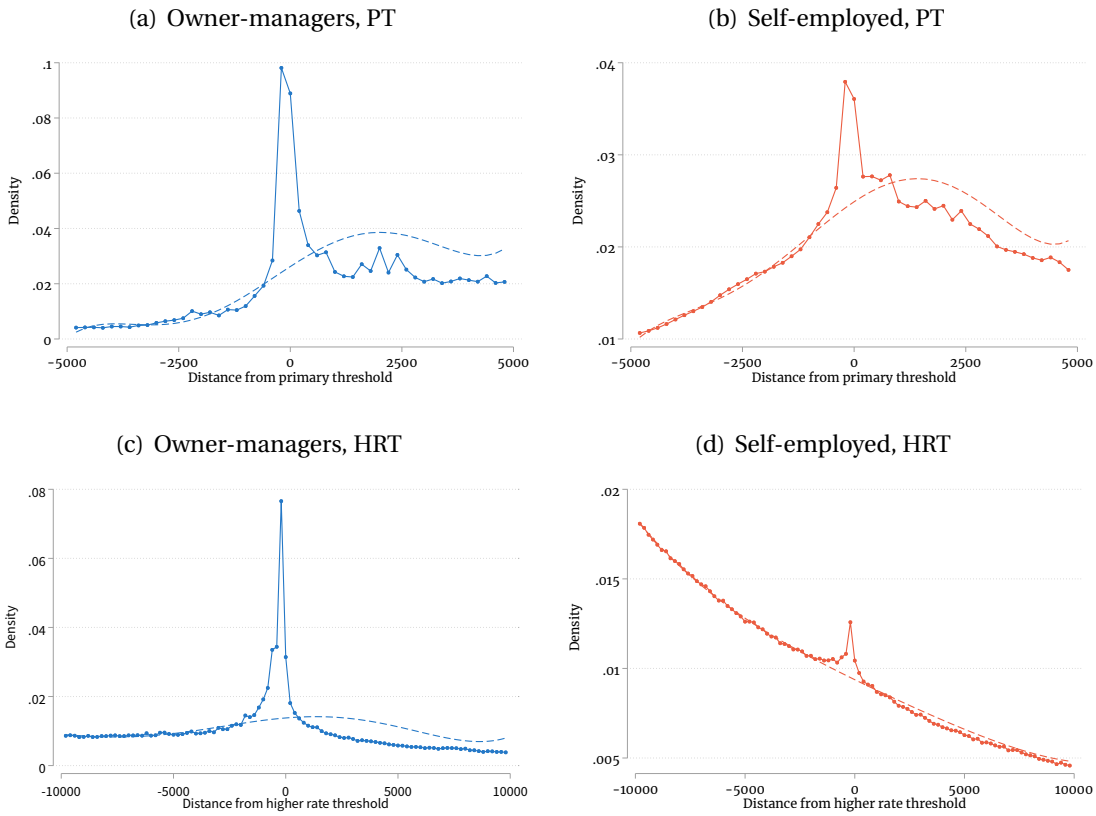
Bunching at tax thresholds

We look at the responsiveness of profit and taxable income to two thresholds: (i) the point at which individuals start to pay social security contributions (PT), which is approximately £10,000 and (ii) the higher rate threshold (HRT), when the marginal tax rate increases by 20 percentage points, which is approximately £40,000.

We use the sample of business owners active in 2014. Figure 3.5 shows the distributions of taxable income around the PT and HRT for owner-managers and the self-employed in 2014. We use the method developed by Chetty et al. (2011): we fit a flexible polynomial to the density, omitting a window either side of the threshold and imposing the constraint that the bunching mass comes from the right of the threshold. The figure shows that there is evidence of bunching at both thresholds for owner-managers and the self-employed. The excess mass is larger for owner-managers than for the self-employed. This is likely driven, at least in part, by the fact that owner-managers are much more easily able to adjust the timing of

their taxable income than the self-employed. In Miller, Pope, and Smith (2020) we show that all of the responsiveness of owner-managers to tax kinks is due to the intertemporal shifting of taxable income, with no evidence that they reduce the amount of profit they create when faced with higher tax rates.

Figure 3.5: *Bunching around tax thresholds*



Notes: We group individuals in income bins of £200 and exclude a window of £1000 (for the PT) and £1400 (for the HRT) to estimate the counterfactual income density. We fit a polynomial of order 5, and impose the integration constraint that the missing mass due to bunching is from the right of the threshold.
Source: Authors' calculations using HMRC administrative datasets.

Rate increases on higher incomes

As discussed, in 2011 there were increases in the marginal tax rates on incomes above £100,000. There is some evidence that this increased movements into incorporation, see Figure B.2. It also affected behaviour for existing owner-managers. Miller, Pope, and Smith (2020) use these reforms and a difference-in-differences approach to estimate the impact of these higher marginal rates on the profit made by owner-managers and their taxable income. They find that following the introduction of the higher rates, the taxable income of the treated group

of owner-managers fell substantially, but there were no statistically significant changes in profit (see Figure 5.3(e)). The higher income owner-managers who faced increased tax rates responded by retaining more profit in their companies, but not by reducing the amount of profit they created.

4 A dynamic model of small business ownership

In this section, we set out a model of small business ownership that is able to generate the empirical patterns described above. It captures the uncertainty associated with running a business, the various decisions that owners (and potential owners make) and the relevant features of the tax system. The model allows us to study the mechanisms through which the tax system affects business owner behaviour, and to perform counterfactual policy experiments.

4.1 Preferences

Individuals derive utility from consumption and leisure; their per-period utility function is given by:

$$u(c_{it}, l_{it}) = \frac{c_{it}^{1-\nu_c} - 1}{1-\nu_c} + \chi \frac{l_{it}^{1-\nu_l} - 1}{1-\nu_l} \tag{4.1}$$

where c_{it} and l_{it} denote consumption and hours of leisure, respectively, of agent i in year t. ν_c and ν_l govern the curvature of the utility function with respect to consumption and leisure, and χ denotes the utility weight on leisure. Utility is separable across time and discounted with a constant discount factor β.

4.2 Legal forms

There are three legal forms through which agents can supply their labour: (i) self-employed business owner, $d_{it} = SE$, (ii) incorporated business owner (also referred to as an owner-manager), $d_{it} = OM$, and (iii) employee, $d_{it} = EE$. Self-employed business owners differ from owner-managers in the way they are treated by the tax system and their scope for retaining profits within the business.

We also allow for there to be non-tax costs (or benefits) associated with incorporation, which we denote by F^{inc}. This is a utility cost incurred when the agent moves from either employment or self-employment into incorporation. This could include costs associated with

higher reporting or compliance requirements, in addition to any benefits from limited liability. We also allow for there to be costs (or benefits) associated with starting a business, which we denote by F^{start}. This is incurred when the agent moves from employment into either self-employment or incorporation.

4.3 Assets

Agents enter each period with a stock of assets, denoted $a_{it} = a^c_{it} + a^p_{it}$. Owner-managers have the option to hold assets within the company, a^c_{it}, or in their personal accounts, a^p_{it}. Self-employed agents and employees hold only personal assets i.e. $a^c_{it} = 0$. Assets held in personal accounts and company accounts attract rates of return, r^p and r^c, respectively, and evolve as follows:[22]

$$a^c_{it+1} = (1 + r^c)(s^c_{it} + a^c_t) \tag{4.2}$$

$$a^p_{it+1} = (1 + r^p)(s^p_{it} + a^p_t), \tag{4.3}$$

where s^c_{it} and s^p_{it} denote saving in the company and personal asset, respectively. We rule out borrowing by imposing $a^c_{it+1} \geq 0$ and $a^p_{it+1} \geq 0$.

The restriction that business owners cannot use uncollaterized debt to finance investment is motivated by empirical evidence that most closely held business owners use their own funds to finance their business. For example, in the Longitudinal Survey of Small Businesses, over 90% of closely held businesses did not seek external finance in the previous 12 months. It is also consistent with the previous literature that has emphasised the impact of liquidity constraints for entrepreneurs; for example, Evans and Jovanovic (1989), Cagetti and De Nardi (2006).

4.4 Investment

In the first part of each period, business owners choose what fraction of assets on hand to invest in productive capital, $\varsigma^k_{it} \in [0,1]$. For owner-managers, if investment is greater than the stock of company assets, they inject capital from their personal assets into the company, denoted by $\tilde{k}_{it} = \max\{0, \varsigma^k_{it} a_{it} - a^c_{it}\}$. Agents then have:

$$k_{it} = \varsigma^k_{it} a_{it} + \varphi \tilde{k}_{it},$$

[22] The rate of return on the corporate asset is defined net of any corporate tax due.

where φ is a tax credit for new equity injection, which we discuss in more detail below. We assume that capital depreciates at rate δ. At the end of each period, the value of undepreciated capital is added to the stock of either company (for owner-managers) or personal (for the self-employed) assets. This rules out non-convex adjustment costs, but significantly reduces the state space as we do not have to keep track of the stock of capital investments.

4.5 Incomes and consumption

Business profit. If the agent is operating as a business owner (whether incorporated or not), the profit that they earn in year t is given by:

$$z_{it} = w_{it} h_{it} \left(k_{it} / \max\{1, \underline{k}\} \right)^{\theta} \tag{4.4}$$

where $h_{it} = L - l_{it}$ denotes hours of labour supplied (L denotes the leisure endowment), k_{it} denotes capital investment, w_{it} denotes productivity. θ governs the importance of capital in the production process and $\underline{k}$ denotes the minimum level of capital required to operate.

Productivity as a business owner, w_{it}, depends on the agent's latent productivity, ω_i, the age of the individual, age_{it}, and a stochastic process, η_{it}:

$$\ln w_{it} = \omega_i + \phi_1 \text{age}_{it} + \phi_2 \text{age}_{it}^2 + \eta_{it} \tag{4.5}$$

$$\text{with} \quad \eta_{it} = \rho \eta_{it-1} + \varepsilon_{it}, \quad \varepsilon_{it} \sim \mathcal{N}(0, \sigma_\epsilon). \tag{4.6}$$

η_{it} is an AR(1) process, where $|\rho| < 1$ governs the persistence of shocks to productivity and σ_ϵ^2 denotes the variance of the shocks. ω_i is normally distributed with mean μ_ω and variance σ_ω^2.

Employee income. If the agent is an employee, then they supply a fixed number of hours per year, $\bar{h}$, and earn a constant wage equal to their latent productivity plus the age trend. Their annual income is $y_i^{EE} = \bar{h} \exp(\omega_i + \phi_1 \text{age}_{it} + \phi_2 \text{age}_{it}^2)$.

Taxation

Tax liability depends on the individual's legal form. Owner-managers are subject to both corporate and personal income taxes, while the self-employed and employees pay only personal income taxes.[23] y_{it} denotes i's choice of *personal* taxable income in period t.

[23] We include social security contributions in the definition of personal income taxes.

Corporate tax. If an owner-manager wishes to withdraw y_{it} from his company, the tax-efficient way to do this is take a fixed salary, $\tilde{y}_{it} = \min(y_{it}, \underline{y})$, where $\underline{y}$ denotes the point at which personal taxes begin to be levied, and the rest as dividends. Taxable corporate profit is equal to:

$$\tilde{z}_{it} = z_{it} - \tilde{y}_{it} - \lambda^{OM} k_{it} \tag{4.7}$$

where λ^{OM} denotes the fraction of capital spending that can be deducted for tax purposes. We let $\mathcal{T}^c(\tilde{z}_{it})$ denote total corporate tax liability.

As highlighted above, we use φ to denote a tax credit for new equity. When we model the current system, we set $\varphi = 0$. Increasing φ allows us to illustrate how policies such as providing a rate of return allowance for new equity investments affects small business outcomes.

Personal tax. An owner-manager's personal taxable income is equal to profit minus corporate tax and any retained profits, s^c_{it} (which can be positive or negative). The personal taxable income of a self-employed individual is equal to profit minus any allowable deductions for capital spending. Individuals' personal taxable income is therefore as follows:

$$y_{it} = \begin{cases} z_{it} - \mathcal{T}^c(\tilde{z}_{it}) + (1+\varphi)\tilde{k}_{it} - \delta k_{it} - s^c_{it} & \text{if} \quad d_{it} = OM \\ z_{it} - \lambda^{SE} k_{it} & \text{if} \quad d_{it} = SE \\ y_i^{EE} & \text{if} \quad d_{it} = EE. \end{cases}$$

An individual's personal income tax liability depends on their taxable income and legal form and is given by $\mathcal{T}^p(y_{it}, d_{it})$.

Optimization errors. We allow for the fact that business owners may make optimization errors when choosing profit and taxable income in response to the tax system. We use the approach developed by Chetty (2012), who shows how even relatively small frictions can reconcile a range of estimates of labour supply elasticities. He specifies a model in which agents only re-optimize their behaviour when, for example, faced with a kink in the tax system, if the utility gain from doing so is greater than some threshold. Following this, we assume that agents only reoptimize labour supply (and, for owner-managers, the share of assets held in the company) if the utility gain from doing so, as a fraction of annual profit, is greater than ς_o.

Consumption

Finally, given post-tax income, $y_{it} - \mathcal{T}^p(y_{it}, d_{it})$, individuals can choose how much to save in their personal asset, s^p_{it}, with the remainder yielding consumption:

$$c_{it} = \begin{cases} y_{it} - \mathcal{T}^p(y_{it}, d_{it}) - s^p_{it} - \tilde{k}_{it} & \text{if} \quad d_{it} = OM \\ z_{it} - \mathcal{T}^p(y_{it}, d_{it}) - s^p_{it} - \delta k_{it} & \text{if} \quad d_{it} = SE \\ y_{it} - \mathcal{T}^p(y_{it}, d_{it}) & \text{if} \quad d_{it} = EE. \end{cases} \tag{4.8}$$

4.6 Recursive formulation

We now set out the recursive formulation of the problem. As is standard, we use prime to denote next period's variables, and for notational simplicity, drop the i subscript. There are two subperiods within each period. In the first subperiod, business owners choose what fraction of assets on hand to invest in capital. In the second subperiod, once they have observed an iid shock associated with switching legal forms, agents choose how much labour to supply, how much to save in personal and company assets (jointly implying consumption), and then their legal form next period.

Let Ω denote each agent's state variables at the start of each period:

$$\Omega = \begin{cases} \text{age}, d, a, \tilde{a}^c, \omega, \eta, & \text{if } d = OM \\ \text{age}, d, a, \omega, \eta, F^{inc}, & \text{if } d = SE \\ \text{age}, d, a, \omega, \eta, F^{start}, F^{inc}, & \text{if } d = EE, \end{cases} \tag{4.9}$$

where a denotes total assets, and $\tilde{a}^c$ denotes the share of assets held within the company. Owner-managers and the self-employed observe the stochastic component to their business owner productivity, η, for that period. Employees observe the productivity that they would have had as a business owner, η, *if they had operated a business that period.* This is a noisy signal of their productivity as a business owner next period, and therefore informative for their decision to enter or not. As above, F^{start} and F^{inc} denote fixed utility costs to starting a business and incorporating. Working backwards, we have:

Retirement. Agents retire with certainty at age 60 and receive a terminal value, $V^T(a)$. This terminal value is given by the solution to maximising consumption over the remaining thirty

years of life, with total assets a and the receipt of a state pension in each year. There is no remaining uncertainty, which means this has an analytical solution.

