Capital Taxation and Entrepreneurship

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Abstract

We develop a dynamic model to study the impact of capital tax reforms on small business formation, exit, investment, and tax revenue. 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. Using the model, we show that removing preferential rates of tax available to incorporated 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. Reforms that reduce the distortions associated with new equity financing and act to relax the credit constaints faced by some business owners are better targeted at investment than lower personal capital tax rates.

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1 Introduction

Small businesses and particularly start-ups are widely perceived to be engines of growth.[1] Business owners are a large and increasingly important part of the workforce in many countries.[2] It is common for governments to give small businesses and their owners 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, as business owners are disproportionately at the top of the income distribution,[3] limit the ability to redistribute from rich to poor. Some policymakers wish to raise personal capital income tax rates,[4] but have 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 advance previous work by developing a dynamic model that allows us to study the long-run effects of policy changes and consider counterfactual reforms. The model allows for both real and avoidance responses to a rich model of the tax system. We estimate the model using novel linked administrative data on the universe of small businesses in the UK, explicitly accounting for heterogeneity across types of business. We find that removing preferential rates of capital gains tax for business owners leads to no change in the overall number of small businesses, only switching in legal form. A small fall in investment is driven entirely by changes on the intensive margin. Changes in the tax base are more important for investment than lower tax rates. Most countries have a bias against new equity financing. Removing this bias leads to large increases in investment, and, if combined with the removal of preferential rates, leads to improvements in equity and efficiency. Providing subsidies that go beyond simply removing distortions and target credit constraints encourages entry and also has significant effects on investment.

We begin by presenting several stylized facts on small businesses and how they are taxed. We illustrate these with rich administrative data from the personal and corporate tax records and company accounts of UK small businesses, and draw on the existing liter-

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

[2] Small business owners make up 15% 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, Yagan, Zidar, and Zwick (2019) and Pope, Joyce, and Roantree (2019).

[4] For example, President Biden has proposed almost doubling the top capital gains tax rate in the US (The White House (2021)). Keir Starmer, Leader of the Opposition in the UK, recently stated, "*People who earn their money from property, dividends, stocks, shares – capital gains tax, these should all be looked at as a broader, fairer way of raising taxes*" in a debate about who should pay for social care.

ature to show these are true more generally. Three broad patterns stand out. First, there is wide variation in the economic activities of small businesses. Although some make substantial capital investments, many invest nothing. Those businesses that invest tend to be longer-lived and more likely to engage in innovative activity.[5] Second, there are significant differences in the tax treatment and characteristics of different legal forms. For example, the owners of incorporated businesses (which we also describe as "owner-managers") face lower tax rates and have more flexibility to shift income intertemporally than the owners of unincorporated businesses (the "self-employed"). There are also non-tax differences, with incorporation offering limited liability but having higher reporting and compliance requirements. Third, small business owners are highly responsive to tax incentives, with legal form and taxable income sensitive to tax changes.[6]

Informed by these facts, we develop a dynamic model to study the effect of tax policies on small businesses and the channels through which they operate. Individuals maximise an intertemporal utility function by choosing whether to start a business and its legal form, investment in capital and their own labour supply, as well as consumption and saving in personal and company assets. The problem is dynamic for several reasons. First, the choice of an owner-manager to save in either a personal or company asset depends on the tax rate they expect to face when they liquidate their company in the future. Second, business owner productivity is uncertain and individuals make choices based not only on their productivity today, but also on how they expect it to evolve in future. Third, there are costs associated with starting a business and incorporating, which means that the choice of legal form cannot be costly re-adjusted each period. Fourth, borrowing constraints mean that business owners need to ensure they have sufficient assets on hand to invest in productive capital.

Not all small businesses are entrepreneurs, and it is widely recognised that empirically measuring entrepreneurial activity is challenging. We allow for rich heterogeneity across small businesses, which allows us to study the impact of policy reforms on different subgroups. We follow the approach of Bonhomme et al. (2021) and use a k-means clustering approach to group business owners into latent "types" and then estimate the model parameters separately by the types. Based on the empirical evidence and the theory underpinning the model, we cluster on the individual's mean (over the time they are in

[5] A fact also documented by Humphries (2017).

[6] A large number of papers used reduced-form approaches to study the effect of the tax system on various business outcomes. 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 Schjerning (2013), Harju and Matikka (2016), Miller, Pope, and Smith (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)).

the sample) profit and mean investment as a share of mean profit. 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 by setting a number of parameters using data and existing evidence, and then using the simulated method of moments to estimate the remaining parameters. We use a range of moments to help identify the model parameters, including some that capture changes in behaviour under different tax environments. For example, we use the changes in incorporation rates associated with a 0% starting rate of corporation tax in the early 2000s to identify the distribution of incorporation costs.[7] We validate the model using evidence on the impact of tax changes that are not directly targeted in estimation. For instance, we compare the predictions of the model to difference-in-differences estimates of the impact of higher rates of tax on incomes above £100,000 that were introduced in 2011.

We use our estimated model to study the implications of policy choices and the channels through which they operate. We conduct counterfactual experiments that highlight the effects of two distortions common to many tax systems and central to current policy debates. We also consider how to design policies specifically targeted at credit constaints – a key market failure – if policymakers wish to actively encourage entrepreneurship.

A common policy to encourage small business start-ups and investment is offering lower tax rates on business income, including dividends, profits from self-employment, and capital gains on business assets.[8] These preferential rates can be accessed even if the business profits entirely reflect the labour returns of the owner. They distort choices over legal form and the intertemporal allocation of resources, and create inequities, yet policymakers are often reluctant to remove them because they fear it will reduce investment. We show that removing the preferential rate of capital gains tax (CGT) for business owners over our period of study[9] leads to no change in the total number of businesses, only switching in business legal form. The entry decision is inelastic with respect to the capital

[7] This reform is also studied by Tazhitdinova (2016) in a static framework. We use the variation in rates 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.

[8] In the UK "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 US, the qualified small business stock exclusion allows small business owners to exclude up to 100% of federal capital gains tax upon the sale of stock.

[9] In the March 2020 Budget Entrepreneur's Relief was renamed "Business Asset Disposal Relief" (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.

gains tax rate because the vast majority of owner-managers prefer running an unincorporated business to not running a business at all. Aggregate investment is also inelastic, because relatively few of the small businesses affected make substantial investments. We find that removing this preferential rate increases the tax revenue raised from small businesses by 3%, 35% of which comes from the top 1% of business owners.

A key feature of many tax systems is that the design of the tax base discourages new equity financing. This "equity bias" is particularly relevant for small companies that may struggle to borrow. Our model takes seriously the incentives created by both the corporate and personal tax bases, which allows us to consider the implications of this distortion. We show that reducing the bias against new equity financing leads to large increases in small business investment, the bulk of which comes from high investment business types. Implementing this reform using a cashflow approach – i.e. allowing owner-managers an upfront deduction against personal tax for new equity investments – has the advantage of relaxing the credit constraints faced by some businesses owners. We find larger increases in investment for those businesses who were credit constrained in the pre-reform world.

Combining the removal of the preferential rate of CGT and a more neutral treatment of investment leads to improvements in efficiency and equity, boosting tax revenue *and* aggregate small business investment. Removing the preferential rate acts to reduce distortions to the choice of legal form and the intertemporal allocation of resources. It improves equity by reducing the tax break that high profit owners get from taking income as capital gains (making the system more progressive) and also reduces the disparities between tax paid by people on similar incomes (improving horizontal equity). Around 40% of high income business owners, many of whom primarily receive disguised labour income, are worse off under such a reform, but, importantly, were previously being *subsidised* by the tax system. The small fall in aggregate investment induced by removing preferential rates is more than offset by adjustments to the tax base, which also reduce the distortions to investment through new equity financing. Around 70% of those individuals who run high investment small businesses are better off under such a reform package.

The reforms discussed so far relate to removing disincentives inherent in many tax systems. If there are market failures, policymakers may wish to go further and actively subsidise business ownership. In this case, it is important that the policy is effectively targeted at the source of the market failure. We consider the effect of investment "start-up" subsidies for new businesses, aimed at reducing the credit constraints faced by some businesses. Even relatively small subsidies (up to £1000) lead to more individuals starting high investment type businesses. On the intensive margin, we find that there is almost perfect crowd-out of the subsidy for non-credit constrained businesses. However, the

mean change in investment for credit constrained businesses is substantial and in excess of the subsidy, as higher profits are subsequently reinvested. These subsidies affect different parts of the distribution of small business investment to the upfront deductions for new equity. They do not affect the *marginal* incentive to invest for non-credit constrained businesses, which means that they lead to smaller increases in aggregate investment than a revenue-equivalent tax credit. However, because the subsidies are lump-sum, they make trying business ownership possible for those with very low levels of assets.

Related literature

We contribute to various strands of the literature, including to that which studies the effect of the tax system on various business outcomes, summarised in footnote 6. We develop a model that allows for the different response margins that the existing literature has highlighted as important, and use quasi-experimental tax variation to help identify the parameters of the model. The model allows us to estimate the long-run effects of 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. As in Evans and Jovanovic (1989), Cagetti and De Nardi (2006, 2009), Jones and Pratap (2020), we account for the effect of credit constraints on small business entry and investment. We allow for heterogeneity across types of businesses, a fact also identified as important by Humphries (2017). Relative to these papers,[10] 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. These avoidance behaviours are important, as they result in substantial costs of poorly targeted tax policies.

There is a long literature on the economics of tax design, with Mirrlees et al. (2011) setting out several principals that relate to the taxation of small businesses. These include taxing all forms of income equally and ensuring tax is neutral with respect to investment and savings. They acknowledge that there are a variety of market failures that may be associated with entrepreneurship, which may warrant policy intervention, but that lower rates are likely poorly targeted (also highlighted by Gordon and Sarada (2018)). We relate to this literature by quantifying the costs of misaligned rates and non-neutrality, the improvements from removing these distortions, and the existence of better policies targeted at market failures.

[10] Others include Catherine (2017), which highlights the importance of non-pecuniary benefits of business ownership and entrepreneurial learning. Hamilton et al. (2019) and Levine and Rubinstein (2017) provide evidence on the importance of traits and personality in selection into self-employment.

The rest of the paper is structured as follows. In the next section, we present a set of stylized facts on small businesses and how they are taxed. In Section 3 we set out a dynamic model of business ownership, and in Section 4 we present our estimates of the model. In Section 5 we conduct a series of counterfactual experiments, and a final section concludes. Several appendices provide further detail.

2 Stylized facts on small businesses

We begin by presenting several stylized facts on small businesses and how they are taxed. We use data and examples from the UK, however these patterns are true more generally. These facts inform our modelling choices and the policy reforms that we study.

Data. We use data on small businesses in the UK over the period 2001-16. We combine information from three sources: personal tax records, corporate tax records, and company accounts.[11] All small business owners are required to submit a personal ("self-assessment") tax return. These data provide information on: the individual's taxable income (amount and whether it is from salary, self-employment, dividends, or capital gains); whether the individual is self-employed or incorporated (whom we also describe as "owner-managers"); age and sex. We also have information on business activities including: turnover; profit; use of capital allowances for investment spending; industrial classification; and, for companies, the number of director and shareholders; assets and liabilities. 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 two or fewer directors and shareholders. This is to avoid the complications of modelling more complex ownership structures.[12] Further details on the data are provided in Appendix A.

2.1 Most small businesses exit quickly and invest little

There is a great deal of heterogeneity in the small business population, which includes low-income "gig economy" workers, high-income individuals selling their labour, as well as those making risky investments.

Small businesses experience a high degree of churn. Cribb et al. (2019) use the same data as us to show that exit rates among small businesses are high. For example, 20% of

[11] 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).

[12] 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.

newly established self-employed businesses are not trading after their first year and 60% have ceased trading by their fifth year. Unsurprisingly, more profitable businesses are less likely to exit. Businesses that invest, conditional on profit, are also less likely to exit than non-investment businesses. This is consistent with the findings in Humphries (2017), who highlights that many self-employment spells are short, most do not involve substantial investments and those that invest tend to be longer-lived. A report by the OECD (2017) finds that the churn rate (the sum of birth and death rates) among enterprises which employee at least one person is around 20%; it is likely higher among businesses with no employees.

Table 2.1: *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. All statistics are computed for 2014.
Source: Authors' calculations using HMRC administrative datasets.

Table 2.1 shows the distribution of small business owners in the UK across industries. Just under half operate in either the construction or business services sectors. The most profitable business owners are those in business services and the medical sectors. Investment is highly skewed, with the median self-employed business in all industries reporting zero investment, and only owner-managers in the retail, transport, manufacturing, and agriculture sectors having positive median investment. Mean investment is higher, although 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.

Understanding the nature of variation in the activities of small businesses and how they are affected by policy is important for tax design. There is no perfect way to measure

entrepreneurial activity – different measures will capture aspects of behaviour that might be considered "entrepreneurial". However, some aspects of behaviour may be more subject to market failures. For example, there may be under-provision of small business capital investment because of credit constraints and the inability to completely insure risky investments. Another possibility is that the trial of new products and services creates positive spillovers. We do not observe measures of innovation in the tax records. We instead use survey data collected by the UK's business department to describe this element of small business activity.[13] Around 70% of small businesses have no plans to launch new products and services in the next three years. However, among the 25% of small businesses that plan on investing, more than half of these also plan to launch new products or services. This suggests that capital investment is correlated with innovative activity by small businesses.

2.2 Incorporation often brings tax breaks, but also comes with costs

In most countries, there are different legal forms through which business owners can choose to operate. There are common differences in the way that these are taxed. OECD (2015) surveys the taxation of small businesses across the OECD, and finds that, *"many of the tax systems examined provide incentives to incorporate and to distribute income in the form of capital, particularly as capital gains."* Notably, incorporated businesses are taxed under the corporate tax system, with income that is distributed to owners taxed under the personal tax system. In many cases, there is scope for owners of incorporated businesses to shift personal taxable income across time, because it is taxed at a personal level only when it is withdrawn from company.[14] In contrast, the profits of unincorporated businesses are taxed at the personal level in the year that the income is generated. Effective tax rates are often lower for incorporated business owners, and, because they can shift income intertemporally, they can more easily access preferential capital gains tax rates (available only on business sale or liquidation). Appendix B provides more details on the UK taxation of small businesses.

Businesses can, and do, switch between legal forms during their lifecyle. Table 2.2 presents descriptive statistics for UK small businesses over the period 2001-16. Of the 11 million people who were business owners at some point, 10% had a period of self-employment followed by incorporation.[15] Among this group, people spend, on average,

[13] See Appendix A for details.

[14] An exception are S-Corporations in the US, which are taxed on a pass-through basis.

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

3.5 years in self-employment, with a further 4.1 years as an owner-manager. 12% were exclusively incorporated and the remaining 78% were exclusively self-employed.

There are considerable differences in the profits, investment and industry composition across legal forms.[16] Almost 1 in 5 people in the business service sector are owner-managers, compared with under 0.5% of those in domestic services. 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.[17] 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. The self-employed 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.[18] 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.[19] In line with higher taxable income, the annual profit of owner-managers is substantially higher than for the self-employed (in Appendix A we plot the distributions of these variables). Columns (5) and (9) show the average within-business owner standard deviation in taxable income and profits. 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 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.

There are also non-tax differences between the business legal forms, with the OECD (2015) noting, "Incorporation may offer a number of advantages to business, including in many cases limited liability of the shareholders, improved access to capital markets and increased ease of business continuity. However, the formation of an incorporated

[16] Levine and Rubinstein (2017) also document key differences in the characteristics of those that start incorporated and unincorporated businesses.

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

[18] 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.

[19] For more details of the match, see Appendix A and Miller, Pope, and Smith (2020).

business is generally more costly in terms of legal fees in establishing and recognising articles of incorporation,... and typically has higher ongoing costs." The net benefit of these non-tax differences is likely to vary across business owners. We allow for these non-tax incorporation costs in our model and estimate their distribution across small businesses.

2.3 Business owners are responsive to tax, with avoidance a common strategy

Many papers have highlighted the high degree of responsiveness of business owners to tax incentives. They have fewer constraints on labour supply than employees (Chetty et al. (2011), Bastani and Selin (2014)), but also more scope for avoidance and evasion behaviour (Kleven et al. (2011)). Over our period of study, there have been a number of 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. Understanding how small businesses respond to tax changes is informative for two reasons. First, it highlights the margins of response that it is important to model. Second, we use the variation to help identify parameters in the model.

Legal form is sensitive to tax differentials

Variation in the tax treatment across legal forms affects not only the decision to start a small business but also its legal form. Figure 2.1 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. This combines social security contributions, personal and corporate income taxes, and assumes that the owner-manager does not retain any profits 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.

Several countries have lower corporate income tax rates for small businesses below a prescribed threshold, with the largest differences between the basic and small business rates in Canada, France and the United States (OECD (2015)). In 2003-4 the UK introduced a 0% starting rate of corporation tax on profits of up to £10,000.[20] This created a strong incentive for new business owners to enter as owner-managers, and for the existing self-employed to incorporate. In Figure 2.2 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. We use the full sample of business owners, not just those

[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%).

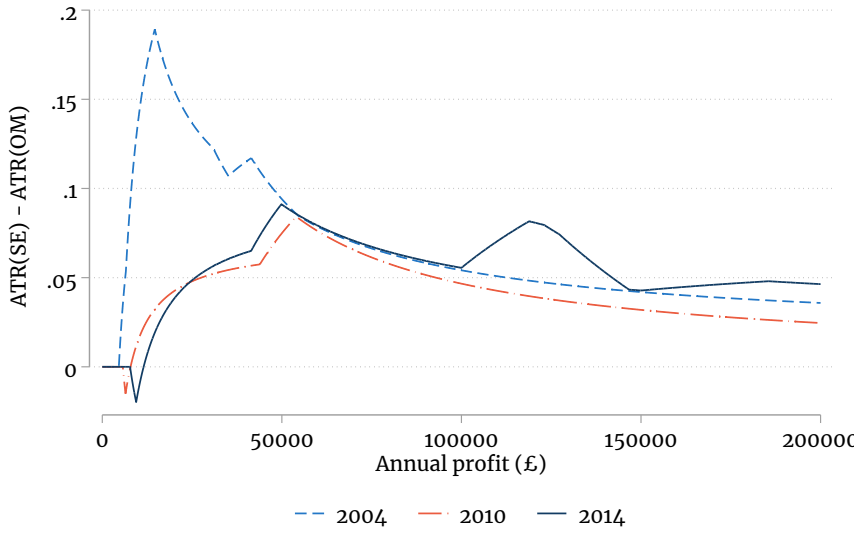
Table 2.2: *Descriptive statistics for UK small businesses, 2001-16*

	(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.

that were active in 2013-14.[21] The figure shows the share of owner-managers within each income group in each year that newly entered in that year. 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 Appendix B, 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. Using our estimated model, we provide evidence on what the marginal new owner-managers would have done in the absence of the 0% starting rate.

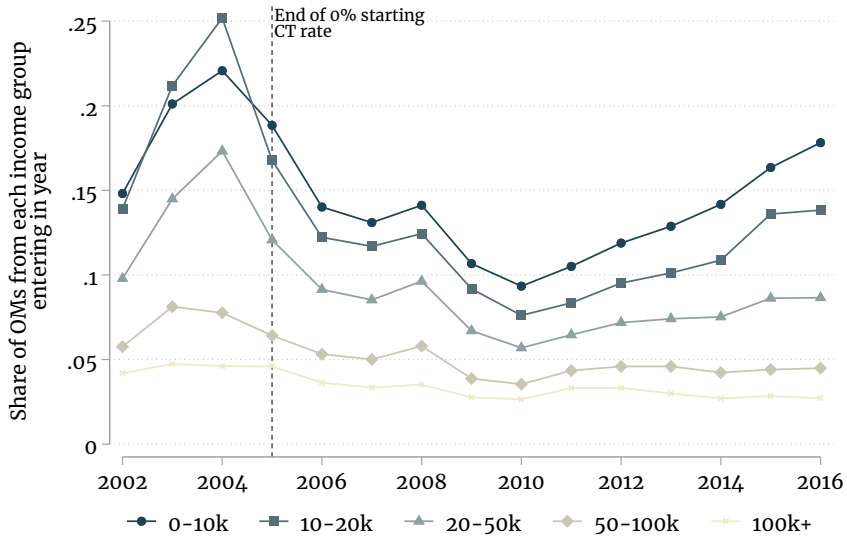
Figure 2.1: *Difference in average tax rates across legal forms, by profit level and tax year*



Notes: The figure 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. Tax includes social security contributions, personal and corporate income taxes.
Source: Various government sources and authors' calculations. Exact rates and thresholds provided in Appendix B.

[21] This requires us to use taxable income, as opposed to profit, because we only observe owner-manager profit for the matched sample (those active in 2013-14).

Figure 2.2: *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.

Business owners shift income across time and bases

Taxes affect not only the decision to start a business and whether to incorporate, but also labour supply, investment and when and how to take income.

Business owners can shift income across tax bases to minimize their tax liability. For instance, owner-managers can choose whether pay themselves a salary (which is deductible from corporate tax) or dividends (which are taxed at lower rates and do not incur social security contributions). The tax minimising way to take income out of the company in a given year, and in all years we study, involves taking a salary equal to the point at which personal taxes become payable (i.e. after exhausting tax free allowances) and withdrawing the remainder as dividend income.[22] Miller, Pope, and Smith (2020) show that this is the most commonly used strategy by owner-managers.

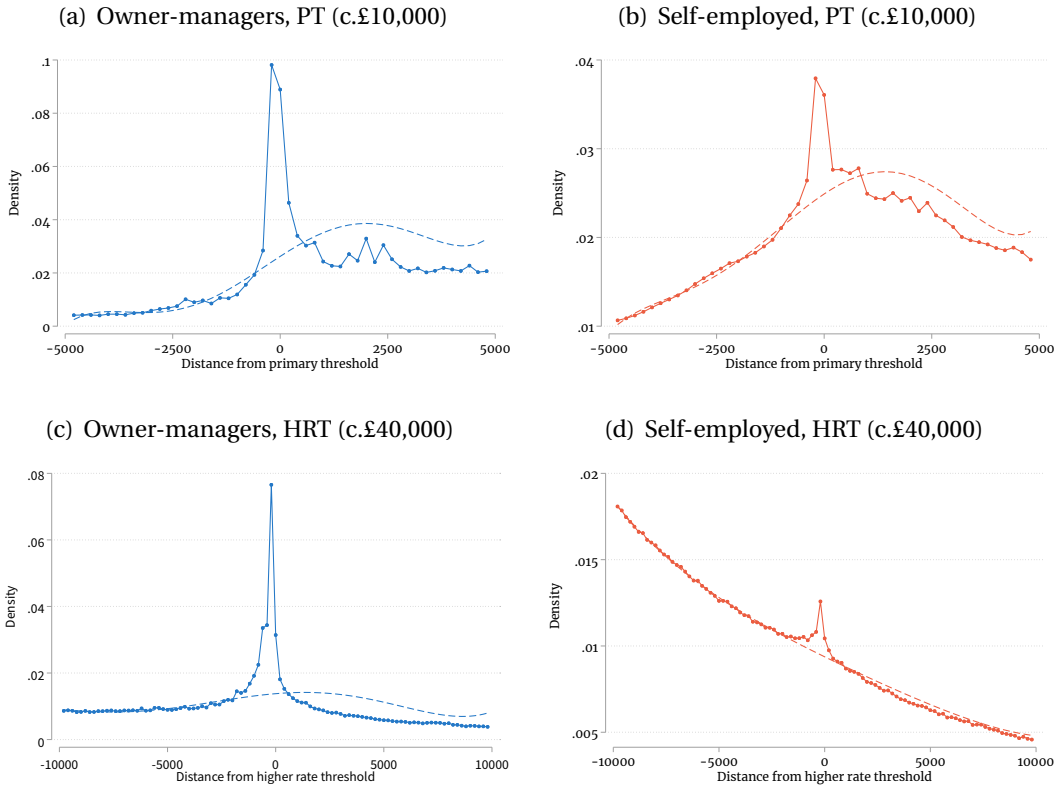
Business owners also respond to "kinks" in the tax schedule (discrete jumps in the marginal rate). Figure 2.3 shows that both owner-managers and the self-employed bunch at the primary threshold (c.£10,000) and the higher rate threshold (c.£40,000).[23] The excess mass is larger for owner-managers than for the self-employed. Miller, Pope, and Smith (2020) show that all of the responsiveness of owner-managers to tax kinks is due

[22] 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.

[23] We use the sample of business owners active in 2014 and 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.

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 2.3: *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.

One of the reasons that owner-managers shift income intertemporally is to take advantage of preferential capital gains tax rates (the other is to smooth volatility in profits around kinks). 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.[24] Over our period of study, capital gains is more heavily taxed than dividend income withdrawn below the higher rate threshold, but more lightly taxed than dividend income above the higher rate threshold.[25] This creates a strong incentive for high profit owner-managers to retain profits in their company until liquidation. Miller, Pope, and

[24]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).

[25]From 2008, the capital gains of owner-managers is eligible for a reduced 10% rate of capital gains tax under "Entrepreneurs' Relief". 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.

Smith (2020) show that this tax-induced retention is large, with half of those generating £150,000 per year retaining more than £50,000 each year. The self-employed are subject to capital gains tax on the disposal of business assets, but have much less scope to shift income across tax years, which gives them fewer opportunities to take advantage of this tax break.

In 2011 there were increases in the marginal tax rates on incomes above £100,000.[26] 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 4.3(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. The increased rates make profit retention more attractive, thus increasing the incentives to incorporate – in Figure B.3, we show that there is some evidence that the higher rates increased movements into incorporation.

3 A dynamic model of small business ownership

In this section, we set out a dynamic model of small business ownership motivated by the stylized facts presented above. The decision-making unit is an individual who maximises an intertemporal utility function by choosing: whether to start a small business and its legal form; capital investment; labour supply; consumption; and savings in personal and company assets. Individuals are exposed to risk over their productivity as a business owner, with heterogeneity in both their productivity and preferences. Individuals face a progressive tax system that treats legal forms differently.

3.1 Business ownership and choices

Heterogeneity. We allow for heterogeneity in the productivity process and preferences across latent types, which we index by j. This means that we can capture the wide variation in economic activities of small businesses, with some requiring high levels of capital to operate, while for others this is much less important. These types are determined before the start of working life and remain fixed for life. We estimate type membership in a first stage, which we describe in more detail in Section 4.1.