Sub-period 2. We let $\tilde{V}(\Omega|k,d')$ denote the value function for the second subperiod, conditional on a particular choice of capital k and choice of legal form next period, d', which is given as follows:

$$V(\Omega|k,d') = \max_{l,a',\tilde{a}'_c} \Big\{ u(c,l) + F^{start}\mathbb{1}_{d=EE,d'=\{SE,OM\}} + F^{inc}\mathbb{1}_{d=\{EE,SE\},d'=OM} + \beta\mathbb{E}\left[V(\Omega'|\Omega,a',\tilde{a}^{c'},d')\right]\mathbb{1}_{age<60} + V^T(a')\mathbb{1}_{age=60} \Big\}$$

subject to constraints (4.1) – (4.8). The solution to this problem gives the policy functions for $l, a', \tilde{a}^{c'}$. For the self-employed, $\tilde{a}^{c'} = 0$, and for employees, $\tilde{a}^{c'} = 0$ and $l = L - \bar{h}$.

The choice of legal form next period is then to $\max_{d'\in\mathcal{D}_d} V(\Omega|k,d') + \zeta_{d'}$, where $\mathcal{D}_d$ denotes the set of legal forms next period available to legal form d this period. We assume that $\zeta_{d'}$ is distributed type I iid extreme value, with variance σ_ζ^2. This allows us to apply the result of Small and Rosen (1981), to integrate over these shocks:

$$V(\Omega|k) = \mathbb{E}_\zeta\left[\max_{d'\in\mathcal{D}_d} V(\Omega|k,d') + \zeta_{d'}\right] = \gamma + \ln\left[\sum_{d'\in\mathcal{D}_d} e^{V(\Omega|k,d')}\right].$$

where γ is a constant of integration that differences out in the choice across d.

Sub-period 1. In the first subperiod, business owners choose capital, k, to maximise their expected value function in the second subperiod:

$$V(\Omega) = \max_{k\in[0,a]} V(\Omega|k).$$

Employees simply set $k = 0$.

The model cannot be solved analytically, so we use numerical techniques to solve for the policy and value functions, which are described in Appendix D.

5 Estimation

We use a two-step estimation strategy. First, we calibrate a number of parameters using data and existing evidence from the literature. In the second step, we estimate the remaining parameters using the simulated method of moments, taking the first step parameters as given.

We find the parameter values that minimize the distance (measured using the GMM criterion function) between features of data simulated from the model and those observed in practice. We allow for heterogeneity across individuals in both preferences and the production process by classifying business owners into latent types and estimating the parameters separately for each types.

5.1 Heterogeneity

In Section 2 we document the wide variation in behaviours and outcomes across small businesses. In order to incorporate key dimensions of heterogeneity into the model, we discretize heterogeneity by assuming that individuals can belong to one of a finite number of 'types'. We do not observe these latent types, and, instead, estimate type membership outside of the model; we then treat these types as given when estimating the preference parameters for each type. We follow the approach of Bonhomme et al. (2021) and use a k-means clustering approach to determine type membership.

The k-means clustering problem in the classification step (for a given number of types K) is defined as:

$$\min_{\mathcal{K},\{\bar{x}\}_{k=1}^{K}} \sum_{k=1}^{K} ||x_i - \bar{x}_k||^2 = \min_{\mathcal{K},\{\bar{x}\}_{k=1}^{K}} SSE, \quad \text{with} \quad \bar{x}_k = \frac{1}{N_k} \sum_{k(i)=k} x_i \tag{5.1}$$

where the classification is given by $\mathcal{K} = \{k(i)\}_{i=1}^{n}$. For a given number of types, K, and vector of individual characteristics, x_i, this procedure determines the classification that minimises the within type sum of squared errors.

Informed by the variation in the data and the economic theory underpinning the model, we classify business owners on the basis of two characteristics: their mean profit, and their mean investment as a share of mean profit. These variables allow for a flexible, yet parsimonious, grouping of individuals. We use heuristic methods to determine the optimal number of types, K, as five, and treat this as known throughout the analysis (see Appendix C for further details).

Table 5.1 summarises the distribution of business owners across types, and provides additional summary statistics for each type (distributions are shown in Appendix C). Types are ranked by their mean profit level. Although legal form is not used to cluster individuals, there is significant variation in the shares of individuals who operate as self-employed and owner-managers across the types. A substantial majority of business owners are classified as low profit, low investment, predominantly self-employed individuals. At the other end of the

extreme are very high profit, low investment, predominantly owner-managers. The middle types do the most investment, and contain a mix of self-employed and owner-managers. The types also capture variation in industry composition – domestic workers are much more likely to be low profit, low investment self-employed, while those working in business services are more likely to be the high profit owner-managers. Those in the middle investment groups are more likely to be in agriculture and manufacturing.

Table 5.1: *Summary of types from clustering procedure*

(1) Type	(2) Description	(3) % business owners	(4) % type that are OM	(5) Mean profit	(6) Mean invest/ mean profit
I	Low profit, low invest, mainly SE	64.7	2.7	7049	0.01
II	Mid-low profit, mid invest, mixed	10.0	9.8	12242	0.18
III	Mid profit, high invest, mixed	2.0	16.7	13064	0.57
IV	High profit, low invest, mixed	18.6	27.6	29387	0.03
V	V high profit, low invest, mainly OM	4.7	74.6	81408	0.04

Notes: The first two columns show the type and description from the clustering procedure. Column (3) shows the share of business owners in 2013/14 that belong to each type; column (4) shows the share of each type that are owner-managers in 2013/14. Column (5) shows the mean profit of each type and column (6) shows the ratio of mean investment to mean profit.
Source: Authors' calculations using HMRC administrative datasets.

5.2 Calibrated parameters

We calibrate several parameters, which are difficult to identify in the model, in a first stage.

Utility function. We do not have data on consumption or assets from the tax records, which makes it challenging to identify the curvature of utility with respect to consumption. We set the coefficient of relative risk aversion, $\nu_c = 0.8$. Chetty (2006) argues that evidence on the elasticity of labour supply bounds the coefficient of relative risk aversion; the average implied value is 0.71, when utility is separable in consumption and leisure, with only three studies implying a value above 1.25. Gourinchas and Parker (2002) estimate its value to be between 0.5 and 1.4, while laboratory estimates of risk aversion often suggest values slightly below 1.[24]

χ governs the weight on leisure in the utility function. We set χ as a function of ν_c, ν_l and the mean of latent productivity, μ_ω such that the hours worked at this productivity level equal

[24]See, for example, Holt and Laury (2002, 2005) and Harrison et al. (2005). Andersen et al. (2008) use experiments to jointly elicit risk and time preferences for the adult Danish population, and estimates a coefficient of relative risk aversion equal to 0.74.

the average hours worked by closely held business owners reported in the UK Labour Force Survey (LFS).[25]

Depreciation process. We estimate the average depreciation experienced by small businesses using the data from tax records and company accounts, which implies $\delta = 22\%$.

Productivity. Due to the endogeneity of labour supply, we have to estimate the parameters governing the productivity process in the second stage. However, we set the coefficients on age and age squared in the productivity process equal to those estimated by Attanasio et al. (2018). We set the minimum level of capital required to operate, $\underline{k}$ to zero for types I, IV and V, and, informed by the data, equal to £500 and £1000 for types II and III, respectively.[26]

Budget constraint. We parametrise, and solve the model for, three tax regimes. The first covers the period 2003-4 (when the 0% starting rate of corporation tax was in operation), the second covers the period before 2003 and 2005-10, and the third 2011-14 (following the introduction of the higher rates on incomes above £100,000). Each regime explicitly models the kinks in the corporate and personal tax schedules.[27] We set the deductibility of investment for tax purposes equal to the depreciation experienced by the business owner, which is consistent with its treatment under the Annual Investment Allowance.[28] We set the personal risk free rate of return, r_p, equal to 2.82%, and the corporate risk free return, $\tilde{r}_c$, equal to 2.02% (with the return net of tax given by $r_c = \tilde{r}_c(1-\tau_c)$). These are the average returns on time deposits for households and private non-financial corporations over the period, estimated by the Bank of England. The hours worked by employees, $\bar{h}$, is set to the full time equivalent of 2080, and the leisure endowment, L, is 5840 (16 hours a day). Individuals receive a state pension equal to £8500 on retirement.

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[25] Specifically, note that the first order condition for the intratemporal problem is $c = \left(\frac{1}{\chi} l^{\nu_l} w(1-\tau'_{it})\right)^{1/\nu_c}$. Approximating consumption with net-of-tax earnings $c = w(L-l)(1-\tau')$ gives $\log\chi = \nu_l \log l - \nu_c \log(L-l) + (1-\nu_c)\log(w(1-\tau'))$. Given ν_c, ν_l, and setting w equal to average business owner productivity for each type and $L-l$ equal to average hours worked estimated using the LFS, allows us to set χ as function of the other parameters.

[26] These values are equal to the minimum of the investment to profit ratio multiplied by the 25th percentile of the mean profit distribution, for each type.

[27] 36% of incorporated businesses have 2 shareholders and 2 directors. Much of this is likely due to the strong incentives to split profits with a spouse – for around 2/3 of these companies, the shareholders share the same last name. We therefore account for this in the model by assuming that, with probability = 0.36, the effective thresholds in the personal tax schedule for owner-managers are double their statutory value.

[28] Appendix B contains more details on the tax systems, and Appendix D for how we implement this in the model.

5.3 Moment conditions and identification

We estimate the remaining parameters by simulated method of moments i.e. matching moments of the data with corresponding moments constructed from data simulated from the model. The moments that we use include: the mean and standard deviation of profit for the self-employed and owner-managers; the permanent component of a variance decomposition of profit; the correlation between profit and lagged profit; mean investment as a share of mean profit; percentiles of the retained profit distribution; the share of business owners that are owner-managers in each year; entry of self-employed and owner-managers and incorporation rates in each year; bunching at tax thresholds. We estimate the model separately by the five latent types described in Table 5.1. However, we assume that two parameters – the discount factor and the optimization error threshold – are common across types and estimate these using only the information for type V. The parameters are jointly identified, but here we describe the variation in the data that helps pin down each parameter (conditional on the values of the other parameters).

Utility function. We estimate the discount factor, β, by matching the 50th, 75th and 90th percentile of retained profits. Intuitively, all else equal, a higher discount factor means that agents are more patient, and therefore more willing to defer consumption until company liquidation, which confers a tax saving. We can only use this approach for type V, the highest profit group, because the ability to retain does not exist for the self-employed and there is no incentive to do so for owner-managers with average profit below the higher rate threshold. The optimization error threshold, ς_o, is pinned down by the amount of bunching at the higher rate threshold for owner-managers. Owner-managers primarily bunch by adjusting retained profits (as opposed to labour supply), which allows us to estimate ς_o. Conditional on a given level of optimization error, a higher value of ν_L implies less elastic labour supply, which corresponds to less bunching for the self-employed at tax kinks (the primary threshold for types I–III, and the higher rate threshold for types IV-V).

Start-up and incorporation costs. The start-up cost, F^{start}, is identified by the entry of self-employed business owners each year. The differential start-up cost for owner-managers and the distribution of incorporation costs, $\underline{F}^{inc}, \overline{F}^{inc}$ are jointly pinned down by the rate of incorporation (from self-employment) and the entry of new business owners as owner-managers (from employment). The change in incorporation rates when the 0% starting rate of corpo-

ration tax is particularly helpful for identifying these parameters. Finally, the dispersion of the logit shocks, σ_ζ, governs the relative importance of the unobserved utility shocks, relative to the observed component of utility, which allows us to match the year-to-year extensive margin shifts (entry and incorporation rates).

Production function. Labour supply is endogenous and unobserved in the data, which means we cannot estimate the parameters governing the production function in the first stage. Instead, we use information on the distribution of profits to help pin down these parameters (conditional on the agents' preferences, ν_c, ν_l, χ). The mean profit of self-employed and owner-managers are informative about the mean of the latent productivity distribution, μ_ω. The standard deviation of latent productivity, σ_ω, is pinned down by the standard deviation of the permanent of log profit. The standard deviation of the productivity shocks is pinned down by the standard deviations of profit of the self-employed and owner-managers. To identify the persistence of productivity shocks, we match the coefficient on lagged profit from a regression of log profit on its lag and business owner fixed effects. Finally, informed by the fact that investment is close to zero for types I we set $\theta = 0$ for this group; for the other types, we use mean investment as a share of mean profit to help identify this parameter.

The GMM techniques that we use are standard, and described more fully in Appendix D. We solve the model for each of the three tax regimes and simulate 50,000 agents for each of the five types. We construct the moments analogously to the data, which accounts for the fact that the data are a selected sample of business owners present in 2013-14. When we present results that aggregate across the five types, we use weights based on the share of business owners belonging to each type in 2013-14 (column (4) in Table 5.1).

5.4 Parameter estimates

Table 5.2 presents the parameters estimated in the second stage. We estimate an annual discount factor, β, equal to 0.976, which is line with estimates in the literature. We estimate an optimization error threshold of 2.2% – i.e. individuals have to get a utility gain of more than 2% of annual profit to adjust their behaviour in response to changes in the marginal tax rate that they face. We estimate ν_L between 1.6 and 2.1. This corresponds to median compensated wage elasticities of hours of 0.57 for the lowest profit type I, falling to 0.32 for the highest profit type V. The implied Marshallian elasticities are substantially lower, with a median of zero, indicating sizeable income effects.

The second panel of the table summarise the parameters that govern the start-up and incorporation costs. These are expressed in terms of utils, so we convert these to a monetary annual equivalent to aid interpretation.[29] The start-up costs captures any differences between the value the agent gets from being employed and running a business that are not explicitly modelled. For the lowest profit type I agents, we estimate the median start-up cost to be £300, increasing to £3,800 for type V. This may include any differences in wages that the agent could earn as an employee compared with the profits made as a business owner; since we do not have data on business owners earnings as employees, we cannot separately identify these from other start-up costs.[30] Incorporation costs are also substantial, ranging from a median of £3030 for type I agents, to £5950 for type V agents. Costs of this magnitude are necessary to rationalise why many agents choose to remain self-employed when there are substantial tax savings to incorporating.[31]

The final panel of the table presents the estimates of the parameters in the production function. Mean productivity, unsurprisingly, is higher for the higher profit types, and these types also have more persistent productivity shocks. The standard deviation of the productivity shocks is substantial. In Figure E.1 the Appendix, we show how productivity shocks affect exit from business ownership and the decision to incorporate. Longer lived businesses have higher average productivity, at all ages. However, regardless of how long the business survives, there is a drop in average productivity in the last year of the business's life. The model therefore endogenously captures the fact that one cause of firm exit is receiving a bad productivity draw. Productivity also affects the decision to incorporate: in the year in which the agent chooses to incorporate, mean productivity spikes, relative to normal.

We estimate θ in the range between 0.00026 (for type IV) and 0.121 for (type III). Capital and labour are complementary in the model, which generates non-monotonicities in the labour supply policy functions for business owners with respect to assets on hand. When $\theta = 0$ (for type I) i.e. capital is not used in the production process, individuals reduce their labour supply as assets increase, all else equal. However, for higher values of θ, at low levels of assets, an increase in assets leads to higher labour supply, in order to take advantage

[29] To do this, we compute the reduction in consumption (annualised over the number of years the business runs), Δc_i necessary to make the agent indifferent between switching legal forms: $u(c_i, l) + F_i/N_i = u(c_i + \Delta c_i, l_i)$, where N_i is the number of years that the business is active for.