[26] There were two reforms that affected higher incomes: (i) the withdrawal of the tax-free allowance for incomes above £100,000 at a rate of 50p per extra £1 earned; (ii) the introduction of the additional 50% rate (later reduced to 45%) on incomes above £150,000.

Legal forms. We model individuals from age 30 through to retirement at age 60. In each period, individuals, indexed i, can either run a small business or be employed. Small business owners can choose one of two legal forms: self-employment or incorporation (also described as owner-managers). We index these three legal forms as $d_{it} = EE$ (employee), $d_{it} = SE$ (self-employed), $d_{it} = OM$ (owner-manager). d_{it} determines the choices available to individuals and how they are taxed.

Start-up and incorporation costs. We allow for there to be non-tax costs (or benefits) associated with incorporation, which we denote by F_i^{inc} and assume is normally distributed with mean F_m^{inc} and standard deviation F_{sd}^{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. We also allow for iid shocks associated with switching between legal forms each period.

Utility. Individuals derive utility from consumption and leisure; their period utility function is:

$$u(c,l) = \frac{c^{1-\nu_c} - 1}{1-\nu_c} + \chi \frac{l^{1-\nu_l} - 1}{1-\nu_l} \tag{3.1}$$

where c and l denote consumption and hours of leisure, respectively. Utility is separable in consumption and leisure, with ν_c and ν_l governing the curvature of the utility function in each argument, and χ denotes the utility weight on leisure. Utility is separable across time and discounted with a constant discount factor β.

Choices. The period in the model is a year, indexed t. In each period, individuals make several choices. Small business owners choose how much to invest in productive capital and how much labour to supply in the running of their business. All individuals choose how much to consume and how much to save, with incorporated business owners having the option to save in a company cash asset. Employees choose whether to start a business next period (and its legal form), the self-employed choose whether to incorporate next period, and both owner-managers and the self-employed can choose whether to exit to employment.

Productivity. Individuals' productivity determines the profit they make as a business owner. Productivity, ω_{it}, depends on the agent's latent productivity, ψ_i, the age of the individual, age_{it}, and a stochastic process, η_{it}, but not on whether they are incorporated or

not:

$$\ln \omega_{it} = \psi_i + \phi_1 \text{age}_{it} + \phi_2 \text{age}_{it}^2 + \eta_{it} \tag{3.2}$$

$$\text{with} \quad \eta_{it} = \rho \eta_{it-1} + \varepsilon_{it}, \quad \varepsilon_{it} \sim \mathcal{N}(0, \sigma_\epsilon), \tag{3.3}$$

where ψ_i is normally distributed with mean μ_ψ and variance σ_ψ^2.

The stochastic AR(1) process, η_{it}, means that productivity is risky. Individuals receive shocks to their productivity each period, ϵ_{it}, where σ_ϵ^2 denotes the variance of the shocks. These shocks persist over time, with the degree of persistence governed by $|\rho| < 1$. Individuals' expectations over their future productivity determine whether they choose to start a business (if currently employed) or exit (if currently a business owner).

3.2 Assets and investment

Individuals start each period with a stock of assets, denoted by $a_{it} = a_{it}^c + a_{it}^p$. Owner-managers have the option to hold assets within the company, a_{it}^c, or in their personal accounts, a_{it}^p. Self-employed agents and employees hold only personal assets i.e. $a_{it}^c = 0$. We allow for owner-managers to save in a separate company asset in order to capture how retained profits respond to tax changes. As discussed in Section 2, preferential capital gains tax rates lead high profit owner-managers to retain substantial sums in their companies over several years, until they exit. Modelling this dynamic aspect of decision making is therefore important to assess the impact of removing preferential rates.

Assets held in personal accounts and company accounts attract rates of return, r^p and r^c, respectively, and evolve as follows:[27]

$$a_{it+1}^p = (1 + r^p)(s_{it}^p + a_t^p) \tag{3.4}$$

$$a_{it+1}^c = (1 + r^c)(s_{it}^c + a_t^c), \tag{3.5}$$

where s_{it}^p and s_{it}^c denote saving in the personal and company assets, respectively. We rule out borrowing by imposing $a_{it+1}^c \geq 0$ and $a_{it+1}^p \geq 0$.

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), Kaboski and Townsend (2011).

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

Investment. At the start of each period, business owners choose what fraction of assets on hand to invest in productive capital, $\varsigma_{it}^k \in [0,1]$. For owner-managers, if investment is greater than the stock of company assets, they inject new equity from their personal assets into the company, denoted by $\tilde{k}_{it} = \max\{0, \varsigma_{it}^k a_{it} - a_{it}^c\}$. Individuals then have total capital:

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

where φ is an upfront deduction for new equity, 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.

3.3 Profits, labour supply and consumption

Business profit. Business owners choose how much labour to supply in running their business, denoted by $h_{it} = L - l_{it}$, where L denotes the leisure endowment. The profit that they make each period depends on on their labour supply, capital investment and productivity:

$$z_{it} = \omega_{it} h_{it} \left(k_{it} / \max\{1, \underline{k}\}\right)^{\theta} - \delta k_{it}. \tag{3.6}$$

θ governs the importance of capital in the production process and $\underline{k}$ denotes the minimum level of capital required to operate. If This allows for the fact that some business models require at least some capital to operate (e.g. agriculture), while for others capital investment is low and profit is primarily a function of the owner's labour supply (e.g. accountant). $\underline{k} = 0$, then the denominator of the expression in the parentheses is set to 1. δk_{it} is the value of depreciated capital.

Employee earnings. If the individual 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 $y_i^{EE} = \bar{h} \exp(\psi_i + \phi_1 \text{age}_{it} + \phi_2 \text{age}_{it}^2)$.

Consumption. Let y_{it} denote individuals' personal taxable income, with personal tax liability, $\mathcal{T}^p(y_{it}, d_{it})$ (details below). Individuals can then choose how much to save in their personal asset, s_{it}^p, with the remainder yielding consumption:

$$c_{it} = y_{it} - \mathcal{T}^p(y_{it}, d_{it}) - s_{it}^p. \tag{3.7}$$

3.4 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.[28]

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:

$$\tilde{z}_{it} = z_{it} - \tilde{y}_{it} - \lambda^{OM} k_{it} \tag{3.8}$$

where λ^{OM} denotes the fraction of capital spending that can be deducted for tax purposes. In our baseline estimation, we set λ^{OM} so that taxation at the corporate level is neutral with respect to investment. We let $\mathcal{T}^c(\tilde{z}_{it})$ denote total corporate tax liability.

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:

$$y_{it} = \begin{cases} z_{it} - \mathcal{T}^c(\tilde{z}_{it}) + \varphi \tilde{k}_{it} - s^c_{it} & \text{if} \quad d_{it} = OM \\ z_{it} + \delta k_{it} - \lambda^{SE} k_{it} & \text{if} \quad d_{it} = SE \\ y_i^{EE} & \text{if} \quad d_{it} = EE. \end{cases} \tag{3.9}$$

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

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

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. These frictions may include adjustment costs or inattention (e.g. DellaVigna (2009)). Chetty (2012) specifies a model

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

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.

3.5 State variables and the individual's maximisation problem

Individuals make choices each period to maximise their expected utility over their remaining years of life. The dynamics of the problem operate through the decisions to save in different assets (which transfer resources across periods), the riskiness of productivity, and the fact that there are costs associated with starting a business and changing legal form. Here we make explicit the state variables and recursive formulation of the individual's problem. We use prime to denote next period's variables and drop the subscripts to simplify notation.

State variables

The state variables are: latent type (j), age, whether the individual is a business owner and its legal form (d), total assets (a), share of assets held in the company ($\tilde{a}^c$), latent productivity (ψ), stochastic productivity (η), incorporation cost (F^{inc}), and start-up cost (F^{start}). We denote the set of state variables by $\Omega = \{j, \text{age}, d, a, \tilde{a}^c, \omega, \eta, F^{inc}, F^{start}\}$. There is uncertainty over the stochastic component of productivity, with the distribution of next period's value, η', depending on its value the previous period, η. Note that we assume that 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.

Recursive formulation

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.

During working life, 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.

Sub-period 2. We let $V(\Omega|k,d')$ 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 (3.1) – (3.9). 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 log-sum result of McFadden (1973) to integrate over these shocks:

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

where γ is a constant of integration that differences out.

Sub-period 1. In the first subperiod, before the realization of the logit shock, 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.

4 Estimation

We first calibrate a number of parameters using data and existing evidence from the literature. We then estimate the remaining parameters using the simulated method of moments, taking the parameters set in the first step as given. We describe both of these steps below, but, before doing so, we set out how we estimate the latent types.

4.1 Data and latent types

To estimate the model we use the data introduced in Section 2, drawn from personal and corporate tax records and company accounts. Our sample consists of the set of small business owners active in 2013-14. This includes all those who are self-employed, and owner-managers for whom we are able to match the personal tax records of the owner to the corporate tax records of the company; the bottom panel of Table 2.2 summarises these businesses. Note that these are a selected sample of the population of small businesses that operate over the entire period 2001-2014. We explicitly account for this selection in estimation. We assume that the model parameters (but not the realized values of the shocks and costs) are common across those we observe entering and potential entrants. Further details on the data and the match between tax records are available in Appendix A.

We discretize heterogeneity in the model 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 and productivity parameters for each type. We follow the approach of Bonhomme et al. (2021) and use a k-means clustering approach to determine type membership. 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 4.1 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, minimal 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 4.1: *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, minimal 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.

4.2 Calibrated parameters

We calibrate several parameters, which are difficult to identify using 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.[29]

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 the average hours worked by closely held business owners reported in the UK Labour Force Survey (LFS).[30]

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

[29] 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.

[30] 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.

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.[31]

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.[32] 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.[33] 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.

4.3 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. We have a total of 66 parameters and 357 moments. 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

[31] 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.

[32] 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.

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

five latent types described in Table 4.1. 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 estimated, but here we describe the variation in the data that helps pin down each parameter (conditional on the values of the other parameters). In Appendix E, we conduct a series of moment informativeness tests to provide additional information on the variation in the data driving the parameters.

Utility function. We identify 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 identify 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 parameters that govern the distribution of incorporation costs, $(F_m^{inc}, F_{sd}^{inc})$ 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 corporation 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_ψ. The standard deviation of latent productivity, σ_ψ, 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 type 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 over our period of study. 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 4.1).

4.4 Parameter estimates

Table 4.2 presents the parameters estimated using the method of simulated moments. We estimate an annual discount factor, β, equal to 0.974, which is line with estimates in the literature. We estimate an optimization error threshold of 2.6% – 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 1.5 and 2.3. 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. We estimate the standard deviation of the logit shocks between 4.3 and 5.6 – these explain around 25% of the transitions between legal forms, with the rest driven by inclusive values, $V(\Omega|k,d)$.

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.[34] 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. We estimate a median start-up cost of £640. This includes any differences in wages that the agent could earn as an employee compared with the prof-

[34] To do this, we compute the reduction in consumption (annualised over the number of years the business is active), Δc_i necessary to make the agent indifferent between switching legal forms: $u(c_i,l) + \frac{F_i}{\bar{N}} = u(c_i + \Delta c_i, l_i)$, where $\bar{N}$ is the average business age.

its 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.[35] We estimate a median incorporation cost of £4440. Costs of this magnitude are necessary to rationalise why many agents choose to remain self-employed when there are substantial tax savings to incorporating.[36] However, it is important to note we estimate substantial dispersion in incorporation costs, with some individuals having very high costs of incorporation but others having very low costs or even benefits to incorporating.

Table 4.2: *Parameter estimates*

		Type				
	Parameter	I	II	III	IV	V
Utility function						
Discount factor (common across types)	β			0.974		
Optimization error threshold	ς_o			0.026		
Curvature of utility in leisure	ν_l	1.907	1.872	2.194	1.808	2.318
Dispersion of logit shocks	σ_ζ	5.588	5.407	4.312	5.270	4.514
Start-up and incorporation costs						
Mean of incorporation costs	F_m^{inc}	40.98	31.89	24.24	32.31	23.24
Std. dev. of incorporation costs	F_{sd}^{inc}	12.00	6.86	8.08	8.25	9.31
Start-up cost	F^{start}	2.29	25.44	33.95	7.86	8.87
Additional start-up cost for OM	$F^{start} \times d = OM$	-8.71	-8.07	-9.81	-9.13	-14.12
Production function						
Mean of latent productivity	μ_ψ	0.691	1.114	0.671	2.406	3.405
Persistence of productivity	ρ	0.476	0.656	0.566	0.655	0.840
Std. dev. of latent productivity	σ_ψ	0.977	0.614	0.976	0.146	0.039
Std. dev. of productivity shocks	σ_ϵ	0.257	0.400	0.555	0.242	0.214
Importance of capital in production	$\theta \times 100$	0.000	4.639	10.745	0.027	0.078

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. Standard errors are shown in Table E.1 in Appendix E.

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. Productivity 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 0.107 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 re-

[35] 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.

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

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

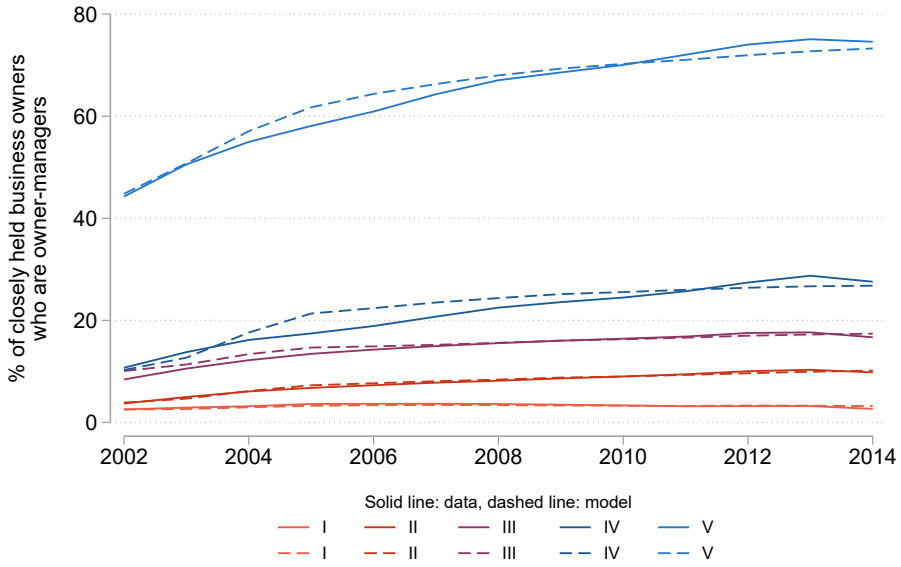
4.5 Model fit

Figure 4.1 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.

Figure 4.2 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.[37] 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 study the removal of the preferential rate of capital gains tax that primarily benefits owner-managers.

[37] 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, see Figure B.4.

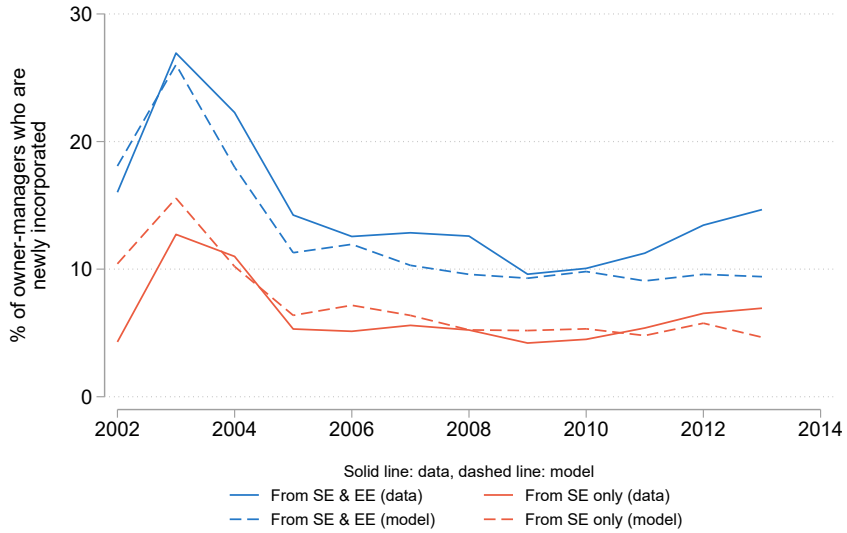
Figure 4.1: *Selected targeted moments*



		Type				
		I	II	III	IV	V
Mean profit - SE	Data	7890	12314	11248	27399	77792
	Model	7348	11353	12740	27249	79635
Mean profit - OM	Data	8216	18368	27657	34873	83568
	Model	14888	19667	30375	32848	83365
Std. dev. profit - SE	Data	7161	11375	18605	15172	44427
	Model	8657	13438	21331	16748	47103
Std. dev. profit - OM	Data	11388	22057	41617	24218	48938
	Model	12819	18995	35618	17596	43611
Std. dev. permanent comp. of log profit	Data	1.07	0.80	1.14	0.38	0.33
	Model	1.07	0.79	1.12	0.39	0.44
Coeff. on AR(1) of log profit	Data	0.26	0.35	0.28	0.45	0.59
	Model	0.25	0.37	0.27	0.44	0.58
Investment/profit	Data	–	0.19	0.57	0.03	0.04
	Model	–	0.30	0.55	0.03	0.02
p.50 retained profits	Data	–	–	–	–	3155
	Model	–	–	–	–	1434
p.75 retained profits	Data	–	–	–	–	14169
	Model	–	–	–	–	13937
p.90 retained profits	Data	–	–	–	–	32270
	Model	–	–	–	–	30269

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 4.2: *Extensive margin responses*

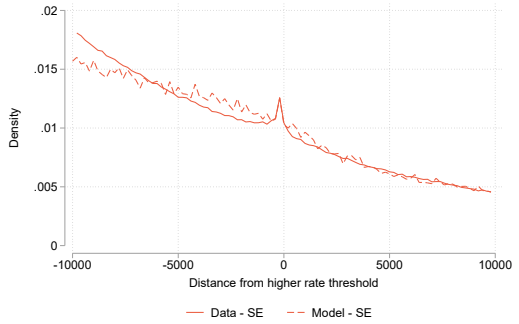


Notes: Details of the estimation process are provided in Appendix E.
Source: Authors' calculations using HMRC administrative datasets and model simulations.

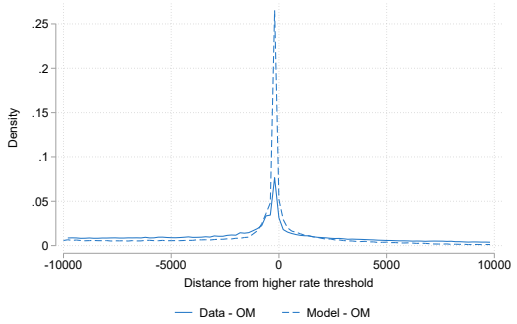
We do a reasonable job of matching behaviour at the intensive margin of business ownership. Figure 4.3(a) and (b) shows that the model generates bunching at the higher rate threshold (see Figure E.4 for bunching at the primary threshold). The bottom four panels show the model's performance at matching untargeted moments. 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 overshooting the 25th percentile at high levels of profits. One possible explanation for this is that we assume a discount factor that is common for everyone. The final two panels in Figure 4.3 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).

Figure 4.3: *Intensive margin responses*

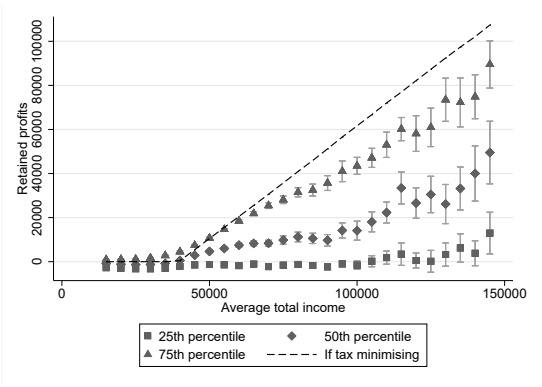
(a) Bunching by SE



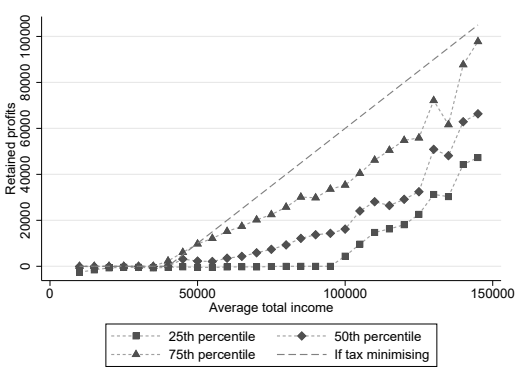
(b) Bunching by OM



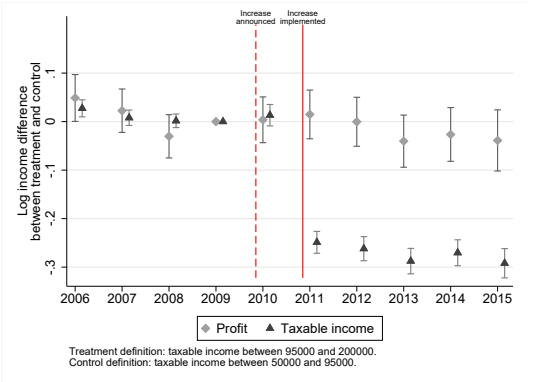
(c) Retained profits: data



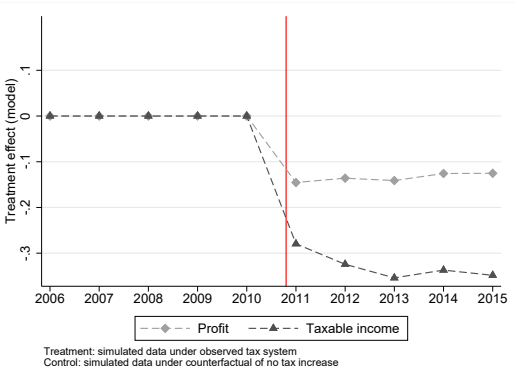
(d) Retained profits: model



(e) Increased top rates: data



(f) Increased top rates: model



Notes: The top left hand panel shows bunching around the higher rate threshold by the self-employed in the data and simulated from the model, and the top right hand panel shows bunching around the higher rate threshold by owner-managers 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.

5 Policy experiments

Governments often use tax policy to try to encourage small business start-ups and investment. A common policy is to tax business owners' income at preferential rates relative to labour income. The design of the tax base is also important for overall incentives to start and invest in businesses. In the UK, as in many countries, marginal investments can be subsidized, untaxed or discouraged, depending on the asset type, financing source and legal form of the owner. In this section, we use our estimated model of small business ownership to consider counterfactual reforms to the taxation of small businesses and draw out lessons for policy design.

5.1 Removing preferential capital tax rates

Many governments offer preferential rates of tax on the incomes derived from small business ownership, including on self-employed profits, dividends and capital gains. For example, in the UK, capital gains from the disposal of certain business assets are taxed at a lower rate than the gains from other asset types (which are also taxed less than labour income). In the US, the qualified small business stock exclusion allows owners of small businesses and startups to exclude up to 100% of the gains from these businesses from federal capital gains tax. Preferential rates such as these share a number of important features. First, they are often only available (or more easily accessible) to certain legal forms. Second, they can be accessed even if the profits of the business entirely reflect the returns to labour of the owner, with minimal capital investment. And, in the case of capital gains tax, they encourage the retention of profits within the company over long periods.

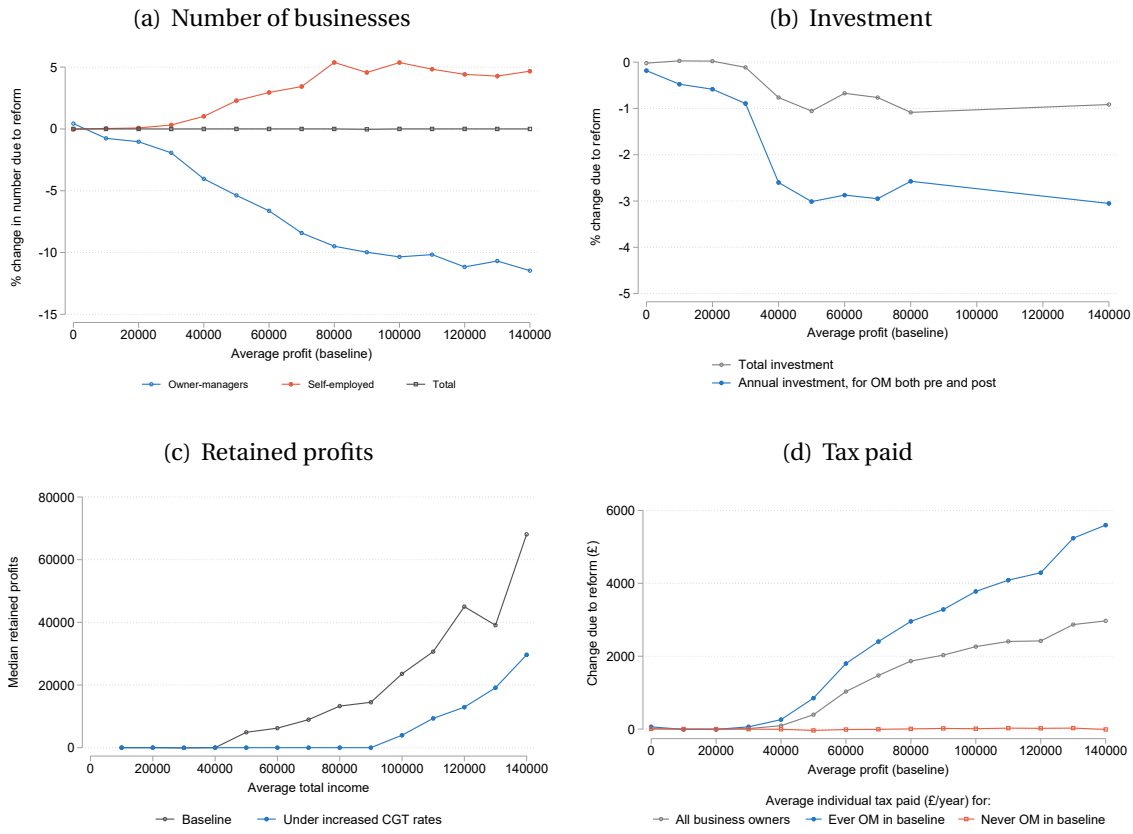
We illustrate the effect of preferential rates and channels through which they operate by studying the removal of the UK's preferential rate of capital gains tax (CGT) for business owners. We simulate a counterfactual world in which this rate had not been in place over our period of study, assuming instead 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).[38] Figure 5.1 shows the impact of this reform.