[30] Previous work, for example, Catherine (2017), have found that business owners tend to earn less running a business than if they were employed. As long as this wage differential does not change when we perform our counterfactual policy experiments, we do not need to separate out this channel.

[31] See, also, Tazhitdinova (2016).

of the greater productivity that the capital gives them. Above a certain level of assets, this relationship reverses, and increases in assets lead to a decline in labour supply.

Table 5.2: *Parameters estimated in the second stage*

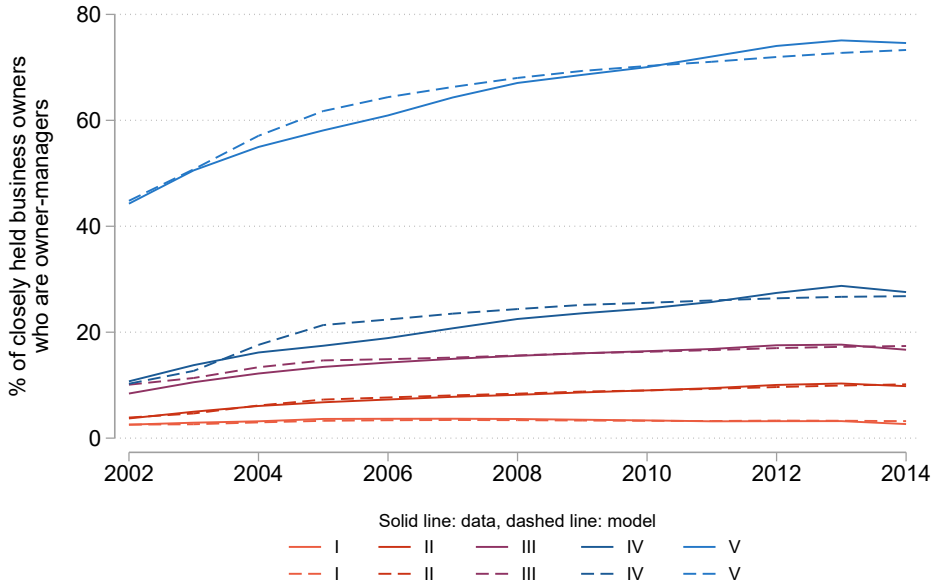
		Type				
	Parameter	I	II	III	IV	V
Utility function						
Discount factor (common across types)	β	0.976				
Optimization error threshold	ς_o	0.022				
Curvature of utility in leisure	ν_l	1.821	1.653	2.160	1.848	2.135
Dispersion of logit shocks	σ_ζ	5.505	5.070	4.780	5.980	3.508
Start-up and incorporation costs						
Start-up cost	F^{start}	2.55	23.97	27.08	10.23	10.60
Additional start-up cost for OM	$F^{start} \times d = OM$	-7.64	-7.61	-12.11	-6.38	-11.22
Lower bound on incorporation costs	$\underline{F}^{inc}$	12.72	14.39	14.51	12.78	16.63
Dispersion of incorporation costs	$\overline{F}^{inc} - \underline{F}^{inc}$	106.27	43.29	26.34	43.56	17.34
Production function						
Mean of latent productivity	μ_ω	0.753	1.157	0.654	2.415	3.416
Std. dev. of latent productivity	σ_ω	0.965	0.610	0.995	0.241	0.112
Std. dev. of productivity shocks	σ_ϵ	0.210	0.342	0.490	0.195	0.179
Persistence of productivity	ρ	0.439	0.671	0.521	0.627	0.859
Importance of capital in production	θ	0.000	0.046	0.121	0.000	0.001

Notes: The discount factor and optimization error threshold are estimated using the data for type V, and assumed to be common across the remaining types. Further details of the estimation process are described in Appendix D.

5.5 Model fit

Figure 5.1 summarises a subset of the targeted moments. The model does a good job of fitting the data – the top figure shows that the model captures the level and change in share of business owners that are owner-managers in each type over our period of study. The bottom panel shows that the fit for other targeted moments. We do a good job matching mean profit levels for the self-employed and owner-managers of different types, as well as the persistence and permanent components of profit. We also match mean investment as a share of mean profit well for types III-V, overshooting for type II. The fit for retained profits for type V (which helps to pin down the discount factor) is good, although we undershoot the median.

Figure 5.1: *Selected targeted moments*

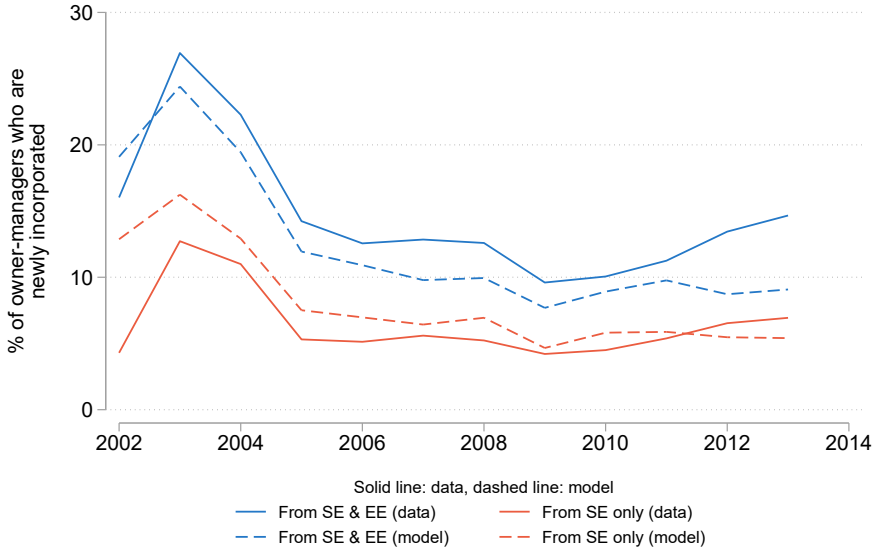


		Type				
		I	II	III	IV	V
Mean profit - SE	Data	7890	12314	11248	27399	77792
	Model	7563	11337	11880	27093	80611
Mean profit - OM	Data	8216	18368	27657	34873	83568
	Model	14949	19602	30167	34073	83231
Std. dev. profit - SE	Data	7161	11375	18605	15172	44427
	Model	8470	12582	18768	15033	46036
Std. dev. profit - OM	Data	11388	22057	41617	24218	48938
	Model	12566	17641	32311	16105	42190
Std. dev. permanent comp. of log profit	Data	1.07	0.80	1.14	0.38	0.33
	Model	1.04	0.78	1.13	0.41	0.43
Coeff. on AR(1) of log profit	Data	0.26	0.35	0.28	0.45	0.59
	Model	0.24	0.38	0.26	0.43	0.60
Investment/profit	Data	–	0.19	0.57	0.03	0.04
	Model	–	0.29	0.58	0.03	0.02
p.50 retained profits	Data	–	–	–	–	3155
	Model	–	–	–	–	1279
p.75 retained profits	Data	–	–	–	–	14169
	Model	–	–	–	–	14511
p.90 retained profits	Data	–	–	–	–	32270
	Model	–	–	–	–	31485

Notes: The top figure shows the share of closely held business owners who are owner-managers in each year for each type, both in the data and simulated in the model. The bottom panel shows a variety of moments targeted in estimation and their model counterparts. Details of the estimation process are provided in Appendix E.
Source: Authors' calculations using HMRC administrative datasets and model simulations.

Figure 5.2 shows that the model matches the increase in incorporation during the years when the 0% starting rate of corporation tax was in place. In the Appendix, we show these conditional on types, as well as entry rates for owner-managers and self-employed by type. We use the model to consider a counterfactual world in which the 0% starting rate of corporation tax had not been in place. 19% of agents who started an incorporated business from employment in the 0% CT years would not have done so, had the 0% rate not been in place. However, over 90% of these would have started an *unincorporated* business instead during this time.[32] This indicates that increasing the tax advantage to incorporation acts primarily to induce people to shift from self-employment to being owner-managers, rather than leading more people to enter business ownership. Below we show that a similar effect is evident when we investigate the removal of the preferential rate of capital gains tax that primarily benefits owner-managers.

Figure 5.2: *Extensive margin responses*

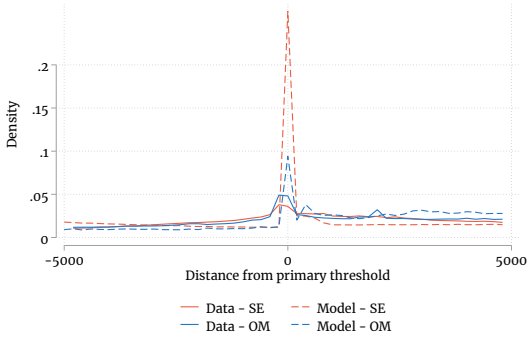


Notes: Details of the estimation process are provided in Appendix E.
Source: Authors' calculations using HMRC administrative datasets and model simulations.

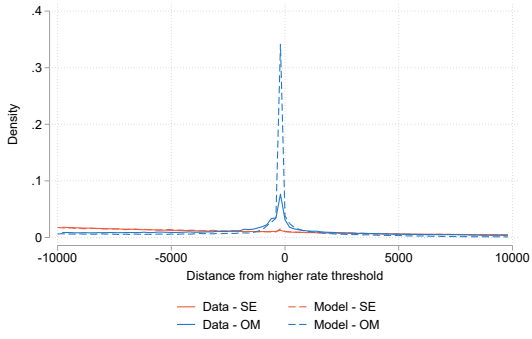
[32] This is also evident in the data, in that we see no increase in the number of new small businesses during the period that the 0% starting rate of corporation tax was in place.

Figure 5.3: *Intensive margin responses*

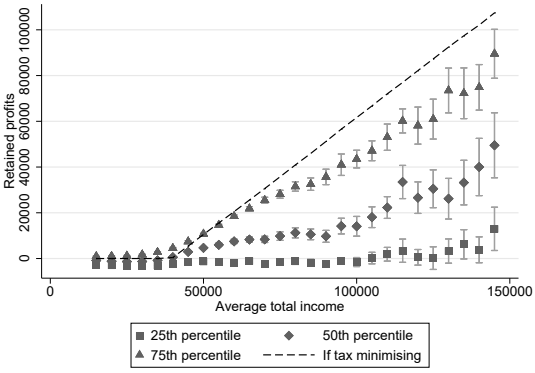
(a) Bunching: primary threshold



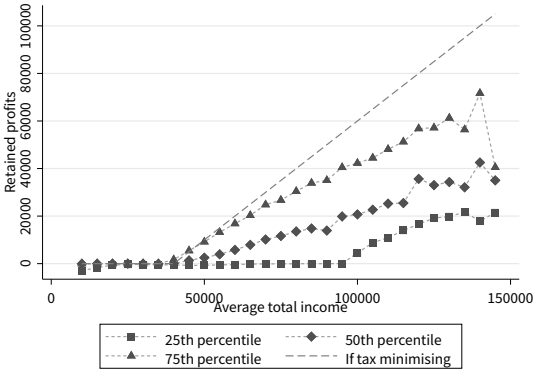
(b) Bunching: higher rate threshold



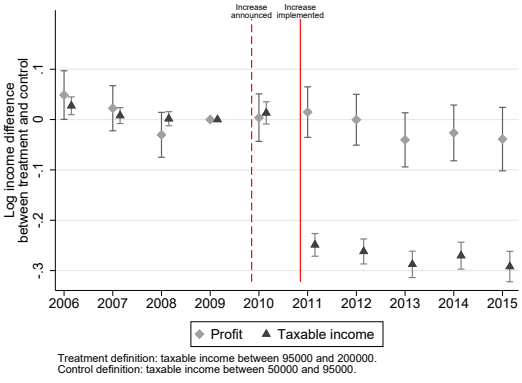
(c) Retained profits: data



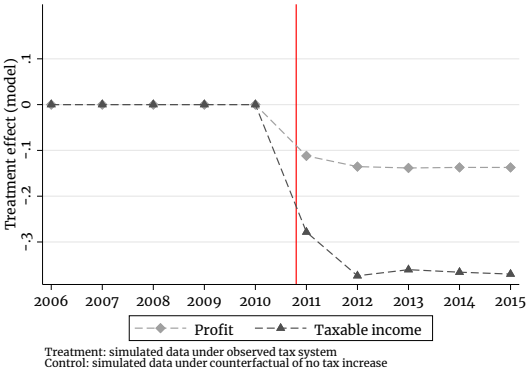
(d) Retained profits: model



(e) Increased top rates: data



(f) Increased top rates: model



Notes: The top left hand panel shows bunching around the primary threshold in the data and simulated from the model, and the top right hand panel shows bunching around the higher rate threshold in the data and simulated from the model. The middle left hand panel reproduces Figure 5.6 from Miller, Pope, and Smith (2020), and the middle right hand panel conducts the same exercise on data simulated from the model. The bottom left hand panel reproduces Figure 5.5(a) from Miller, Pope, and Smith (2020). The bottom right hand panel shows the change in log profit and log taxable income simulated in the model between the actual tax system, and a counterfactual which does not introduce the higher rates of tax on top incomes from 2011 onwards.
Source: Authors' calculations using HMRC administrative datasets and model simulations.

We do a reasonable job of matching behaviour at the intensive margin of business ownership. Figure 5.3(a) and (b) shows that the model generates bunching at tax thresholds. Although the fit is not perfect – we generate too much bunching in self-employed profit at the primary threshold – the model does capture the pronounced bunching at the higher rate threshold for owner-managers, as well as the fact that the excess mass for the self-employed is much lower at this kink. Panels (c) and (d) show how the distribution of retained profits (for owner-managers) varies with the average profit of the company. We match the median well, but do not quite capture the breadth of the distribution of conditional retained profits, overshooting the 25th percentile and undershooting the 75th. One possible explanation for this is that we assume a discount factor that is common for everyone. The final two panels in Figure 5.3 compare the impact of the introduction of higher rates of tax on top incomes in 2011 predicted by the model with that estimated in Miller, Pope, and Smith (2020). We get slightly larger effects of the tax increase on both profit and taxable income than estimated using the data; however, the effects are a similar order of magnitude, and the difference between the profit and taxable income changes is comparable. The model also predicts no change in investment following the introduction of the higher rates, which is also in line with the findings of Miller, Pope, and Smith (2020).

6 Policy experiments

The motivation for estimating a structural model of business ownership is to explore the implications of counterfactual policy reforms. We consider reforms to the rates and base of capital taxes levied on small business owners.

6.1 Changing capital tax rates

Owner-managers with average profit above the higher rate threshold (≈£40,000) have an incentive to retain profits within their companies until they liquidate the business. On liquidation, they can withdraw the income as capital gains, which is taxed at a lower rate (10%) than they would be charged on dividend income (25%). This incentive leads to individuals retaining substantial amounts in their companies, seen both in the data and predicted by the model (Figure 5.3(c) and (d)). Miller, Pope, and Smith (2020) show that these retained profits are held in the form of cash, and not associated with any additional capital investment. We assess the impact of removing this preferential capital gains tax rate by using the model

to simulate a counterfactual world in which this rate had not been in place over our period of study. We assume instead that any profits withdrawn at company liquidation would be taxed at the normal rate of capital gains tax (20%, compared with 10% under Entrepreneur's Relief).[33] Figure 6.1 shows the impact of this reform.