The top left panel shows that removing the preferential rate of CGT leads to no change in the overall number of small businesses. The entry decision is inelastic with respect to the capital gains tax rate because those people running incorporated businesses in the pre-reform world prefer being self-employed to not running a business at all. The removal of the preferential rate of CGT thus affects the margin between incorporation and self-

[38] 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.

employment, but not between business ownership and employment. The tax advantage to being incorporated is reduced (but not removed) leading to a large fall in the number of owner-managers that is fully offset by individuals instead choosing to be self-employed. This is particularly true at higher profit levels, as these individuals see the biggest change in the benefits from being incorporated (in level terms). These results illustrate the extent to which preferential rates distort decisions over legal form: the existence of non-tax costs to incorporation means that many people only choose the corporate form *because* of the tax break.

Figure 5.1: *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.

The top right hand panel shows the change in small business investment on the intensive margin. Investment falls by approximately 1% per year for individuals with average profit (pre-reform) in excess of £60,000. The figure also shows that investment falls by more than average for those that were (and remained) owner-managers. However, the

share of investment accounted for by those businesses affected by the removal of the preferential rate is small: only 4% of aggregate small business investment is conducted by businesses that have positive average retained profits (thus benefitting from the preferential CGT rate). This means that, overall, there is only a 0.18% decline in aggregate closely held business investment due to the removal of the preferential rate of capital gains tax.

Peferential rates of capital gains tax act to distort the intertemporal allocation of consumption. If individuals cannot costlessly borrow against profits retained in a company, then the difference in tax rates payable during company life and on liquidation creates a kink in the intertemporal budget constraint. Individuals will optimally retain to equalise the marginal rate of substitution between today and tomorrow, adjusting for the difference in rates (see Miller et al. (2020) for further discussion). This creates inefficiencies relative to a system that taxes income at the same rate, regardless of when it is withdrawn from the company.[39] Removing the preferential rate reduces the incentive to retain: the bottom left hand panel of Figure 5.1 shows that retained profits fall substantially due to the reform, although are still positive for those making more than £100,000.

The reduction in retained profits is one of three factors that contribute to increases in tax revenue that arise from removing the preferential rate of CGT for business owners. First, some business owners choose to be self-employed as opposed to incorporated and therefore pay higher average rates. Second, the profits that are not retained are instead withdrawn during company life and thus taxed at higher rates of dividend tax. Third, any profits that are retained are now taxed at a higher rate of CGT. The bottom right hand panel shows the increase in average tax paid (£ per year) at different average profit levels. Among those who *were* owner-managers pre-reform, tax paid increases by almost £6000 for those making an average of £140,000 per year, with no change for those who were never owner-managers pre-reform. Thus, there is a reduction horizontal inequities between business owners who choose different legal forms. Overall, the reform leads to an increase in tax revenue of £390m per year (2.8% of total revenue from small business owners). This is progressive, with 36% of the increase coming from individuals making average profits of more than £100,000 – the top 1% of closely held business owners.

In summary, when business ownership is already tax favoured, reducing the tax advantage to one type of legal form does not affect the decision to enter. If, as in our setting, businesses that do the most investment are not the primary beneficiaries of lower capital gains tax, then removing these tax breaks does not lead to a large fall in aggregate small

[39] It is worth noting that this is a particular feature of preferential capital gains taxes, which are accessible only on company liquidation, and does not apply to lower rates of tax on self-employed profits or dividends.

business investment. It also raises revenue from high earning business owners and reduces the distortions to legal form and the timing of income withdrawal.

5.2 Tax base reforms that reduce the bias against new equity financing

The design of the personal and corporate tax bases in most countries tends to distort businesses' investment decisions (both through subsidies and disincentives). A key example, common in almost all countries, is the discouragement of equity financing. This arises because debt interest payments are commonly deducted for tax purposes but there is no equivalent deduction for equity financing. For those running incorporated small businesses, the extent of the bias is affected by taxes at the corporate and personal level. Even if investments are fully deductible from corporate tax, as is the case for most investment in the UK, equity financed investments are discouraged because there is no deduction for the cost of finance at the *personal level*.[40] As an example, if someone invests £1000 in a company and receives the normal rate of return of 5%, this return can be excluded from tax at the corporate level but will still be taxed at their marginal personal tax rate. This means that marginal investments by company owner-managers are taxed, and thus discouraged. This bias against equity finance is particularly important for small businesses that may struggle to borrow. It also acts as a disincentive to incorporation, which may limit the expansion of successful businesses.

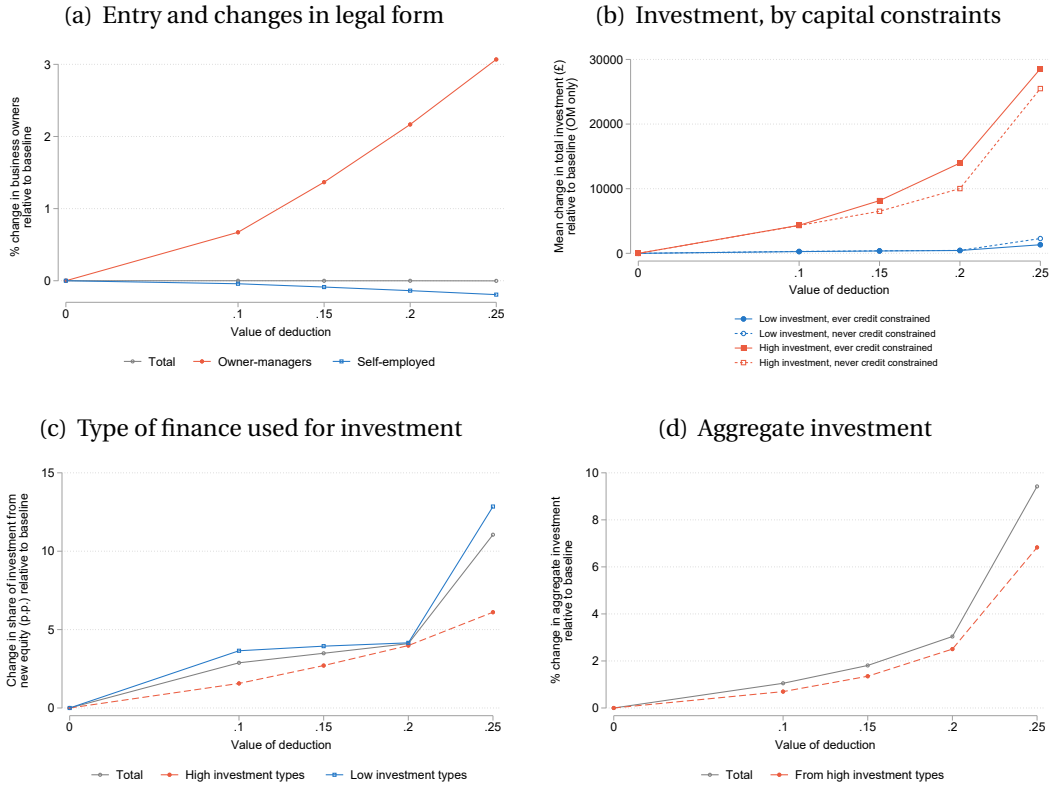
We explore the implications of reducing this bias by moving to a cash-flow treatment of new equity. We model this by giving people upfront deductions, φ, against personal tax for investments out of new equity (incomes from which are then taxed on withdrawal).[41] We set $\varphi = 0$ for individuals whose taxable income is below the higher rate threshold in that year – this is equal to their marginal personal rate if they withdraw income in that year. For those above the threshold, the relevant rate will vary. We vary φ between 0.1 and 0.25 for individuals whose taxable income is above the higher rate threshold. This corresponds to giving them a credit ranging from the capital gains tax rate (0.1) and the dividend tax rate (0.25). Higher values of φ therefore reduce the fraction of individuals for whom equity financing is discouraged (possibly leading to subsidies for some).[42]

[40] The "new view" of dividend taxation argues that personal taxes on capital incomes are irrelevant for marginal investments financed from *retained* equity because they equally affect the opportunity cost of retaining today and the post-tax returns generated tomorrow (Zodrow (1991)). However, this is not true for investments funded by new equity, and thus the "old view" (that personal taxes do affect corporate investments) should be expected to hold.

[41] An alternative policy is a rate of return allowance, which can be thought of as a deduction for the (opportunity) cost of equity finance – it is similar to a cash-flow tax, but with deferred rather than immediate tax relief. For further discussion of how these policies could be implemented in practice, see Adam and Miller (2021).

[42] For the tax treatment to be perfectly neutral with respect to investment, it must be the case that the marginal rate used to calculate deductions is equal to the rate paid on withdrawal. In practice, this is difficult

Figure 5.2: *Removing the distortion associated with new equity investments*



Notes: We simulate policies that introduce an upfront deduction for new equity investments of between 0.1 and 0.25 for individuals whose taxable income exceeds the higher rate threshold. The top left hand panel shows the percentage change in the total number of small businesses, owner-manager and self-employed relative to the baseline. The top right hand panel shows the mean change in the total investment by owner-managers (over our period of study), for high and low investment types and by whether they were ever credit constrained. The bottom left hand panel shows the mean percentage point change in the share of total investment from new equity financing. The bottom right hand panel shows the change in aggregate small business investment, relative to baseline, in total and from high investment types.
Source: Model simulations.

Figure 5.2 shows the impact of varying φ in this way. The top left hand panel shows entry and changes in legal form. Increasing the value of the deduction for new equity does not lead to any change in the overall number of small businesses, but does lead to switching to the corporate form. This suggests that discouragement of new equity financing can create distortions in the choice of legal form for small businesses, but does not deter overall entry. The reform changes incentives in two ways. First, its aim is to remove the disincentive to investing using new equity, at which it is successful. The right hand panels show that it achieves large increases in investment, especially for investment-intensive business types. The bottom left hand panel shows that there is also a shift in the composition of funds used to finance investment. Second, the fact that it is implemented via a cash

to achieve if individuals can choose how to withdraw income and the rates on these vary (e.g. as either capital gains or dividends), or if tax rates vary across time.

flow treatment, with the deductions provided upfront, helps to alleviate the credit constraints felt by some businesses. The top right panel illustrates the change in investment by whether the business owner was ever credit constrained.[43] We find that increases in investment are larger for businesses that were credit constrained in the pre-reform world.

Overall, the current disincentives to invest using new equity distort the total amount and source of small business investment. These distortions are particularly large for high investment business types, who are seen as the most likely to grow and are the target of policymakers.

Combining rate and base reforms

Policies that affect the tax base are much better targeted at investment than lower rates. We show above that removing preferential rates of capital gains tax reduces distortions and raises revenue in a progressive way. It does however, lead to a small fall in aggregate small business investment. In addition, the bias against equity financing inherent in the current tax system (and discussed above) increases when personal tax rates are higher. We now illustrate how combining changes to tax rates and the base can improve effiency and equity. We consider reforms that increase the capital gains tax rate for business owners from 10% to 20% (i.e. as in Section 5.1), in addition to providing upfront deductions for higher rate taxpayers ranging between 0.1 and 0.25 (as in Section 5.2).

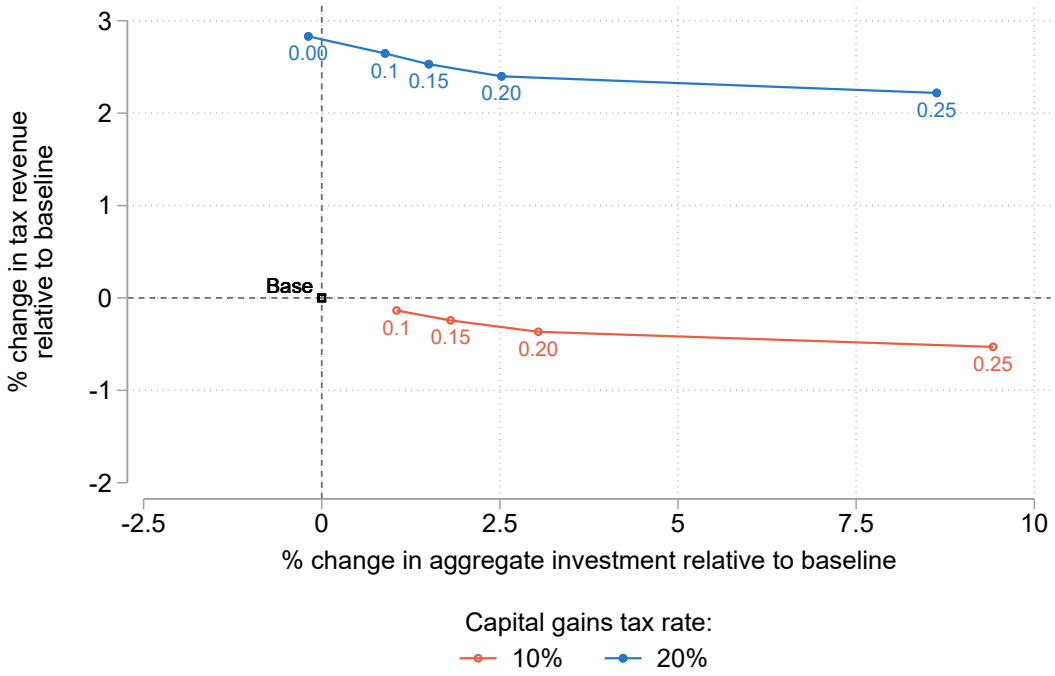
Figure 5.3 summarises the impact of these reforms. The red line illustrates the changes in aggregate investment and tax revenue under each value of the deduction in combination with the baseline 10% capital gains rate, as described in Section 5.2. The blue line shows the impact of the upfront deductions in combination with the higher rate of capital gains tax: all the points where $\varphi \geq 0.1$ are in the top right quadrant i.e. lead to higher tax revenue and investment. Increasing the capital gains tax rate on business income to 20% and combining this with a deduction for new equity equal to 20% for higher-rate taxpayers leads to a 2.4% increase in tax revenue, and 2.5% increase in aggregate small business investment.

This illustrates how removing preferential tax rates (that only benefit some business owners) can raise significant revenue and reduce distortions, with the small decline in investment being more than offset by reforms to the tax base. We recover the change in the expected value function at age 30 for individuals in our simulated sample, and calculate the share of individuals who are indifferent between, better or worse off under the different reform packages. For the policy that combines an increase in the capital gains to 20% with a 20% upfront deduction, 70% of the high investment types are better off,

[43] We define this as individuals who ever invest more than 95% of their assets on hand in productive capital.

with only 2.5% worse off. In contrast, only 14% of the low investment types are better off, with 40% worse off. This highlights that the design of the current tax system subsidises high-income individuals primarily selling their own labour, at the expense of those making larger investments.

Figure 5.3: *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 0.1 and 0.25 (for higher rate taxpayers), 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 0.1 and 0.25 (for higher rate taxpayers), when the capital gains tax rate equals 20%.
Source: Model simulations.

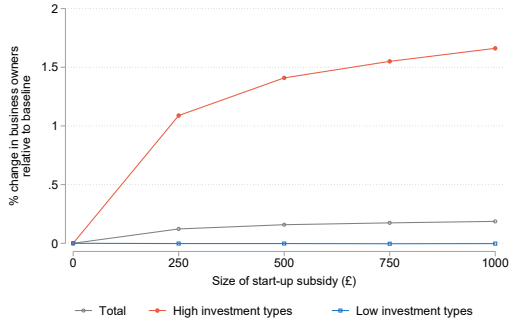
5.3 Investment subsidies for new start-ups

So far, we have described reforms aimed at removing disincentives that are common to many tax systems. If there are market failures associated with enterpreneurial activity, then there may be gains to providing subsidies to small business ownership. The efficacy of these subsidies depend on how well targeted they are at the market failures. One leading example is credit constraints, which can prevent some individuals from starting a business and may mean that some business owners invest less than they would otherwise like to. Lower rates of tax on the incomes derived from business ownership are not well targeted at credit constraints. Instead, one way to relax these constraints is to provide subsidies for investment that are available to businesses in their first year of operation.

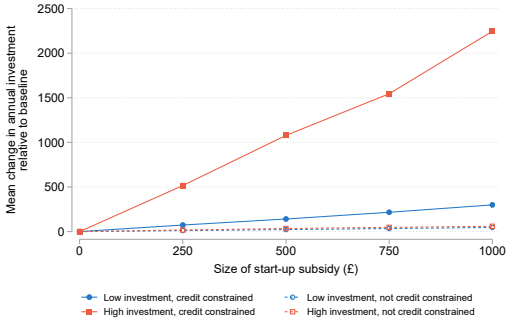
We consider a policy that gives new business owners a subsidy (ranging between £250 and £1000) that they are required to spend on investment.[44] Figure 5.4 summarises the impact of these subsidies. The top left-hand panel shows the change in the number of small businesses that start over our period of study. Start-up subsidies increase the number of high-investment types by allowing more individuals to meet the minimum level of capital required to enter. Since these are a relatively small fraction of the overall population of small businesses, the percentage change in total number of small businesses is not large; however, the policy does allow credit constrained high-investment types to try business ownership.

Figure 5.4: *Impact of introducing start-up investment grants*

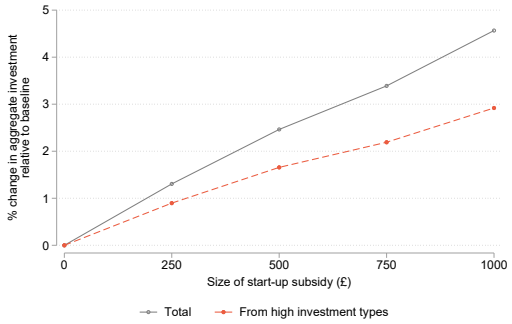
(a) Entry



(b) Mean changes in annual investment



(c) Aggregate investment



Notes: We simulate the effect of offering subsidies (the value of the subsidy is shown on the horizontal axis) to people entering business ownership that they are required to spend on investment. The top left hand panel shows the percentage change in the number of small businesses relative to the baseline, separately by high (II and III) and low (IV and V) investment types. The top right hand panel shows the mean change in annual investment (£) (relative to baseline) for (i) low investment businesses who were credit constrained, (ii) low investment businesses who were not credit constrained, (iii) low investment businesses who were credit constrained, (iv) high investment businesses who were not credit constrained. Credit constraints are defined as investing more than 95% of assets in the baseline. The bottom panel shows the change in aggregate investment over our period of study, and the contribution made by high investment businesses.
Source: Model simulations.

[44] We simulate this for types II-V (i.e. the subsidies are not available to type I businesses, for whom $\theta = 0$). In practice, this could be enforced by requiring new business owners to provide details on what they plan on doing with the grant.

The top right-hand panel shows the change in investment on the intensive margin i.e. for businesses that operated in the pre-reform world. It shows the mean change in annual investment (across businesses and years active), separately by whether the business is a high or low investment type and whether it was credit constrained in that year.[45] There is almost perfect crowd-out of the subsidy for non-credit constrained businesses: their average change in capital is approximately zero. However, the mean change in annual investment for credit constrained businesses is substantial. For high investment types, the mean change is in excess of the subsidy: this is driven by the fact that the subsidy acts not only to increase investment in the first year, but creates higher profits that are subsequently reinvested in future periods (in which they were also credit constrained in the pre-reform world). Overall, the subsidies increase aggregate small business investment by between 1.3 and 4.5%, with more than half of this increase coming from high investment types.

A policy of providing start-up investment subsidies of £750 would lead to a 0.5% fall in government revenue from small businesses. This is approximately equivalent to providing a 25% deduction for new equity for higher-rate taxpayers. The latter reform leads to a larger increase in aggregate small business investment because it reduces the disincentive associated with investing a marginal pound, whereas the lump-sum nature of the investment start-up subsidies do not alter incentives at the margin. However, the start-up subsidies increase the number of people trying business ownership, because they allow people with very low assets to enter. The two types of policies thus affect different parts of the distribution of small business investment. Both types of reform are much better targeted at entrepreneurial investment than preferential rates of capital gains tax, which cost more than six times the amount of tax revenue than either the tax credits or start-up subsidies.

6 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 entrepreneurial investment. We show that preferential rates of capital gains tax are poorly targeted at encouraging investments, and removing them would lead to increases in tax revenue, which would come from the highest profit individuals. In contrast,

[45] We define this as individuals who invest more than 95% of their assets on hand in productive capital.

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

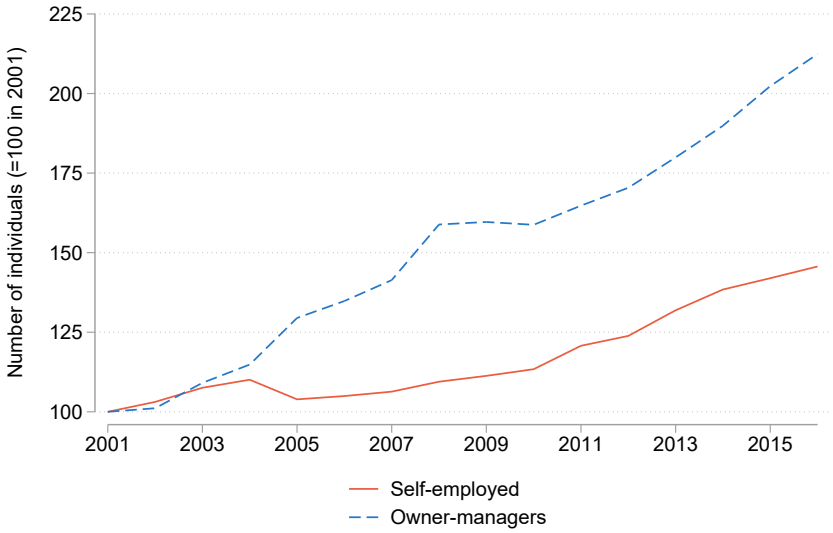
Information on small business owners is from the universe of self–assessment income tax records, available from 2000-01 to 2015-16. Most UK adults are not required to complete a self–assessment tax return (between 9 and 10 million did so each year, out of an adult population of more than 40 million). All company directors and those with self-employment income are required to submit a self-assessment tax return.[46]

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.

Figure A.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.

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

Figure A.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.

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

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

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 directors are required to submit a tax return, which means that all directors should be in both datasets.

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

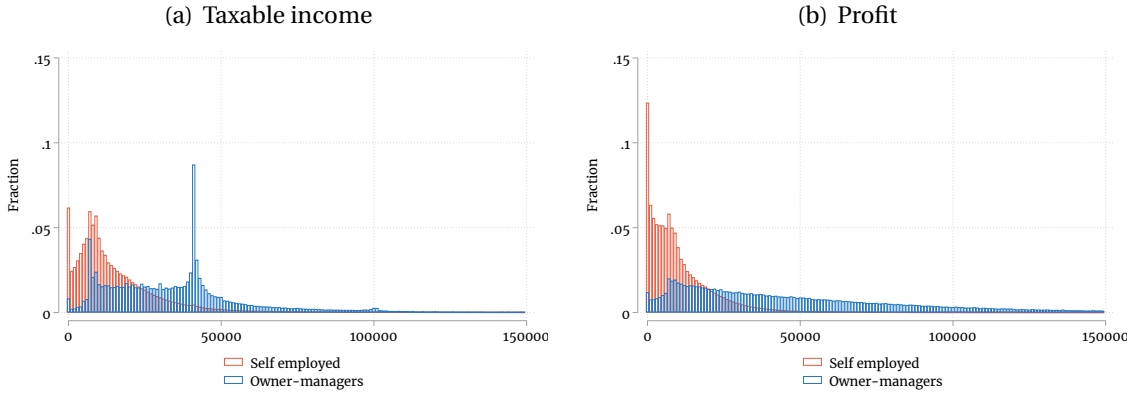
not the set of companies that HMRC tried to match (we do not have the list of companies included in that exercise), but the "matched" companies all fall within this full sample.

This match is also used by Miller et al. (2020), who compare the matched and unmatched 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 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.

Figure A.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.

Figure A.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.

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 information 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.

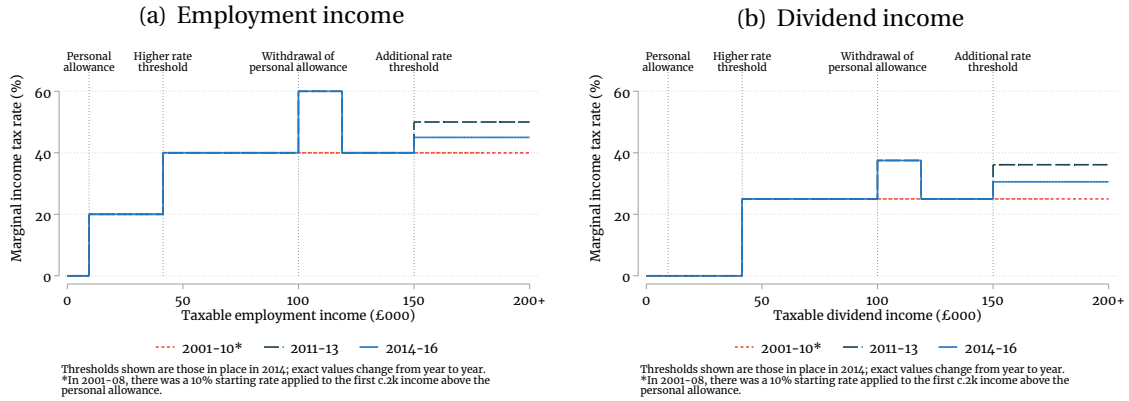
B Tax system and its effects

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.

Figure B.1: *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.

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

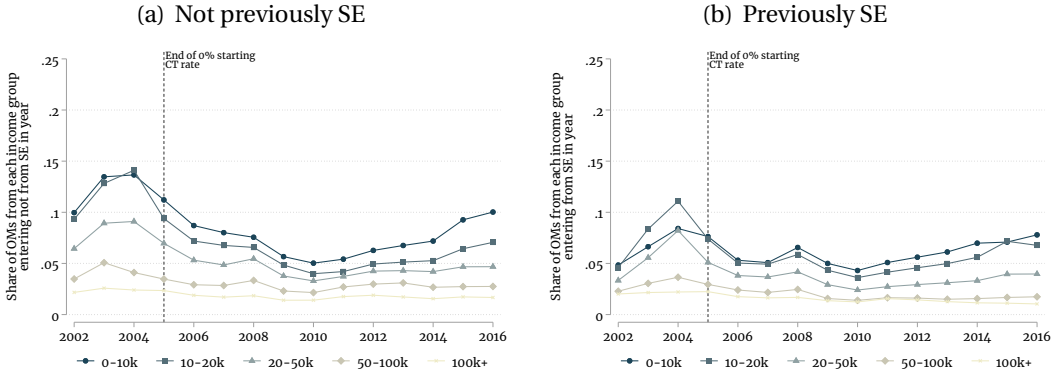
Current expenditure (such as wages and material inputs) is directly deductible from turnover in the calculation of (corporate) taxable profits. For capital expenditure (such as on buildings and machinery that depreciate over time), companies can claim capital allowances.