The top left panel shows that there is a substantial fall in the number of owner-managers, and particularly so at higher average profit levels. However, this is entirely offset by individuals instead choosing to be self-employed, such that the total number of closely held businesses does not change as a result of the reform. This is because the vast majority of those starting incorporated businesses in the pre-reform world prefer incorporation to self-employment, but prefer self-employment to remaining employed. This is driven by two things. First, the estimated distribution of incorporation costs: only a small fraction of owner-managers are estimated to get positive non-tax benefits from incorporation. Second, incorporation remains tax advantaged, relative to self-employment, and the removal of the preferential rate acts only to reduce this advantage. Thus some people (with relatively high incorporation costs) opt not to incorporate in the post-reform world, but still choose to start businesses.

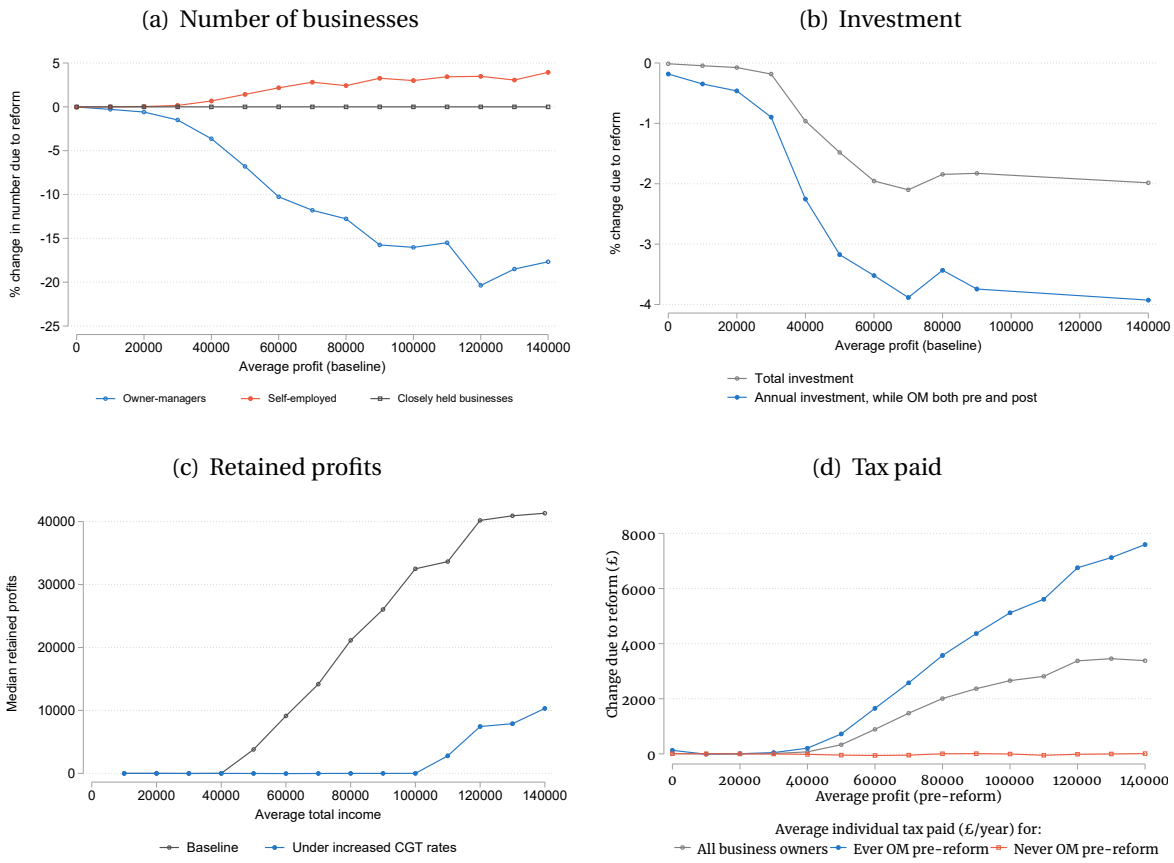
The top right panel shows the percentage change in total investment for individuals with different levels of average profit pre-reform. Investment falls by approximately 2% per year, for individuals with average profit (pre-reform) in excess of £60,000. The figure also shows the percentage change in mean annual investment for business owners in the years that they were self-employed both pre- and post-reform, and analogously for those that were owner-managers both pre- and post-reform. Investment falls by more than average for those that were (and remained) owner-managers. Overall, there is a 0.35% decline in aggregate closely held business investment due to the removal of the preferential rate of capital gains tax.

The main benefit of removing the preferential rate of capital gains tax is to increase tax revenue. This is achieved both through the fact that some business owners choose to be self-employed as opposed to incorporated (and therefore pay higher average rates), and owner-managers have a lower incentive to retain profits and instead pay dividend tax in the year profits arise. The bottom left panel shows that retained profits fall substantially due to the reform, although are still positive for those making more than £100,000. The bottom right hand panel shows the increase in average tax paid (£ per year) at different average profit levels. Across all business owners, the average tax paid per year increases by more than £2000 for

[33] In the March 2020, "Entrepreneur's Relief" was renamed "Business Asset Disposal (BAD) Relief" and a £1 million lifetime limit on total gains that could be claimed was introduced. We do not consider the implications of this reform in our counterfactual analysis.

those making more than £80,000 in profit pre-reform. However, this masks differences across those business owners who were and were not owner-managers prior to the reform. There is no tax change in tax paid among those business owners who were never owner-managers pre-reform. Among those who *were* owner-managers pre-reform, tax paid increases by almost £8000 for those making an average of £140,000 per year. Overall, the reform leads to an increase in tax revenue of £436m per year (3.2%); 39% of this comes from individuals making average profits of more than £100,000 – the top 1% of closely held business owners.

Figure 6.1: *Impact of removing the preferential rate of capital gains tax*



Notes: We use the model to simulate the effect of removing the preferential rate of capital gains tax over the period 2002-14. The top left panel shows the percentage change in the number of individuals who were ever owner-managers, self-employed, or at least one over this period, by the average profit earned pre-reform. The top right panel shows the percentage change in total investment by individuals in bins based on average profit earned pre-reform. The bottom left panel shows the median retained profits before and after the reform for owner-managers with different levels of average profit. The bottom right panel shows the change in average tax paid by individuals in each bin, expressed in £per year.
Source: Model simulations.

6.2 Changing the capital tax base

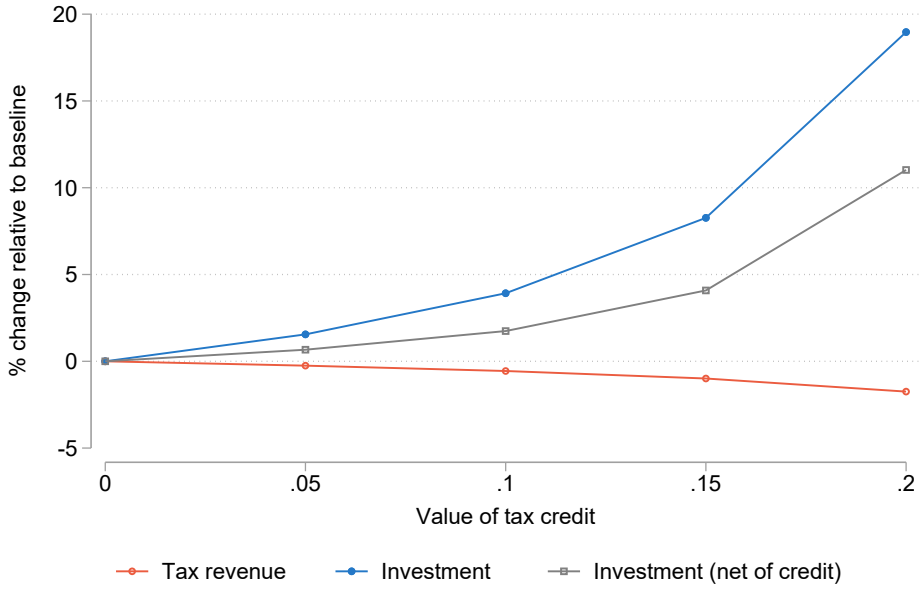
We now consider reforms to the capital tax base that effectively make upfront capital investments cheaper. There are a variety of policy instruments that could achieve this. One possibility is to provide a tax credit for new equity invested in incorporated small businesses. Under the current system, new equity investments by company owner-managers are discouraged because the normal rate of return is subject to personal tax. Specifically, we analyse the impact of tax credits for new equity invested in incorporated businesses (i.e. by owner-managers). We vary the credit, φ, between 0 and 0.2, which has the effect of grossing up any new equity injections for capital investment. When φ equals the personal tax rate paid on income withdrawn from the company (i.e. the dividend or capital gains tax rate) then this reform is equivalent to removing both the investment and the normal rate of return on that investment from the capital tax base. It is therefore neutral with respect to investment. However, if φ exceeds the rate at which income is withdrawn, then this is effectively a subsidy for investment, and if it is less, then it is still taxed. Figure 6.2 shows the impact of varying φ.

The top panel shows the impact on aggregate investment and tax revenue. Tax credits for investment lead to much larger proportional increases in investment than falls in tax revenue. For example, when $\varphi = 0.1$, aggregate investment increases by almost 4% with tax revenue falling by 0.55%. The grey line shows that investment increases beyond the mechanical effect of the deduction in the year of equity injection, as higher profits are subsequently reinvested.

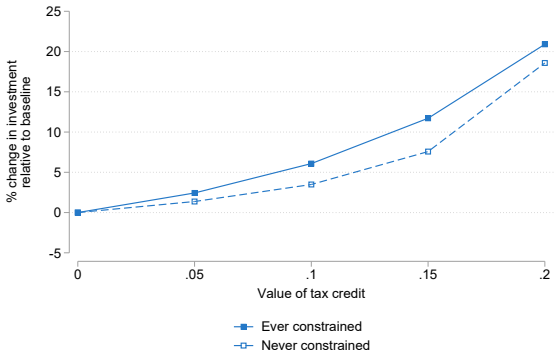
The fact that the credit is given upfront acts to relax the capital constraint some business owners face. In the bottom two panels, we show how behaviour changes for business owners by whether they were ever capital constrained pre-reform, which we define as investing at least 95% of their total assets. The bottom left panel shows that the increase in investment is higher for those who were capital constrained at some point. In order to take advantage of the deduction, business owners need to be incorporated, which increases the incentive to become owner-managers. The bottom right hand panel shows that there was a substantial increase in the number of owner-managers, primarily driven by those who were capital constrained. It did not affect the overall number of closely held businesses, however.

Figure 6.2: *Impact of deductions for new equity investments*

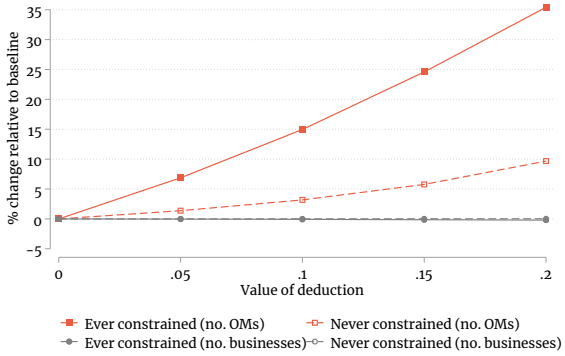
(a) Aggregate effect



(b) Investment, by capital constraints



(c) Legal form, by capital constraints



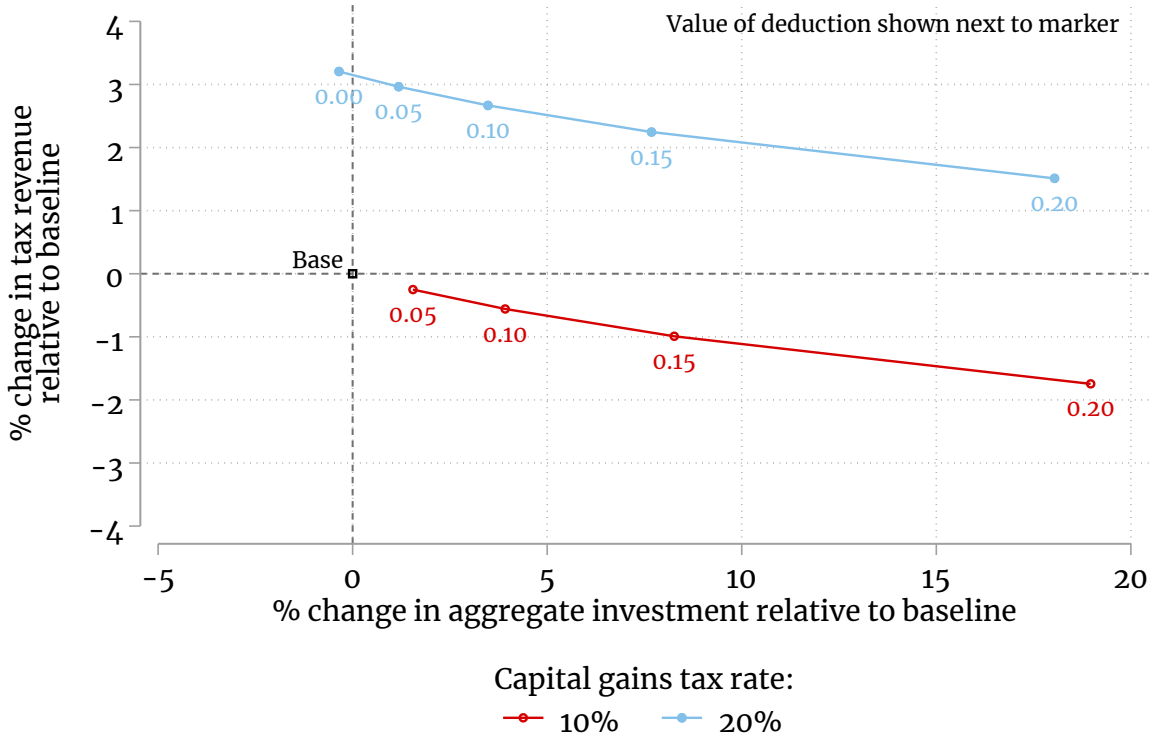
Notes: We vary φ between 0 and 0.2 as counterfactual scenarios to our period of study (all other features of the tax system remain the same). The top panel shows the percentage change in tax revenue, investment, and investment net of the credit, for each value of the tax credit. The bottom left panel shows the percentage change in investment by whether the business owners was ever capital constrainted (invested more than 95% of assets) pre-reform. The bottom right hand shows the percentage change in the number of owner-managers and small business owners, again, by capital constraints in the pre-reform world.
Source: Model simulations.

6.3 Combining tax rate and base reforms

We show above that increasing the capital gains tax rate leads to large rises in tax revenue and small falls in aggregate investment, whereas providing investment tax credits leads to big

rises in investment and smaller falls in tax revenue. We now show how combining rate and base changes can lead to increases in aggregate investment *and* tax revenue. We consider reforms that increase the capital gains tax rate available to business owners from 10% to 20% (i.e. as in Section 6.1), in addition to providing tax credits ranging between 0 and 0.2 (as in Section 6.2).

Figure 6.3: *Impact on tax revenue and investment from combining tax rate and base reforms*



Notes: The red line plots the percentage change in aggregate investment and tax revenue (relative to baseline) for values of the deduction for new equity investment between 0.05 and 0.2, when the capital gains tax rate equals 10%. The blue line plots the percentage change in aggregate investment and tax revenue for values of the deduction for new equity investment between 0 and 0.2, when the capital gains tax rate equals 20%.
Source: Model simulations.