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 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%). 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.

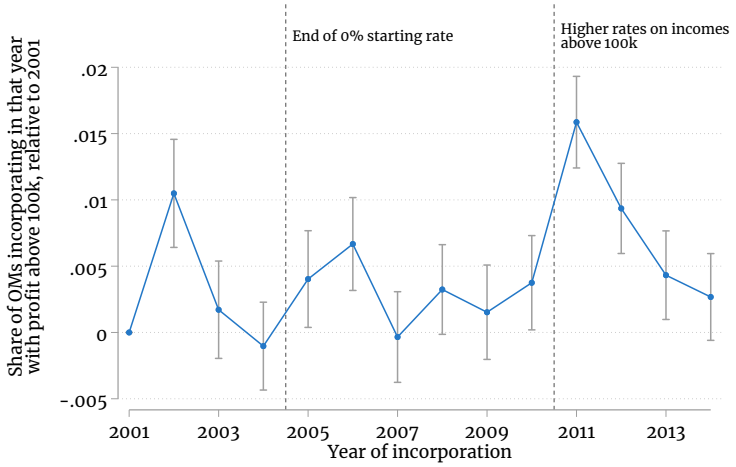
B.2 Additional figures

Figure B.2: *Entry of owner-managers, 2001-16*



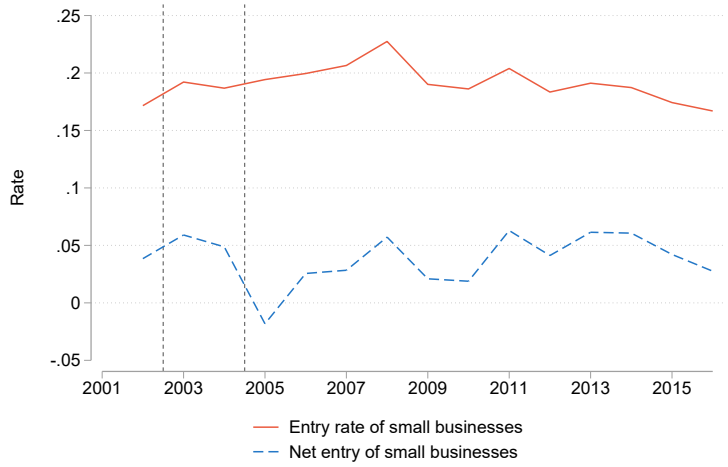
Notes: The left hand panel shows the share of owner-managers within each taxable income band that are newly present in each year and were not self-employed in the previous year, and the right hand panel shows the share entering that were self-employed in the previous year.
Source: Authors' calculations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

Figure B.3: *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.

Figure B.4: *Entry of small businesses, 2002-16*



Notes: The red line shows the number of new small businesses as a fraction of the previous year's total. The blue line shows the number of new small businesses minus the number of exiting small businesses as a fraction of the previous year's total.
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 approach, 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 Clustering problem

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

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

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. We define x_i to be a two-dimensional vector

containing individual i's mean profit and mean investment as a share of mean profit. Each individual's average is calculated over the time that he/she is in the sample.

C.2 Number of clusters

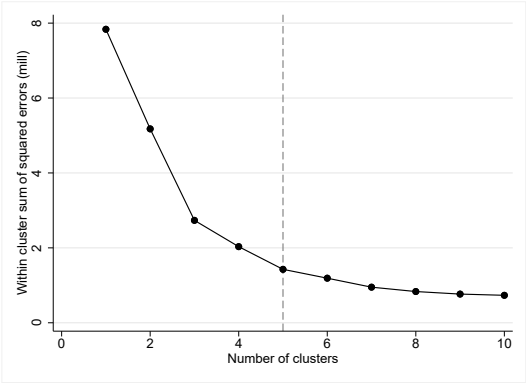
In order to select the number of clusters we use heuristic methods. Our goal is to approximate the heterogeneity, while limiting the total number of clusters.

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.

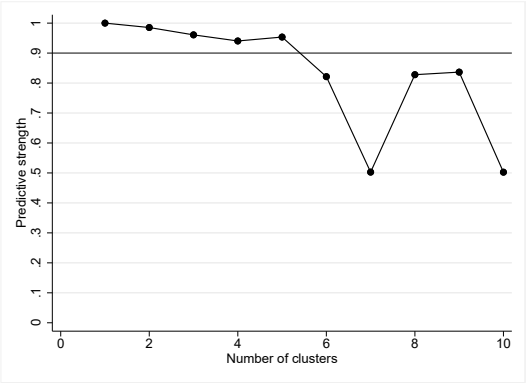
The second method we use is based on predictive strength, as suggested by Tibshirani and Walther (2005). The basic idea of this approach is to: (i) cluster the test data set into K clusters, (ii) cluster the training data into K clusters, and then (iii) measure how well the training set cluster predicts 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.

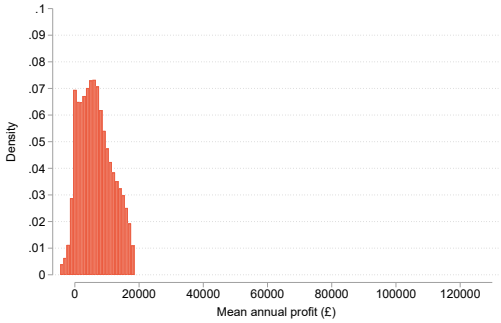
C.3 Distributions within latent types

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.

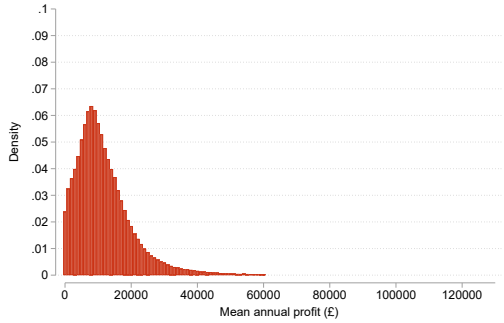
Table C.1 shows that these differences are also reflected in variation in industry composition across types. More than 40% of type V business owners work in business services, while type III (the highest investment type) are more likely to work in agriculture, mining or utilities.

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

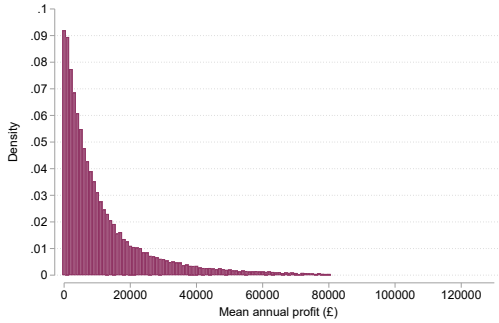
(a) Type I



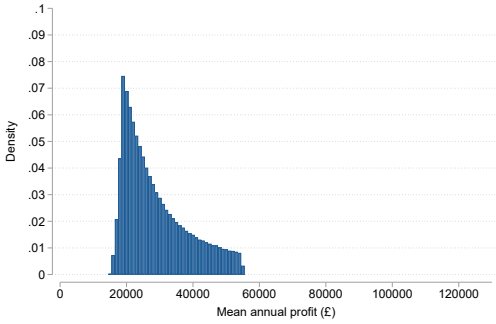
(b) Type II



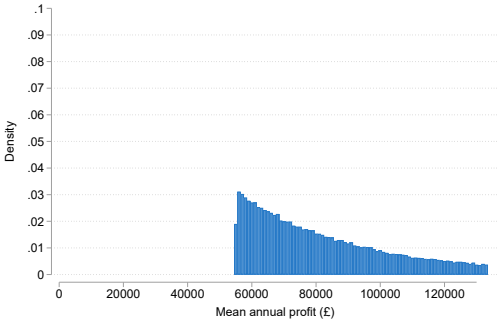
(c) Type III



(d) Type IV



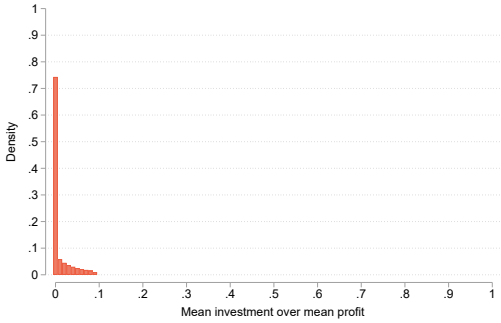
(e) Type V



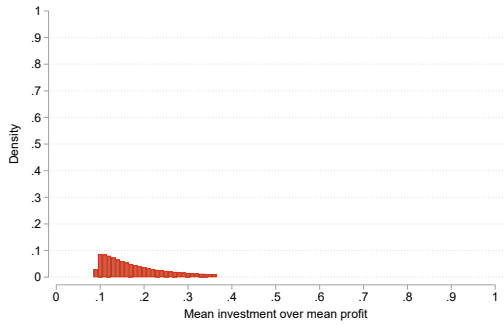
Notes: Each panel shows the distribution of mean profit by the different latent types.
Source: Authors calculations using HMRC administrative datasets.

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

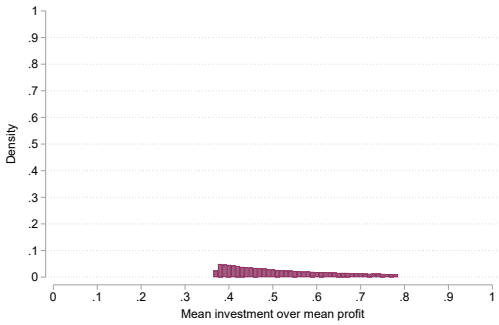
(a) Type I



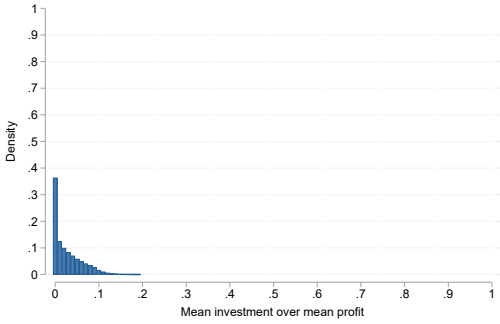
(b) Type II



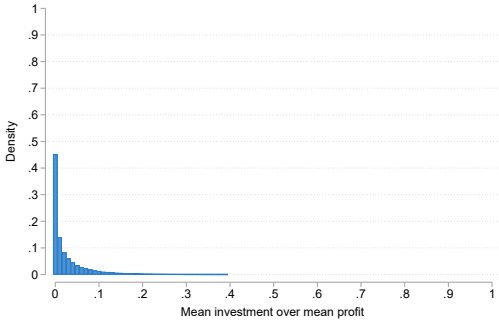
(c) Type III



(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, calculate the optimal choice of capital in the first sub-period.

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 are 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).[48] 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 normally distributed, and we place this on grid with 6 points using the Adda and Cooper (2003) method.

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 place the capital investment decision on a grid with 5 points, and linearly interpolate the first order condition between these points to find the optimal value of capital. 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', share of assets held in the company next period, $\tilde{a}^{c'}$.

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

[48] 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.

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 described above.

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:

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

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: $c(\Omega|\tilde{k},d',\tilde{a}^{c'})$, $l(\Omega|\tilde{k},d',\tilde{a}^{c'},mtr)$, $a'(\Omega|\tilde{k},d',\tilde{a}^{c'},mtr)$ 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 section 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 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 (the EGM step described above must be performed on each iteration).

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:

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

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

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. It also serves 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, $\tilde{k}$:

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

We do this by evaluating the first order condition with respect to the choice of capital at five points and linearly interpolating between these points to find the choice of k where it is equal to zero (or equal to the corner solutions of of investing nothing or a).

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 on profits 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 of 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 (i) zero assets, and (ii) 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, we set the share of business owners that are owner-managers in the first year by matching this share to the data. [49]

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 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:

$$\hat{\theta}_j = \arg\min G_j(\theta_j)' W_j G_j(\theta_j) \tag{D.5}$$

$$\text{where } \theta_j = (\beta, \zeta_o, \{\nu_L, \sigma_\zeta, F^{start}, F^{start}_{d=OM}, F^{inc}_m, F^{inc}_{sd}, \mu_\psi, \sigma_\psi, \sigma_\epsilon, \rho, \theta\}_j) \tag{D.6}$$

[49] In a robustness exercise, we estimate this share to account for the selected sample of business owners over time. The results are insensitive to this.

and $G_j(\theta_j)$ 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_j, the weighting matrix, equal to the diagonal of the asymptotically optimal weighting matrix.[50] We estimate the parameters separately by the latent types, j. 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 (pattern search).

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 ten candidate parameter values from the final step of the first stage and use these as starting values 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

[50] 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.