Figure 6.3 summarises the impact of these reforms. The red line illustrates the changes in aggregate investment and tax revenue under each value of the credit in combination with the 10% capital gains rate, as described in Section 6.2. The blue line shows the impact of the tax credits in combination with the higher rate of capital gains tax: all the points where $\varphi >= 0.05$ are in the top right quadrant i.e. lead to higher tax revenue and investment. Increasing the capital gains tax rate on closely held business income to 20% and providing a deduction for

new equity equal to 5% leads to a 3% increase in tax revenue, and 1.2% increase in aggregate small business investment.

This illustrates how lower capital tax rates for business owners are poorly targeted at investment, are costly in revenue terms, and (as shown above) primarily benefit those on higher incomes. Removing this preferential treatment raises significant revenue, and the small decline in investment can be more than offset by reforms to the tax base. If policymakers wished to go further, providing more generous tax credits would lead to larger increases in closely held business investment and, if combined with higher capital gains tax rates, more tax revenue than the baseline policy environment.

7 Conclusion

We develop and estimate a dynamic model to study the impact of capital tax reforms on small business formation, exit and investment, as well as over the legal form of the business and the shifting of income across tax bases and time. We use this model to consider the impact of a range of counterfactual policy experiments and assess how well targeted they are at the market failures associated with entrepreneurial activity. We show that preferential rates of capital gains tax are poorly targeted at encouraging investments, and removing them would lead to substantial increases in tax revenue, which would come from the highest profit individuals. In contrast, targeted tax credits for investment are cheaper in revenue terms, and lead to much larger increases in aggregate investment.

In this paper we focus on small businesses run by, effectively, a single agent. These are an important part of the workforce, and often the target of tax policy aimed at boosting entrepreneurship. An important avenue for future research will be to investigate the implications of reforms for larger (but still closely held) companies, which are likely to have more complicated ownership structures.

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Appendix

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. We also use information from the Longitudinal Small Business Survey. This appendix describes the data.

A.1 Administrative tax data

Personal income tax data

Information on small business owners is from the universe of self–assessment income tax records, available from 2000-01 to 2015-16. Most UK adults are not required to complete a self–assessment tax return (between 9 and 10 million did so each year, out of an adult population of more than 40 million). All company directors and those with self-employment income are required to submit a self-assessment tax return.[34]

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). For the self-employed, it records information on business expenses, such as the use of capital allowances.

Company data

Information on the business operations of incorporated businesses comes from two sources. First, we use 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.[35] 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

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

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

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. Table A.1 sets out the information provided on the number of directors and number of shareholders for companies that file accounts covering 12 months at least once between April 6th 2012 and April 5th 2015. In 2% of cases information on the number of directors is missing and in 23% of cases the number of shareholders is missing. Miller, Pope, and Smith (2020) show that those with missing shareholder information are disproportionately younger, lower profit and have lower asset values than those with non-missing information.

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.

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.

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 di-

rectors 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 2002.

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. 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.

This match is also used by Miller et al. (2020), who compare the matched and unmatches samples extensively. To summarise, the matched companies are similar in terms of company age, have lower (at the mean) turnover and assets, but higher profits. 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.

In this paper, we take as our starting point individuals who record being directors of close companies – this is defined as a, "a company which is under the control of: five or fewer participators, or any number of participators if those participators are directors, more than half the assets of which would be distributed to five or fewer participators, or to participators who are directors, in the event of the winding up of the company." Note that this is not the same as the list of 4.5 million company directors that HMRC tried to match to self-assessment tax records. We match approximately two-thirds of these to the corporate tax records and company accounts of their companies, using the HMRC match file. Of those matched, we keep those whose companies have fewer than two directors and two shareholders. Many two director, two shareholder companies have two spouses as their owner-managers, reflecting the tax advantage to doing so. This allows us to focus on businesses that are essentially under the control of one agent, to avoid the complicating factors of multi-owner businesses.

A.2 Longitudinal Small Business Survey

We supplement the information from tax records with survey data on small businesses collected by the UK's Department of Business, Energy and Industrial Strategy. We use informa-

tion on 19,023 small businesses (defined as either self-employed or companies with two or fewer owners) interviewed over the period 2015 to 2017.

The survey asks businesses on their number of employees, which are not recorded in tax data. 81% have no employees, and a further 15% have between 1 and 9 employees: these businesses are not major employers.

The survey asks a set of questions seeking to elicit businesses plans for the next three years. These include, "Do you plan on investing in the next three years?", and "Do you plan on launching new products/services?". Table A.2 shows the the fraction of businesses that plan on launching new products or services, conditional on their plans to invest.

Table A.2: *Correlation between investment and innovation plans*

	Plan on launching new products:	
Plan on investing:	No	Yes
No	77%	22%
Yes	44%	55%

Notes: The numbers show the proportion of businesses that plan on launching new products or services, conditional on their plans to invest over the next three years. Numbers shown for 19,023 small businesses, and weighted using weights provided.

Source: Longitudinal Small Business Survey, 2015-17.

B Tax system and its effects

B.1 Tax system

Rates and thresholds

Tables B.1, B.2 and B.3 set out, for each year that our analysis covers, the relevant thresholds and statutory tax rates for the corporate, personal income and capital gains tax systems respectively.

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

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Thresholds (£)				Marginal rate (%)				
Tax year	Lower rate threshold ($\pi 1$)	Lower rate marginal relief end ($\pi 2$)	Small profits rate threshold ($\pi 3$)	Small profits marginal relief end ($\pi 4$)	$\pi < \pi 1$	$\pi 1 \leq \pi < \pi 2$	$\pi 2 \leq \pi < \pi 3$	$\pi 3 \leq \pi < \pi 4$	$\pi \geq \pi 4$
2002-03	10,000	50,000	300,000	1,500,000	0.0	22.5	20.0	32.8	30.0
2003-04	10,000	50,000	300,000	1,500,000	0.0	23.8	19.0	32.8	30.0
2004-05*	10,000	50,000	300,000	1,500,000	0.0	23.8	19.0	32.8	30.0
2005-06*	10,000	50,000	300,000	1,500,000	0.0	23.8	19.0	32.8	30.0
2006-07			300,000	1,500,000	19.0	19.0	19.0	32.8	30.0
2007-08			300,000	1,500,000	20.0	20.0	20.0	32.5	30.0
2008-09			300,000	1,500,000	21.0	21.0	21.0	29.8	28.0
2009-10			300,000	1,500,000	21.0	21.0	21.0	29.8	28.0
2010-11			300,000	1,500,000	21.0	21.0	21.0	29.8	28.0
2011-12			300,000	1,500,000	20.0	20.0	20.0	27.5	26.0
2012-13			300,000	1,500,000	20.0	20.0	20.0	25.0	24.0
2013-14			300,000	1,500,000	20.0	20.0	20.0	23.8	23.0
2014-15			300,000	1,500,000	20.0	20.0	20.0	21.3	21.0

*Note: Table sets out the relevant thresholds for pre-tax corporate profit, π, (columns 2-5) and the marginal corporation tax rate on profits that apply on profits between these thresholds. *After 2003–4, the starting rate of corporation tax (applying below the lower-rate threshold) only applied to profits that were not distributed to shareholders in that tax year.*

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

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Thresholds (£)				Dividend tax rates			Ordinary income tax rates		
Tax year	Primary threshold (PT)	Higher-rate threshold (HRT)	PA withdrawal	Additional-rate threshold (ART)	Below HRT	HRT to ART	Above ART	Below HRT	HRT to ART	Above ART
2002-03	4,524	34,515			0.0	25.0	25.0	22.0	40.0	40.0
2003-04	4,628	35,115			0.0	25.0	25.0	22.0	40.0	40.0
2004-05	4,732	36,145			0.0	25.0	25.0	22.0	40.0	40.0
2005-06	4,888	37,295			0.0	25.0	25.0	22.0	40.0	40.0
2006-07	5,044	38,335			0.0	25.0	25.0	22.0	40.0	40.0
2007-08	5,200	39,825			0.0	25.0	25.0	22.0	40.0	40.0
2008-09	5,460	40,835			0.0	25.0	25.0	20.0	40.0	40.0
2009-10	5,720	43,875			0.0	25.0	25.0	20.0	40.0	40.0
2010-11	5,720	43,875	100,000 - 112,950	150,000	0.0	25.0	36.1	20.0	40.0	50.0
2011-12	7,228	42,475	100,000 - 114,950	150,000	0.0	25.0	36.1	20.0	40.0	50.0
2012-13	7,592	42,475	100,000 - 116,210	150,000	0.0	25.0	36.1	20.0	40.0	50.0
2013-14	7,748	41,450	100,000 - 118,880	150,000	0.0	25.0	30.6	20.0	40.0	45.0
2014-15	7,956	41,865	100,000 - 120,000	150,000	0.0	25.0	30.6	20.0	40.0	45.0

Note: Table sets out the statutory thresholds (columns 2-5) that determine the point at which personal taxes are due (primary threshold) and the end of the basic rate (higher rate threshold). Columns (6)-(8) show the statutory tax rates applied to dividend income and columns (9)-(11) show the statutory tax rates applied to ordinary (e.g. employment and self-employed) income. PA withdrawal is the point at which the tax-free income tax personal allowance begins to be withdrawn (an individual loses 50p of their personal allowance for every pound they earn until their personal allowance is zero).

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

(1) Tax year	(2) Capital gains allowance (£)	(3) Marginal rate (%) if taxable income is:	(4)
		Below HRT	Above HRT
2002-03	7,700	5.5	10.0
2003-04	7,900	5.5	10.0
2004-05	8,200	5.5	10.0
2005-06	8,500	5.5	10.0
2006-07	8,800	5.5	10.0
2007-08	9,200	5.5	10.0
2008-09	9,600	10.0	10.0
2009-10	10,100	10.0	10.0
2010-11	10,100	10.0	10.0
2011-12	10,600	10.0	10.0
2012-13	10,600	10.0	10.0
2013-14	10,900	10.0	10.0
2014-15	11,000	10.0	10.0

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

Effective marginal tax rates

In this section, we describe how the statutory rates and thresholds translate into effective marginal tax rates.

Table B.4: *Definitions statutory rates and and thresholds*

Parameter	Description
Personal income tax and NICs thresholds	
γ^{PA}	personal allowance
γ^{PT}	NICs primary threshold (employees)
γ^{ST}	NICs secondary threshold (employers)
γ^{UEL}	NICs upper earnings limit
γ^{LPL}	NICs lower profit limit (self-employed)
γ^{UPL}	NICs upper profit limit (self-employed)
γ^{BRT}	basic rate threshold (in excess of PA)
γ^{HRT}	higher rate threshold (in excess of PA)
γ^{WPA}	point at which PA gets withdrawn
γ^{ART}	additional rate threshold
Personal income tax rates	
$\tau^{SR}_{inc,E}$	starting rate applied to employment income
$\tau^{BR}_{inc,E}$	basic rate applied to employment income
$\tau^{HR}_{inc,E}$	higher rate applied to employment income
$\tau^{AR}_{inc,E}$	additional rate applied to employment income
$\tau^{SR}_{inc,D}$	starting rate applied to dividend income
$\tau^{BR}_{inc,D}$	basic rate applied to dividend income
$\tau^{HR}_{inc,D}$	higher rate applied to dividend income
$\tau^{AR}_{inc,D}$	additional rate applied to dividend income
National Insurance Contributions (NICs) rates	
$\tau^{LEL}_{nics,ee}$	class 1 employee rate applied between PT and UEL
$\tau^{UEL}_{nics,ee}$	class 1 employee rate applied above UEL
$\tau_{nics,er}$	class 1 employer rate applied above ST
$\tau^{LPL}_{nics,se}$	class 4 employee rate applied between LPL and UPL
$\tau^{UPL}_{nics,se}$	class 4 employee rate applied above UPL
Corporate tax system	
ζ^{SRT}	starting rate threshold
ζ^{SRE}	starting rate end of marginal relief
τ^{SR}_{corp}	starting rate
τ^{MR}_{corp}	marginal relief fraction
τ^{SCR}_{corp}	small companies' rate

Note: Table defines statutory thresholds and rates used to compute effective marginal tax rates.

The effective marginal tax rates paid on an extra pound of income earned depend on income level and legal form. Table B.4 defines thresholds and rates used to compute effective

marginal tax rates on different forms of income. Let z denote the total value created by work (i.e. profit for self-employed or owner-managers, and total employer cost for employees.) The effective marginal tax rates are as follows.

Self-employed. Marginal rates:

$$MTR = \begin{cases} 0 & \text{if} \quad z \leq \gamma^{PA} \\ \tau^{SR}_{inc,E} & \text{if} \quad \gamma^{PA} \leq z \leq \gamma^{LPL} \\ \tau^{SR}_{inc,E} + \tau^{LPL}_{nics,se} & \text{if} \quad \gamma^{PA} < z \leq \gamma^{PA} + \gamma^{BRT} \\ \tau^{BR}_{inc,E} + \tau^{LPL}_{nics,se} & \text{if} \quad \gamma^{PA} + \gamma^{BRT} < z \leq \gamma^{PA} + \gamma^{HRT} \\ \tau^{HR}_{inc,E} + \tau^{UPL}_{nics,se} & \text{if} \quad \gamma^{PA} + \gamma^{HRT} < z \leq \gamma^{PA} + \gamma^{WPA} \\ 1.5\tau^{HR}_{inc,E} + \tau^{UPL}_{nics,se} & \text{if} \quad \gamma^{PA} + \gamma^{WPA} < z \leq \gamma^{PA} + \gamma^{WPA} + 2 * \gamma^{PA} \\ \tau^{HR}_{inc,E} + \tau^{UPL}_{nics,se} & \text{if} \quad \gamma^{PA} + \gamma^{WPA} + 2 * \gamma^{PA} < z \leq \gamma^{ART} \\ \tau^{AR}_{inc,E} + \tau^{UPL}_{nics,se} & \text{if} \quad z \geq \gamma^{ART} \end{cases}$$

Owner-managers. The optimal withdrawal strategy, given total earnings (all to be withdrawn in this year): take γ^{PT} in salary, and then pay dividends above this amount. Corporate taxable profit is therefore $z - \gamma^{PT}$. Here note that γ^{BRT} and γ^{HRT} are defined in excess of the primary threshold (PT), as opposed to the personal allowance (PA). Marginal rates:

$$MTR = \begin{cases} 0 & \text{if} \quad z \leq \gamma^{PT} \\ \tau^{SR}_{corp} + (1 - \tau^{SR}_{corp})\tau^{BR}_{inc,D} & \text{if} \quad \gamma^{PT} \leq z \leq \gamma^{PT} + \zeta^{SRT} \\ \tau^{MR}_{corp} + (1 - \tau^{MR}_{corp})\tau^{BR}_{inc,D} & \text{if} \quad \gamma^{PT} + \zeta^{SRT} \leq z \leq \gamma^{PT} + \zeta^{SRT} + \frac{\gamma^{HRT} - (1-\tau^{MR}_{corp})\zeta^{SRT}}{(1-\tau^{MR}_{corp})} \\ \tau^{MR}_{corp} + (1 - \tau^{MR}_{corp})\tau^{HR}_{inc,D} & \text{if} \quad \gamma^{PT} + \zeta^{SRT} + \frac{\gamma^{HRT} - (1-\tau^{SR}_{corp})\zeta^{SRT}}{(1-\tau^{MR}_{corp})} \leq z \leq \gamma^{PT} + \zeta^{SRE} \\ \tau^{SC}_{corp} + (1 - \tau^{SC}_{corp})\tau^{HR}_{inc,D} & \text{if} \quad \gamma^{PT} + \zeta^{SRE} \leq z \leq \frac{\gamma^{WPA}}{(1-\tau^{SC}_{corp})} \\ \tau^{SC}_{corp} + (1 - \tau^{SC}_{corp})1.5\tau^{HR}_{inc,D} & \text{if} \quad \frac{\gamma^{WPA}}{(1-\tau^{SC}_{corp})} \leq z \leq \frac{\gamma^{WPA} + 2\gamma^{PA}}{(1-\tau^{SC}_{corp})} \\ \tau^{SC}_{corp} + (1 - \tau^{SC}_{corp})\tau^{HR}_{inc,D} & \text{if} \quad \frac{\gamma^{WPA} + 2\gamma^{PA}}{(1-\tau^{SC}_{corp})} \leq z \leq \frac{\gamma^{ART}}{(1-\tau^{SC}_{corp})} \\ \tau^{SC}_{corp} + (1 - \tau^{SC}_{corp})\tau^{AR}_{inc,D} & \text{if} \quad z \geq \frac{\gamma^{ART}}{(1-\tau^{SC}_{corp})} \end{cases}$$

If the owner-manager withdraws income in the form of capital gains, as opposed to dividend income, then the rates $\tau^{HR}_{inc,D}$ and $\tau^{AR}_{inc,D}$ are replaced with the capital gains tax rate above the higher rate threshold.

Employees. Given total employer cost, z, then earnings (i.e. net of employer NICs) are $y = z - \tau_{nics,er}(y - \gamma^{PA})$, which implies $z = y(1 + \tau_{nics,er}) - \tau_{nics,er}\gamma^{PA}$. Given this, we can derive the

marginal rates:

$$MTR = \begin{cases} 0 & \text{if} \quad z \leq \gamma^{PA} \\ \frac{1}{1+\tau_{nics,er}}(\tau_{nics,er} + \tau^{SR}_{inc,E} + \tau^{LEL}_{nics,ee}) & \text{if} \quad 0 < z - \gamma^{PA} \leq (1+\tau_{nics,er})\gamma^{BRT} \\ \frac{1}{1+\tau_{nics,er}}(\tau_{nics,er} + \tau^{BR}_{inc,E} + \tau^{LEL}_{nics,ee}) & \text{if} \quad (1+\tau_{nics,er})\gamma^{BRT} < z - \gamma^{PA} \leq (1+\tau_{nics,er})\gamma^{HRT} \\ \frac{1}{1+\tau_{nics,er}}(\tau_{nics,er} + \tau^{HR}_{inc,E} + \tau^{UEL}_{nics,ee}) & \text{if} \quad (1+\tau_{nics,er})\gamma^{HRT} < z - \gamma^{PA} \leq (1+\tau_{nics,er})\gamma^{WPA} \\ \frac{1}{1+\tau_{nics,er}}(\tau_{nics,er} + 1.5\tau^{HR}_{inc,E} + \tau^{UEL}_{nics,ee}) & \text{if} \quad (1+\tau_{nics,er})\gamma^{WPA} < z - \gamma^{PA} \\ & \qquad \leq (1+\tau_{nics,er})(\gamma^{WPA} + 2\gamma^{PA}) \\ \frac{1}{1+\tau_{nics,er}}(\tau_{nics,er} + \tau^{HR}_{inc,E} + \tau^{UEL}_{nics,ee}) & \text{if} \quad (1+\tau_{nics,er})(\gamma^{WPA} + 2\gamma^{PA}) < z - \gamma^{PA} \\ & \qquad \leq (1+\tau_{nics,er})\gamma^{ART} \\ \frac{1}{1+\tau_{nics,er}}(\tau_{nics,er} + \tau^{AR}_{inc,E} + \tau^{UEL}_{nics,ee}) & \text{if} \quad z \geq (1+\tau_{nics,er})\gamma^{ART} \end{cases}$$

Capital allowances

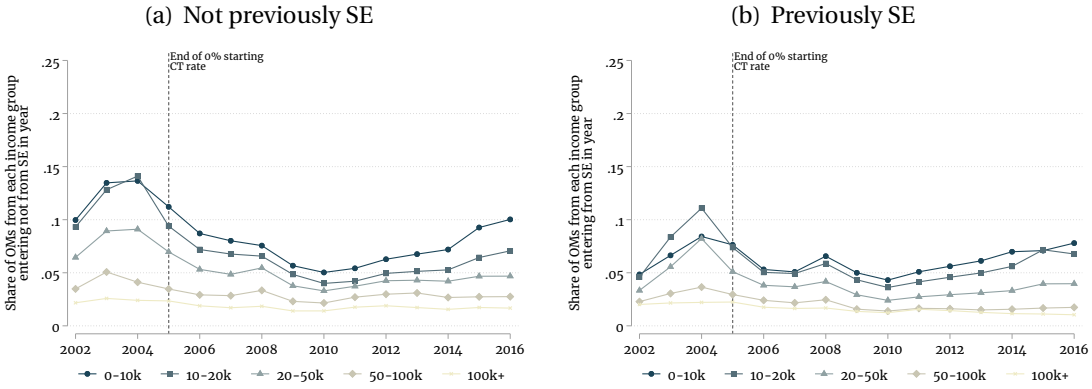
Current expenditure (such as wages and material inputs) is directly deductible from turnover in the calculation of (corporate) taxable profits. For capital expenditure (such as on buildings and machinery that depreciate over time), companies can claim capital allowances.

Since 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.

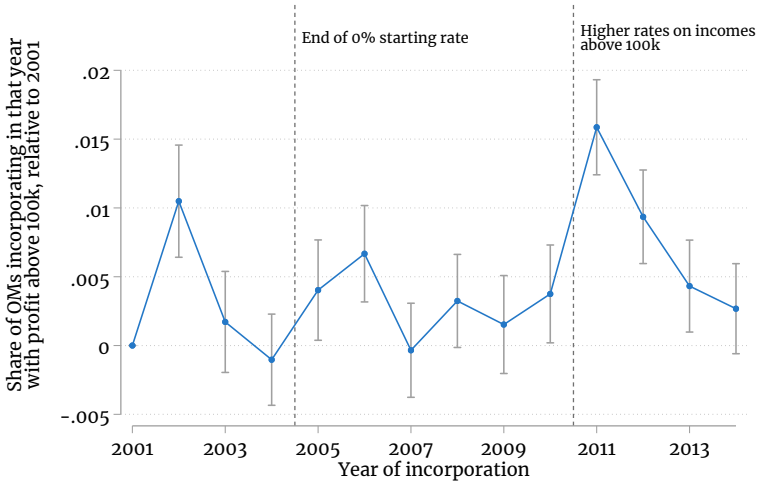
B.2 Additional figures

Figure B.1: *Entry of owner-managers, 2001-16*



Notes: The left hand panel shows the share of owner-managers within each taxable income band that are newly present in each year and were not self-employed in the previous year, and the right hand panel shows the share entering that were self-employed in the previous year.
Source: Authors' calculations using HMRC administrative datasets.

Figure B.2: *Incorporation rates for high profit companies*



Notes: The line shows the share of owner-managers that incorporated in the year shown on the horizontal axis that made profits in excess of £100,000 (in 2014 prices), relative to 2001.
Source: Authors' calculations using HMRC administrative datasets.

C Additional details on clustering

We use a two-step procedure, following Bonhomme et al. (2021), to model latent types of business owner. In the first step, we classify business owners using a k-means clustering ap-

proach, and in the second step, we estimate the parameters of the model separately by the latent types.

When implementing the k-means clustering approach, the researcher needs to decide the variables on which to cluster, and the number of clusters (or types). The choice of variables is motivated by the economic problem faced by agents. We use two variables: (i) business owners' average annual profit, and (ii) business owners' average annual investment as a share of average annual profit. These variables are tightly related to the parameters that govern the productivity process and production function in the model.

C.1 Number of clusters

In order to select the number of clusters we use heuristic methods. Our goal is to approximate the heterogeneity, while limiting the total number of clusters.

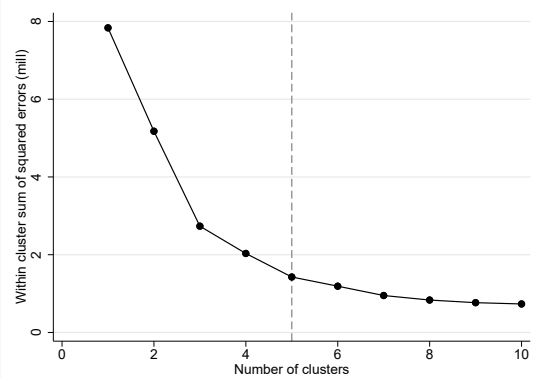
The first heuristic is based on the rate of decline in the within-cluster sum of squared errors as we increase the number of clusters. The idea behind this approach is that when the number of clusters is below the true number, increasing the number is associated with a large decrease in the measure of cluster dissimilarity (sum of squared errors). In contrast, when the number of clusters is above the true number, an increase in the number of clusters leads to a smaller increase in the measure of cluster dissimilarity. Thus, at some K, the decrease in the measure of cluster dissimilarity flattens, and it is at this "elbow" point that indicates the appropriate number of clusters. Figure C.1(a) shows how the cluster dissimilarity declines as we increase the number of clusters from 1 to 10. Beyond 5 clusters, this flattens off considerably, suggesting 5 as the optimal number of clusters.

The second method we use is based on predictive strength, as suggested by Tibshirani and Walther (2005). The basic idea of this approach is to: (i) cluster the test data set into K clusters, (ii) cluster the training data into K clusters, and then (iii) measure how well the training set cluster predicts co-memberships in the test set. For each pair of test observations that are assigned to the same test cluster, we determine whether they are also assigned to the same cluster based on the training centers. For each test cluster, we compute the proportion of observation pairs in that cluster that are also assigned to the same cluster by the training set centroids. The measure of predictive strength takes the minimum over the different test clusters. When $K = 1$, the predictive strength equals 1, since the training and test datasets all fall into one cluster. We choose the largest K such that the predictive strength is above some threshold; Tibshirani and Walther (2005) find that a threshold of 0.8-0.9 works well in

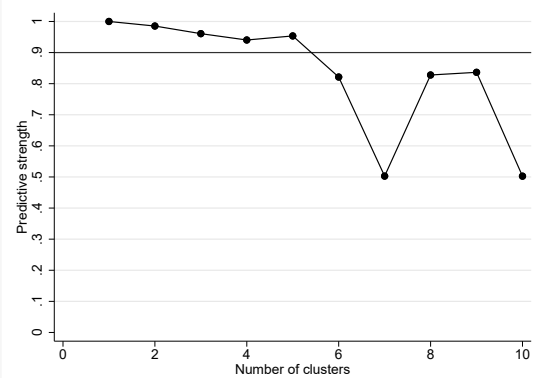
practice. Figure C.1(b) shows the measure of predictive strength for $K = 1, \ldots, 10$, for two-fold cross-validation. $K = 5$ is the largest K such that the predictive strength is above the threshold of 0.9. Both approaches give the optimal number of clusters (elsewhere referred to as types) equal to 5.

Figure C.1: *Methods for determining optimal number of types*

(a) Sum of squared errors



(b) Predictive strength



Notes: The left hand panel shows the within-cluster sum of squared errors when we set the number of types between 1 and 10. The right hand panel shows a measure of predictive strength when we set the number of types between 1 and 10.
Source: Authors calculations using HMRC adminstrative datasets.

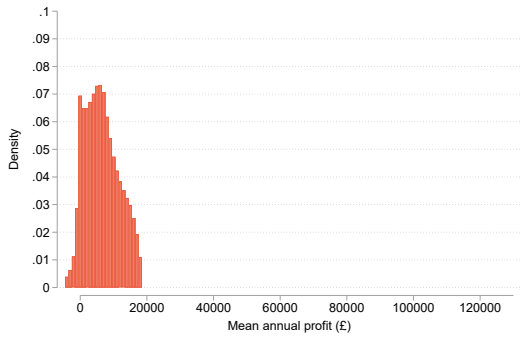
C.2 Distributions within latent types

Figures C.2 and C.3 show the marginal distributions of mean profit, and mean investment as a share of mean profit, within each latent type (referred to as clusters above). These are the variables on which we cluster. The types are ordered by the mean profit levels, with the type I having the lowest profit levels, and type V the highest. For types I, IV and V there is a mass point at zero investment as a share of profit, and for all these types, investment is relatively low. Types II and III do the most investment, as a share of profit, with the average investment as a share of profit equal to 0.19 for type II and 0.57 for type III.

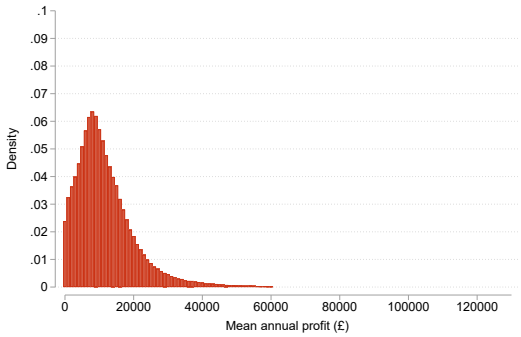
Table C.1 shows that these differences are also reflected in variation in industry composition across types. More than 40% of type V business owners work in business services, while type III (the highest investment type) are more likely to work in agriculture, mining or utilities.

Figure C.2: *Distributions of mean profit by type*

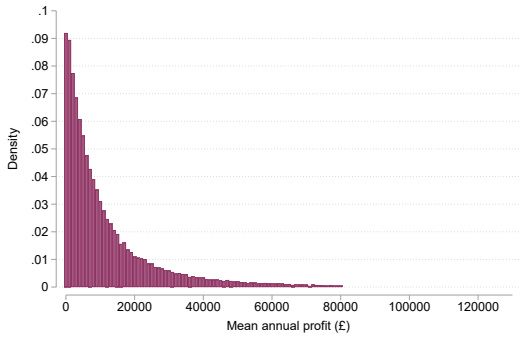
(a) Type I



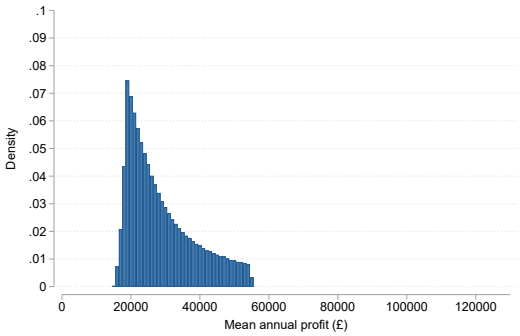
(b) Type II



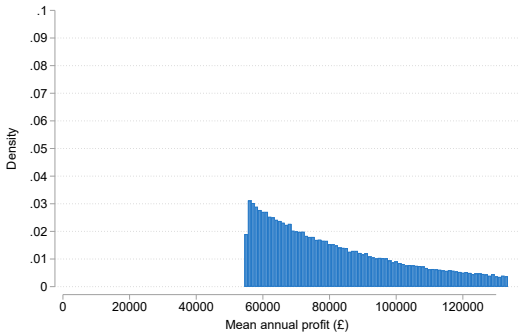
(c) Type III



(d) Type IV



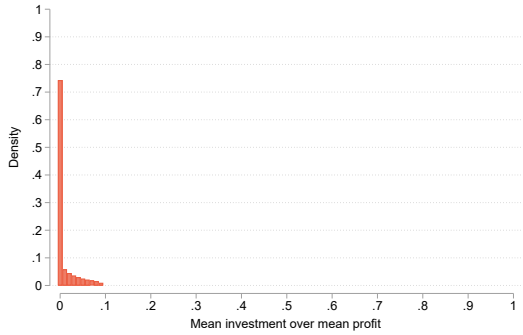
(e) Type V



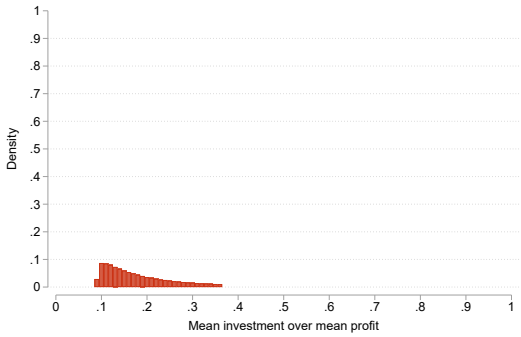
Notes: Each panel shows the distribution of mean profit by the different latent types.
Source: Authors calculations using HMRC administrative datasets.

Figure C.3: *Distributions of mean investment over mean profit by type*

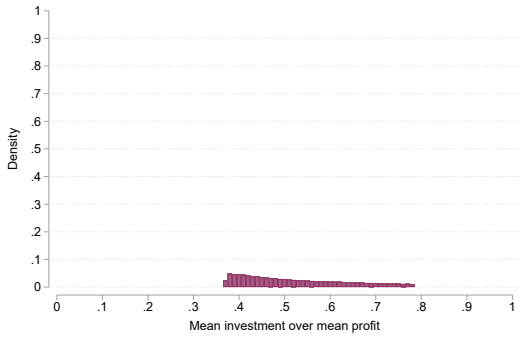
(a) Type I



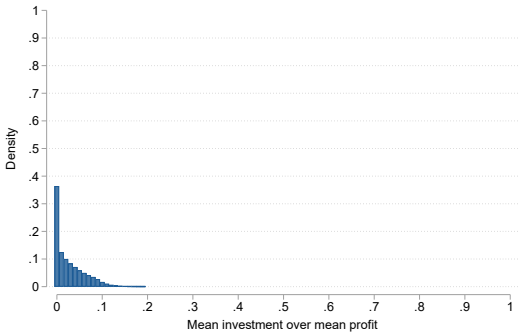
(b) Type II



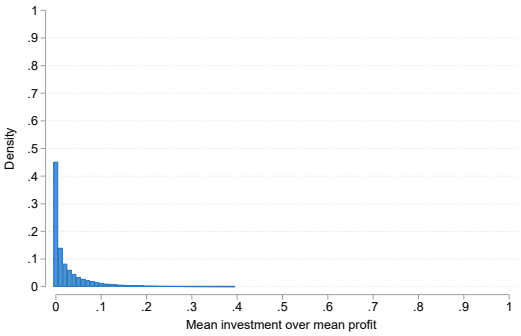
(c) Type III



(d) Type IV



(e) Type V



Notes: Each panel shows the distribution of mean investment as a share of mean profit by the different latent types.
Source: Authors calculations using HMRC administrative datasets.

Table C.1: *Industry distribution by type*

	% of each type in each industry				
	I	II	III	IV	V
Construction	23.3	20.2	10.5	37.0	8.6
Business services	22.8	16.1	16.0	24.0	43.7
Retail	10.7	9.0	8.1	5.6	3.6
Domestic services	9.5	4.8	3.6	1.6	0.2
Medical	6.5	5.7	4.3	5.8	10.5
Transport	5.7	13.6	10.9	3.0	2.5
Wholesale	5.0	8.2	7.9	3.7	1.4
Manufacturing	3.0	4.4	4.7	2.8	1.7
Agriculture, mining, utilities	1.7	5.0	15.3	1.3	0.8
Other/missing	11.9	13.0	18.6	15.3	26.9

Notes: Each column shows the distribution of business owners within each type across the top 10 industries.
Source: Authors' calculations using HMRC administrative datasets.

D Numerical procedure

The model cannot be solved analytically. We therefore use numerical techniques to solve for the policy and value functions. This is done recursively, from the final period of working life (age 60). Working backwards, at each age, we use an endogenous grid point method to solve for the optimal choices of assets, share of assets in the company (for owner-managers), and labour supply, conditional on the choice of capital and legal form next period. We then calculate the expected value of choosing the different legal forms next period, and then, given this, take the max over possible capital choices.

D.1 Discretization

The model has two discrete state variables: age and legal form. Age takes values between 30 and 60, at which point individuals retire with certainty. Legal form can take the values: employee, self-employed, and owner-manager, with the latter running either a one or two shareholder company, which affects the progressivity of the personal tax system.

There are five additional state variables that must be discretized: total assets, the share of assets held in the company, the individual's latent productivity, the transitory productivity component, and the fixed cost associated with incorporation. Total assets are placed on a grid with 25 points, unequally spaced, with more points at the low end of the asset distribution. We can use a relatively low number of grid points because the solution method involves calculating an exact solution to the Euler equation at each point. The share of assets held

in the company is placed on an equally spaced grid with 6 points. The log of individual's latent productivity is placed on a grid with 4 elements using the method of Adda and Cooper (2003).[36] The AR(1) process for the transitory productivity component is placed on a grid with 4 points, using the method developed by Rouwenhorst (1995); Fella et al. (2019) find that this method performs better than others, even with a relatively small number of states. The incorporation fixed cost is assumed to be uniformly distributed (we estimate the bounds of the distribution), and is placed on an equally spaced grid with 6 points.

In addition to legal form, the choice variables each period are: the share of assets to invest in capital, total assets next period, share of assets to hold within the company next period, and labour supply (which jointly imply consumption). We discretize the the investment decision using a grid with 5 points. We iteratively search over next period's share of assets held in the company using a grid with 6 points, such that the intervals on the final grid equal 0.008. Total assets next period and labour supply are not placed on a grid; instead individuals can choose any feasible combination of these variables.

D.2 Solution to the agent's problem

We use a version of the endogenous grid-point method (EGM) for discrete continuous dynamic choice models developed in Iskhakov et al. (2017). The EGM algorithm was first introduced in economics by Carroll (2006), who demonstrates that it improves both speed and accuracy in a buffer stock savings model. We calculate the solution to the agent's problem in a series of steps; we describe these steps in details for owner-managers, for whom the problem is most complex, and note where the problem simplifies for employees and the self-employed.

1. EGM step

First, conditional on the state and some choice variables, we calculate optimal consumption by inverting the Euler equation and recovering total assets from the budget constraint. The choice variables on which we condition are: the share of assets invested in capital, $\tilde{k}$, legal form next period, d', (discretized) share of assets held in the company next period, $\tilde{a}^{c'}$, and the possible values of the effective marginal tax rate, mtr (which includes corporate and personal taxes).

[36] This is similar to Tauchen (1986), except that the support of the unconditional distribution is partitioned into N intervals, each having equal probability mass. In contrast, Tauchen (1986) chooses nodes that are equally spaced between two truncated extremes.

The Euler equation is:

$$u_c(c,l) \geq \beta \mathbb{E}\left[\frac{\partial}{\partial a'}\left(V(\Omega'|\Omega,a',\tilde{a}^{c'},d')\mathbb{1}_{age<60} + V^T(a')\mathbb{1}_{age=60}\right)\right]. \tag{D.1}$$

When the agent is not borrowing constrained, the equation holds with equality. The EGM approach is to calculate the right hand side, for a given level of assets tomorrow, a', and calculate the implied optimal consumption, c by inverting the marginal utility of consumption. Note that, as set out by Iskhakov et al. (2017), the existence of productivity uncertainty and the logit taste shocks associated with switching legal form (discussed below), smooths out next period's expected value function. This yields a unique solution to the choice of c, conditional on the choice variables.

Given consumption and an effective marginal tax rate, mtr, we can use the intra-temporal optimality condition to solve for the agent's optimal leisure choice, l:

$$l = \left(\frac{c^{-\nu_c} \times w \times (k/\max(1,\underline{k})^{\theta} \times (1-mtr)}{\chi}\right)^{-1/\nu_L}. \tag{D.2}$$

If the agent is borrowing constrained, then we solve the intratemporal problem given a choice of zero assets tomorrow to recover c and l. Given c, l, a', and the other conditioning choice variables, we can recover assets today, a, from the budget constraint. In order to compare these choices in subsequent steps, we linearly interpolate the choices of c, l, a' over an exogenously set grid for a, in a regularization step.

We therefore define the optimal conditional policy functions: $c(\Omega|\tilde{k},d',\tilde{a}^{c'},mtr)$, $l(\Omega|\tilde{k},d',\tilde{a}^{c'},mtr)$, $a'(\Omega|\tilde{k},d',\tilde{a}^{c'},mtr)$ and conditional value function $V(\Omega|\tilde{k},d',\tilde{a}^{c'},mtr)$. We also solve for these optimal conditional choices when mtr is undefined, because the agent is located at a kink in the tax schedule; in these cases, we can recover the optimal conditional choices by setting taxable income, y or profit, z, equal to the relevant kink point and rearranging the budget constraint to get l.

In our setting, the presence of kinks in the tax system and discrete choices over legal form next period potentially introduce non-concavities, which complicates the solution to the problem.

2. Choice of taxable income

The tax system is piecewise linear, with a range of possible effective marginal tax rates, mtr, which creates kinks in the budget set. We account for this by solving for the optimal choices of consumption, leisure, and assets next period, conditional on being either on an interior sec-

tion of the tax system with an effective marginal tax rate equal to mtr, or at the kink points. We then calculate the implied profit, $z(\Omega|\tilde{k}, d', \tilde{a}^{c'}, mtr)$, and taxable income, $y(\Omega|\tilde{k}, d', \tilde{a}^{c'}, mtr)$, given these choices. We select the choice such that the marginal tax rate associated with the choice is equal to the marginal tax rate given implied profit and taxable income.

For example, let $y_{0.2} = y(\Omega|\tilde{k}, d', \tilde{a}^{c'}, mtr = 0.2)$ denote the implied taxable income when leisure is chosen given a marginal tax rate of 0.2, and analogously for $y_{0.4} = y(\Omega|\tilde{k}, d', \tilde{a}^{c'}, mtr = 0.4)$. Let y^K denote the point at which the marginal tax rate increases from 0.2 to 0.4. If $y_{0.2} \leq y^K$, we select the choices associated with $mtr = 0.2$; if $y_{0.4} \geq y^K$, we select the choices associated with $mtr = 0.4$; and if $y_{0.2} > y^K \wedge y_{0.4} < y^K$ then we select the choices associated with $y = y^K$.

At the end of this step, we have a set of conditional policy and value functions that depend on the state variables, choice of assets held in the company next period, the choice of legal form next period, and the choice of share of assets to invest in capital e.g. $c(\Omega|\tilde{k}, d', \tilde{a}^{c'})$.

Note that for employees, labour supply (and hence leisure) is exogenously fixed at the full time equivalent. This means that they do not have there is no decision over taxable income, and instead they simply have to choose consumption and assets next period. This is done using the EGM step described above.

3. Choice of assets held in the company next period

To solve for the share of assets held in the company next period, we take the maximum across all possible choices:

$$V(\Omega||\tilde{k}, d') = \max_{\tilde{a}^{c'} \in [0,1)} V(\Omega|\tilde{k}, d', \tilde{a}^{c'}).$$

We perform this search across a grid of $\tilde{a}^{c'}$, which is iteratively shrunk until the interval between the points equals 0.008.

Note that for the self-employed and employees, there is no option to save in a company asset, and so this step is unnecessary (we set $\tilde{a}^{c'} = 0$ everywhere).

4. Choice of legal form next period

Agents make a discrete choice over legal form next period. This depends on their conditional value functions, $V(\Omega||\tilde{k}, d')$, any utility costs from switching F^{start}, F^{inc}, and the logit shock

associated with switching legal form, $\zeta_{d'}$. The choice of legal form next period is then:

$$\max_{d' \in \mathcal{D}_d} V(\Omega|\tilde{k}, d') + \zeta_{d'} \tag{D.3}$$

$$\Rightarrow V(\Omega|\tilde{k}) = \mathbb{E}_{\zeta}\left[\max_{d' \in \mathcal{D}_d} V(\Omega|\tilde{k}, d') + \zeta_{d'}\right] = \gamma + \ln\left[\sum_{d' \in \mathcal{D}_d} e^{V(\Omega|k,d')}\right]. \tag{D.4}$$

The inclusion of the shocks associated with switching legal form ensures that the predictions from the model are statistically non-degenerate i.e. they allow for agents to move between forms for reasons that are not explicitly modelled. They also serve as a form of *homotopy perturbation*, which helps to smooth the expected value functions and thus simplifies the numerical solution of the model.

5. Choice of share of assets to invest in capital

The final step is to take the max over the possible choices of the share of assets to invest in capital, $\tilde{k}$:

$$V(\Omega) = \max_{k \in [0,a]} V(\Omega|k).$$

Employees (and business owners in type I, for which we set $\theta = 0$) simply set $k = 0$.

D.3 Policy regimes

As set out in Appendix B, the tax system applying to employees and business owners depends on a range of thresholds and rates, many of which vary over time. Solving the model is computationally intensive, and we therefore solve the model for three different tax regimes (as opposed to one for each of the 12 years that we model). These account for the important features of the tax system as it pertains to business owners, and the large changes over time, but abstracts from some of the smaller differences such as changes in tax thresholds.

In all three regimes, we model the personal and corporate tax systems. The personal tax system is piecewise linear, with kinks at the point at which personal taxes become payable (£9440), at the higher rate threshold (£41450), and, for 2011-14, at the withdrawal of the personal allowance (£100,000–£118,800), and the start of the additional rate (£150,000). The rates at each segment of the tax system vary across employees, self-employed, and owner-managers. Owner-managers who are exiting can take income out as capital gains, which is taxed at a lower rate of 10%.

We model the corporate tax system has having a main rate (set equal to the small companies rate), and, for 2003-04, a 0% starting rate up to 10,000. This introduces additional kinks for owner-managers. We explicitly account for these when we solve the agent's problem (described above). Self-employed business owners can deduct depreciated capital from their taxable profit, and owner-manager can deduct it from the corporate taxable profit. This is consistent with the treatment of investment spending under the Annual Investment Allowance.

D.4 Simulation

We simulate 50,000 agents for each latent type over the period 2000-15. We require the initial conditions for business owners to simulate the model over our period of study. We do not observe the distributions assets in the data, and we therefore use information from the UK's Wealth and Assets Survey to make the initial draw of assets for our simulations. We estimate a Tobit model for assets as a function of average earnings, a quadratic in age, whether the individual is self-employed, an owner-manager or an employee. The dependent variable is financial assets, reflecting the fact that other savings may be substantially more illiquid. Using the coefficients from this model, we predict the whether the individual has (a) zero assets, and (b) the expectation of log assets, conditional on having positive assets. This gives us initial draws for agents in our first year of simulation (2000), and also the asset draws for 30 year olds who are 'born' in subsequent years. We use a similar method to get the initial share of assets held in the business for owner-managers. The draws for productivity, incorporation and start-up costs are drawn from their estimated distributions using Monte Carlo methods. Finally, the share of business owners that are owner-managers in the first year (2001) is estimated in the second stage as a nuisance parameter; this is pinned down by the share of owner-managers in the first year of our data.[37]

Given the agents' state variables, the optimal choices are calculated from the first year of observation and then solved forward. We first calculate the optimal choice of share of assets invested in capital, linearly interpolating between the grid points. Conditional on this and the draws from the logit shocks, we calculate the value functions associated with each choice of legal form next period. Given this, we then solve for the optimal consumption choice (again, interpolating between the grid points). From this, we can solve exactly for the choices of leisure and (for owner-managers) share of assets held in the company next period. This allows

[37] We cannot set this directly because the data moments are based on a selected sample of business owners present in 2014.

agents to locate exactly at kinks in the tax schedule. Agents are simulated through the three different tax regimes; the movement between regimes is unexpected in each case.

D.5 Second stage estimation

Given the parameters set in the first stage, the second stage estimation solves for the parameter vector, $\hat{\theta}$, which minimises the GMM objective function:

$$\hat{\theta}_k = \arg\min G_k(\theta_k)' W_k G_k(\theta_k) \tag{D.5}$$

$$\text{where } \theta_k = (\beta, \zeta_o, \{\nu_L, \sigma_\zeta, F^{start}, F^{start}_{d=OM}, \underline{F}^{inc}, \overline{F}^{inc}, \mu_\omega, \sigma_\omega, \sigma_\epsilon, \rho, \theta\}_k) \tag{D.6}$$

and $G_k(\theta_k)$ denotes the vector of differences in the moments constructed using the data simulated from the model and those observed in practice. We construct the model moments analogously to those in the data, and, in particular, account for the fact that the data moments are calculated for a selected sample of business owners who are active in 2014. We set W_k, the weighting matrix, equal to the diagonal of the asymptotically optimal weighting matrix.[38] We estimate the parameters separately by the latent types, k. We first estimate these for type V, and then use the estimated $\hat{\beta}$ and $\hat{\zeta}_o$ from this type when we estimate for the remaining types.

The GMM objective function for dynamic models of the type featured here may have multiple local minima and no analytic derivatives. In practice, simulated method of moments estimates are found by using multiple starting points to ensure a global minimum is reached. We use a method similar to that of Guvenen and Smith (2014), where minimization of the GMM objective function proceeds in two steps. In the first, we use an iterated grid search, and in the second use the best estimates from the first step as starting points for a derivative free optimizer.

In the first step, we compute 2000 candidate parameter values, which are drawn from a low discrepancy quasi-random sequence with dimension equal to the number of parameters to be estimated. We evaluate the objective function at each of these parameter values. We use the 1% with the smallest value of the objective function to generate a new hypercube on the parameter space. We compute another 2000 candidate parameter values using these new bounds, and iterate on this procedure six times. In the second step, we take the top five candidate parameter values from the final step of the first stage and use these as starting values

[38] The fully asymptotically optimal weighting matrix is known to behave poorly in small samples (Altonji and Segal (1996)). Although we have a large number of business owners, for some of the latent types, the samples sizes are much smaller.

for a derivative free optimizer. We use a pattern search optimization routine. In practice, we find that the iterated grid search in the first step yields parameters that are close to their final value. By using a number of starting points, it appears that the parameters obtain the global minimum. We parallelize the evaluations of the candidate parameter vector in the first stage, and the starting points in the second stage using the UCL Myriad High Performance Computing Facility.

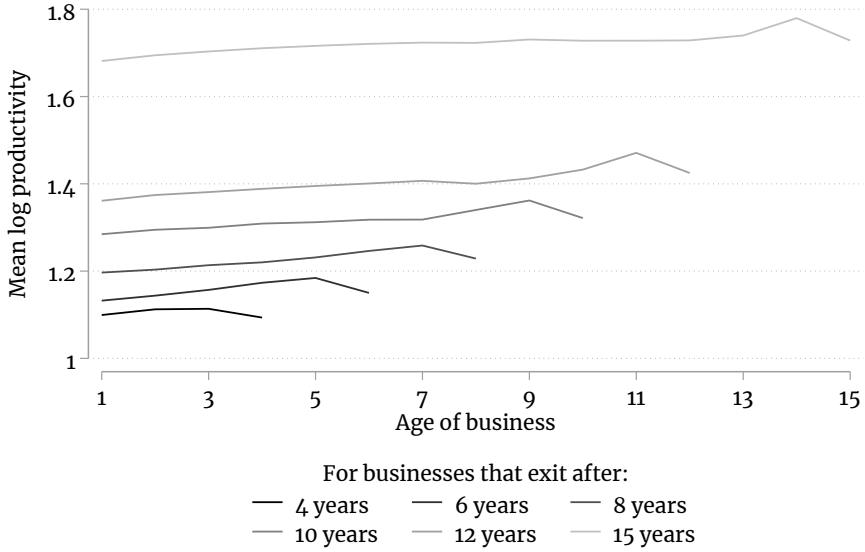
We use the standard formula for the asymptotic variance of the MSM estimator, including adjustment for simulation error. We use numerical differentiation to calculate the Jacobian of the moment conditions with respect to the parameters.

E Additional estimation results

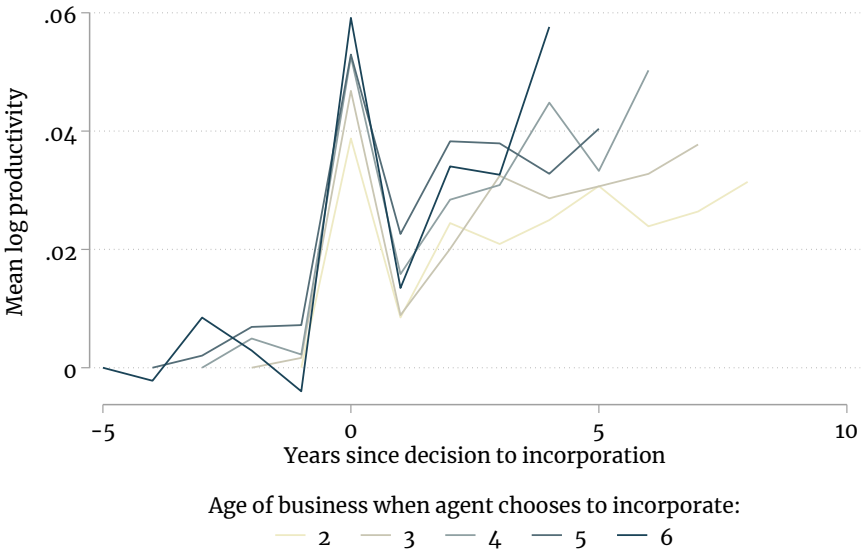
E.1 Model properties

Figure E.1: *Productivity around exit and incorporation*

(a) Productivity by business age



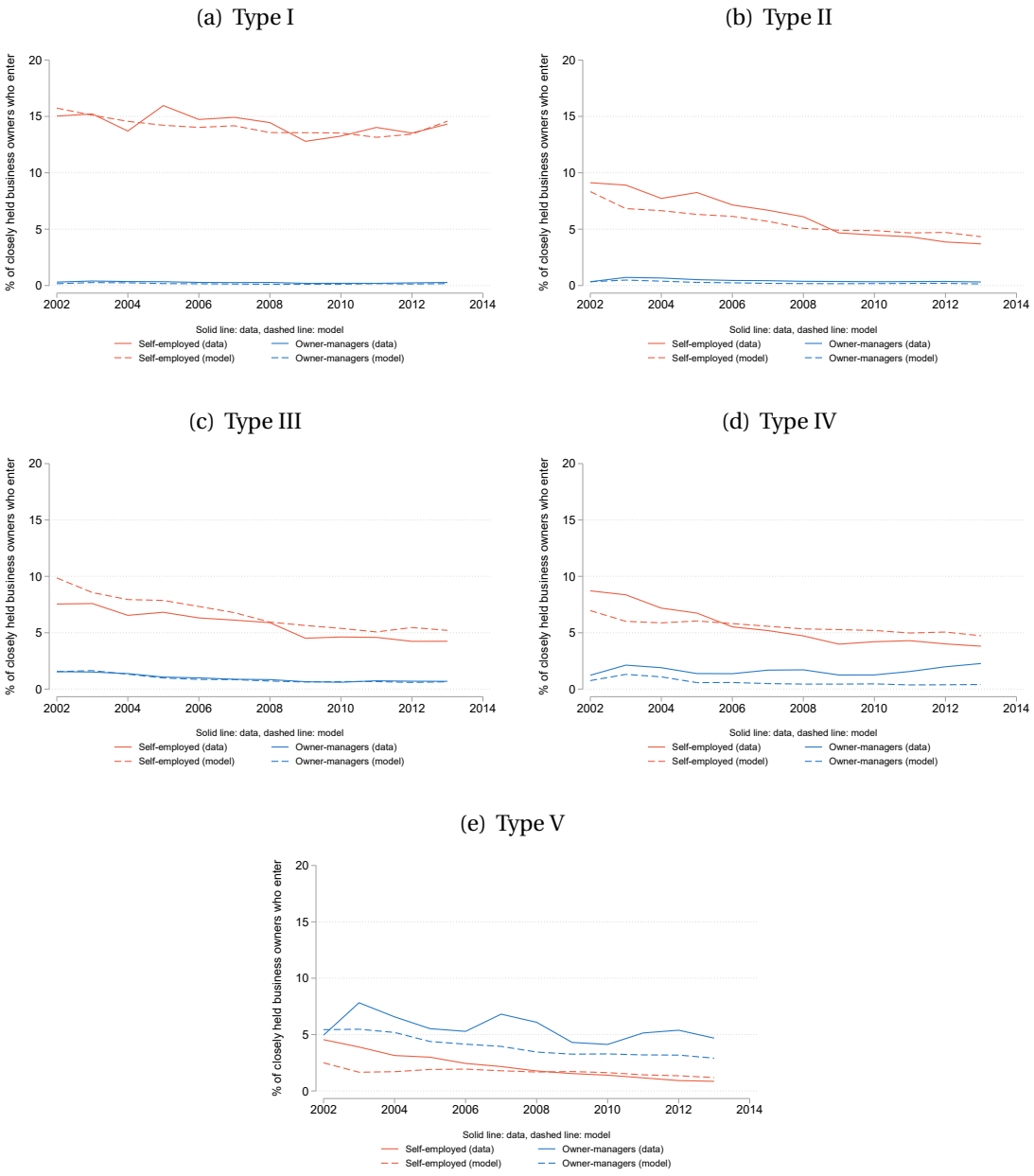
(b) Productivity around incorporation



Notes: In the top panel, we use data simulated from the model to plot the average log productivity in each year of the business's life. We do this separately for businesses that exit after different numbers of years. In the bottom panel, we plot mean log productivity around the age at which the business owner chooses to incorporate, separately by business age at the date of incorporation. We control for the number of years that the business is in operation. Source: Model simulations.

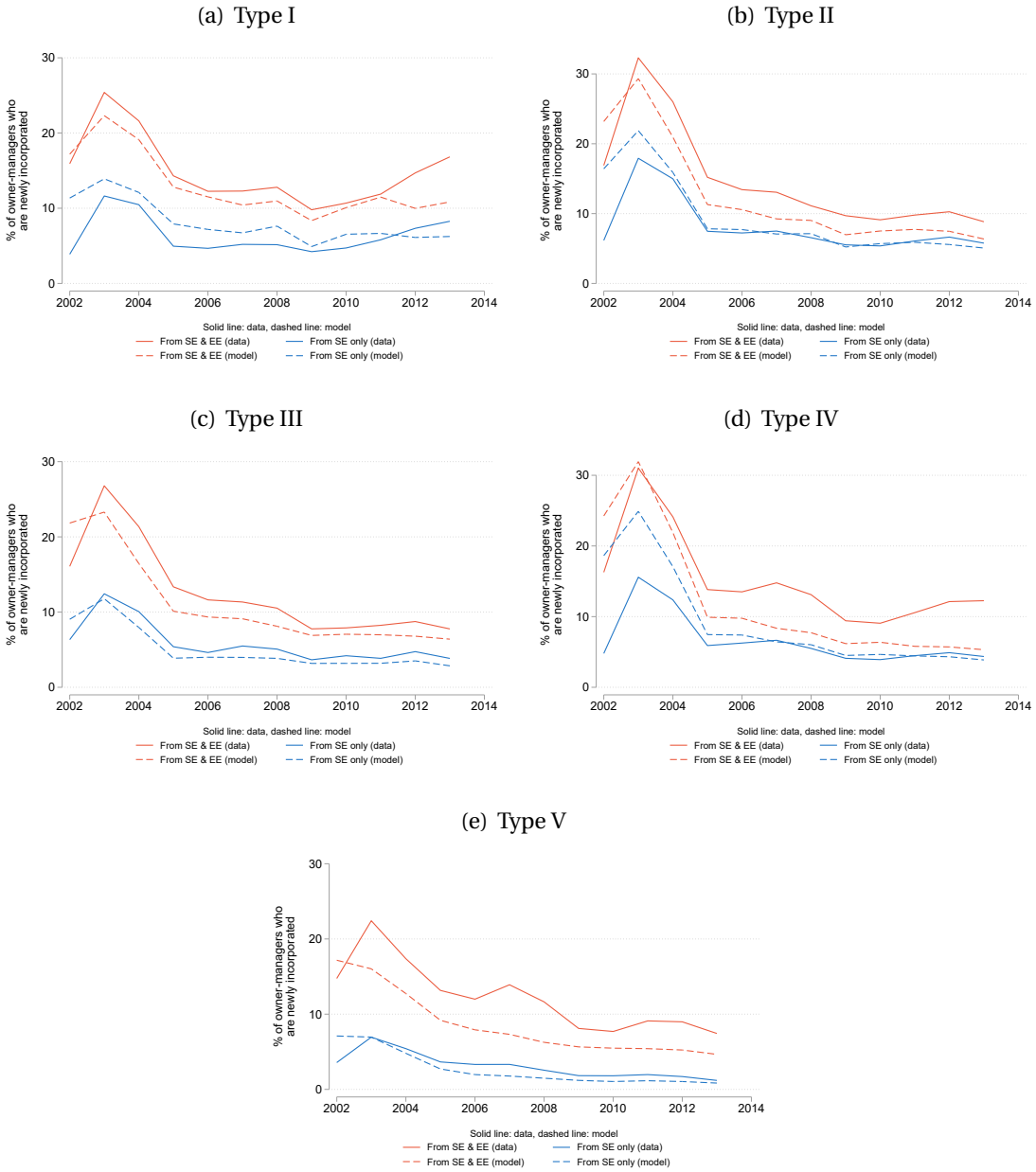
E.2 Targeted moments

Figure E.2: *Targeted moments: entry*



Notes: Each panel shows the entry rates for the self-employed and owner-managers in the data and predicted by the model for each type. Entry rates are defined as the number of new self-employed or owner-managers as a fraction of the total number of business owners.
Source: Authors' calculations using HMRC administrative datasets.

Figure E.3: *Targeted moments: incorporation*



Notes: Each panel shows the incorporation rates from self-employed or from self-employed and employment in the data and predicted by the model for each type. Incorporation rates are defined as the number of new owner-managers (from either SE or EE) as a fraction of the total number of owner-managers.
Source: Authors' calculations using HMRC administrative datasets and model simulations.