E.1 Depreciation rate

We estimate the depreciation of capital experienced by small businesses using data on capital allowances and changes in the value of assets from company accounts. Let K_{it} denote the value of fixed assets recorded in company accounts for business i in year t, and let k_{it} denote the value of new investment spending, constructed from the data on capital allowances. The depreciation rate for each business i in year t is:

$$\delta_{it} = 1 - \frac{K_{it} - k_{it}}{K_{it-1}} \tag{E.1}$$

We use the mean value of δ_{it}, which is equal to 0.22 in estimation.

E.2 Standard errors and moment informativeness

Table E.1 shows the standard errors for the estimated parameters.

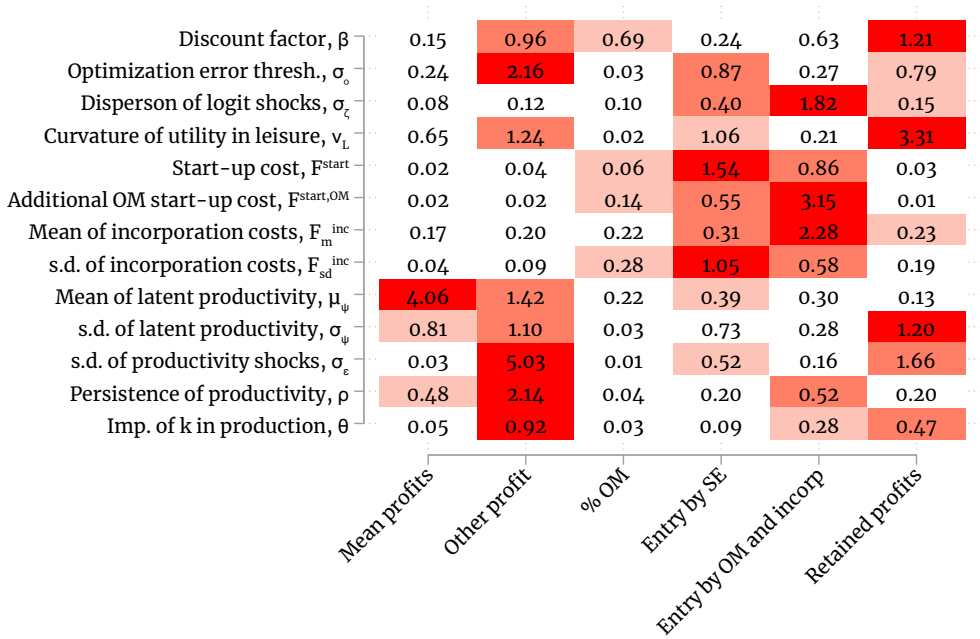
Table E.1: *Parameters estimated in the second stage*

		Type				
	Parameter	I	II	III	IV	V
Utility function						
Discount factor (common across types)	β			0.974		
				(1.8e-04)		
Optimization error threshold	ς_o			0.026		
				(2.6e-02)		
Dispersion of logit shocks	σ_ζ	5.588	5.407	4.312	5.270	4.514
		(9.7e-03)	(1.5e-02)	(5.3e-02)	(1.7e-02)	(2.7e-02)
Curvature of utility in leisure	ν_l	1.907	1.872	2.194	1.808	2.318
		(6.9e-03)	(1.4e-02)	(3.7e-02)	(1.7e-02)	(2.1e-04)
Start-up and incorporation costs						
Start-up cost	F^{start}	2.29	25.44	33.95	7.86	8.87
		(2.4e-02)	(2.4e-01)	(1.2e+00)	(7.5e-02)	(1.2e-01)
Additional start-up cost for OM	$F^{start} \times d = OM$	-8.71	-8.07	-9.81	-9.13	-14.12
		(3.4e-02)	(7.5e-02)	(1.5e-01)	(4.8e-02)	(9.1e-02)
Mean of incorporation costs	F_m^{inc}	40.98	31.89	24.24	32.31	23.24
		(5.9e-02)	(6.1e-02)	(2.1e-01)	(5.9e-02)	(8.9e-02)
Std. dev. of incorporation costs	F_{sd}^{inc}	12.00	6.86	8.08	8.25	9.31
		(4.6e-02)	(7.8e-02)	(2.4e-01)	(7.6e-02)	(1.1e-01)
Production function						
Mean of latent productivity	μ_ψ	0.691	1.114	0.671	2.406	3.405
		(1.3e-03)	(2.3e-03)	(4.7e-03)	(1.4e-03)	(2.5e-03)
Std. dev. of latent productivity	σ_ψ	0.977	0.614	0.976	0.146	0.039
		(5.7e-04)	(1.8e-03)	(3.7e-03)	(2.0e-03)	(3.8e-03)
Std. dev. of productivity shocks	σ_ϵ	0.257	0.400	0.555	0.242	0.214
		(1.3e-03)	(1.9e-03)	(3.7e-03)	(1.2e-03)	(1.3e-03)
Persistence of productivity	ρ	0.476	0.656	0.566	0.655	0.840
		(9.9e-04)	(1.8e-03)	(3.4e-03)	(1.1e-03)	(1.4e-03)
Importance of capital in production	$\theta \times 100$	0.000	4.639	10.745	0.027	0.078
		(.)	(7.2e-02)	(1.9e-01)	(3.3e-02)	(2.3e-02)

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.

We calculate meaures of sensitivity of the parameters to the included moments using the methods developed by Honoré et al. (2020).[51] We consider the change in the asymptotic variance from completely excluding the kth set of moments, relative to the baseline when all moments are included (this is measure ϵ_4 in Honoré et al. (2020)). We compute the change in the asympototic variance of each parameter for six sets of parameters: mean profit of the self-employed and owner-managers, other profit measures (including the decomposition, investment as a share of profit, and bunching), the percentage of business owners who are owner-managers, entry by the self-employed, entry by owner-managers and incorporation, and retained profits. Table E.1 shows this measure for type V (and Table E.2 for types I-IV). A higher value indicates the set of moments is more informative for that parameter – the dark red highlights the most informative set of moments for each parameter. Retained profits are the most informative moment for the discount factor, while entry and incorporation are the most important for the start-up and incorporation costs. As expected, the profit moments are the most informative moments for the parameters governing the producticity process.

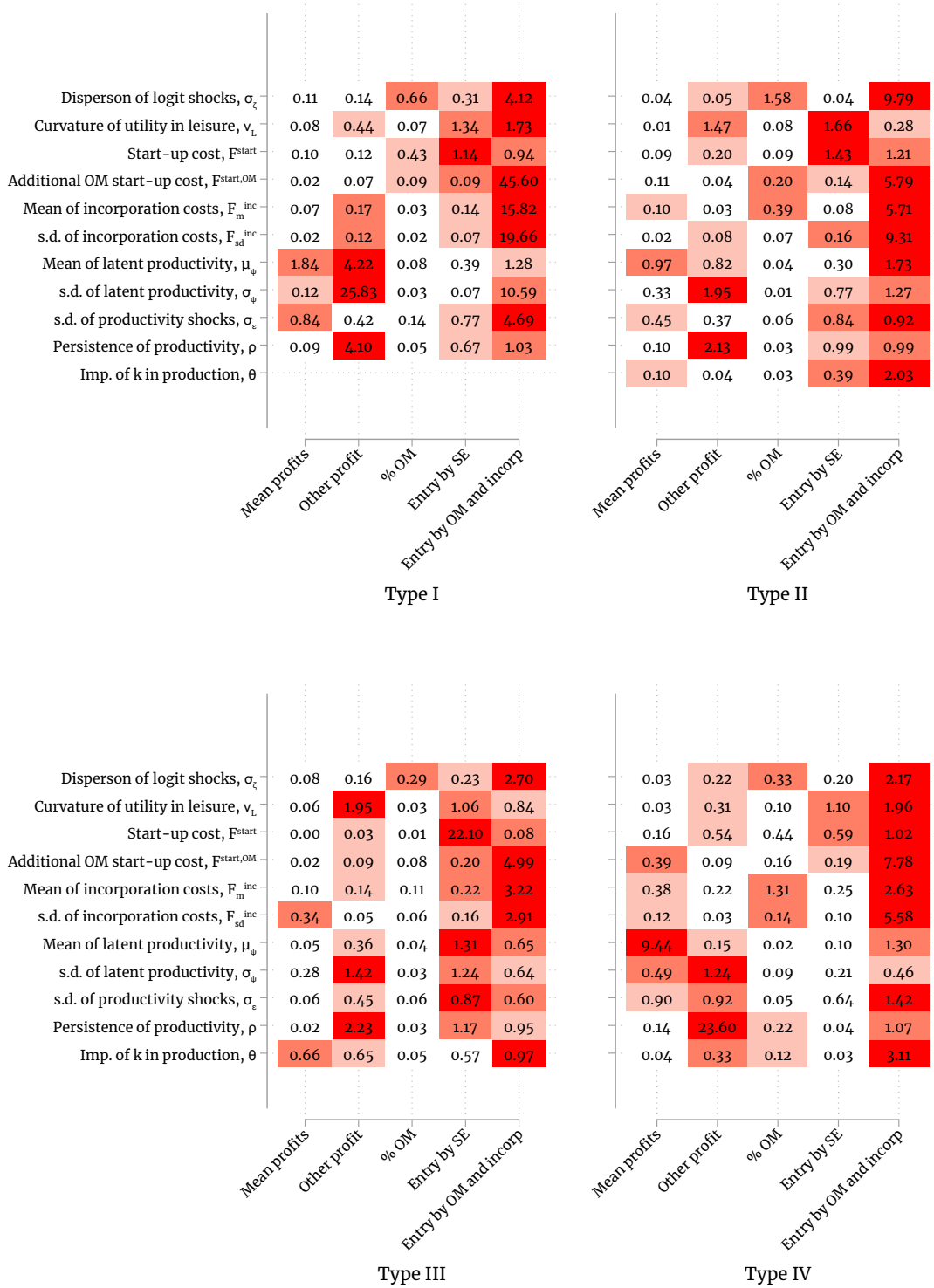
Figure E.1: *Moment informativeness, type V*



Notes: The number in the (j,k) cell shows the change in the asympotic variance of parameter j when the set of moments k are removed, relative to the baseline asympotic variance when all moments are included. The dark (medium, light) red cells indicate the (second, third) most informative set of moments for each parameter.

[51] These are similar to, and designed to complement, the measures proposed by Andrews et al. (2017)).

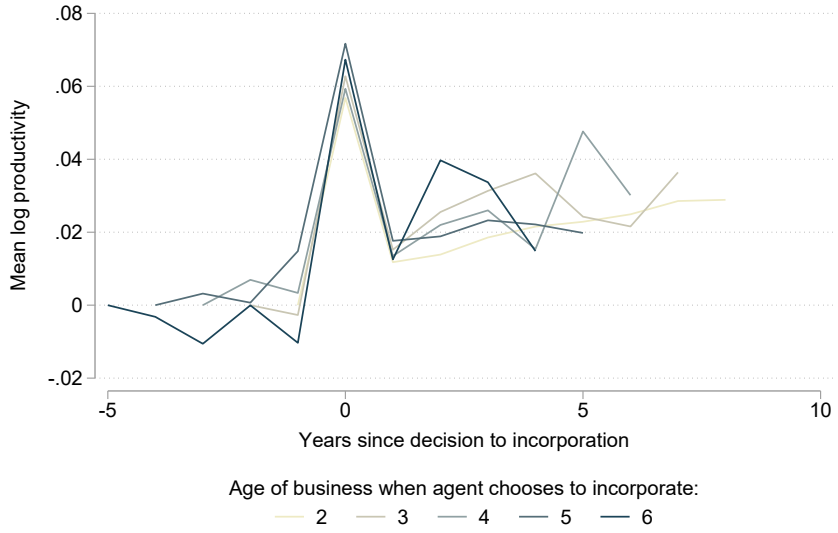
Figure E.2: *Moment informativeness, types I-IV*



Notes: The number in the (j,k) cell shows the change in the asympotic variance of parameter j when the set of moments k are removed, relative to the baseline asympotic variance when all moments are included. The dark (medium, light) red cells indicate the (second, third) most informative set of moments for each parameter.

E.3 Model properties

Figure E.3: *Productivity around incorporation*

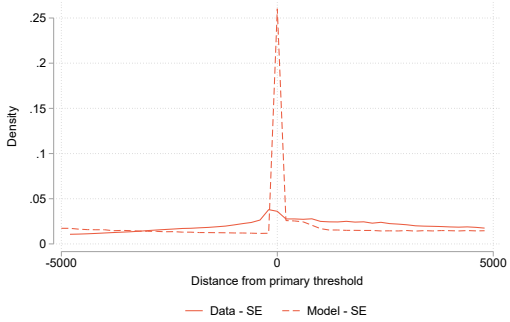


Notes: We plot mean log productivity around the age at which the business owner chooses to incorporate, separately by business age at the date of incorporation. We control for the number of years that the business is in operation.
Source: Model simulations.

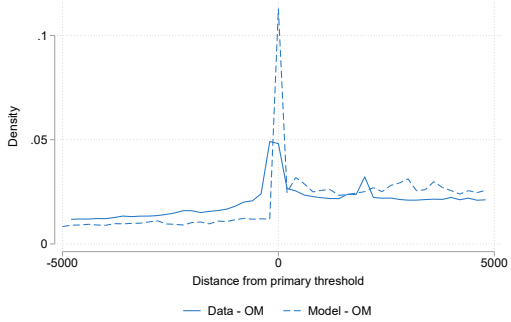
E.4 Targeted moments

Figure E.4: *Intensive margin responses*

(a) Bunching by SE

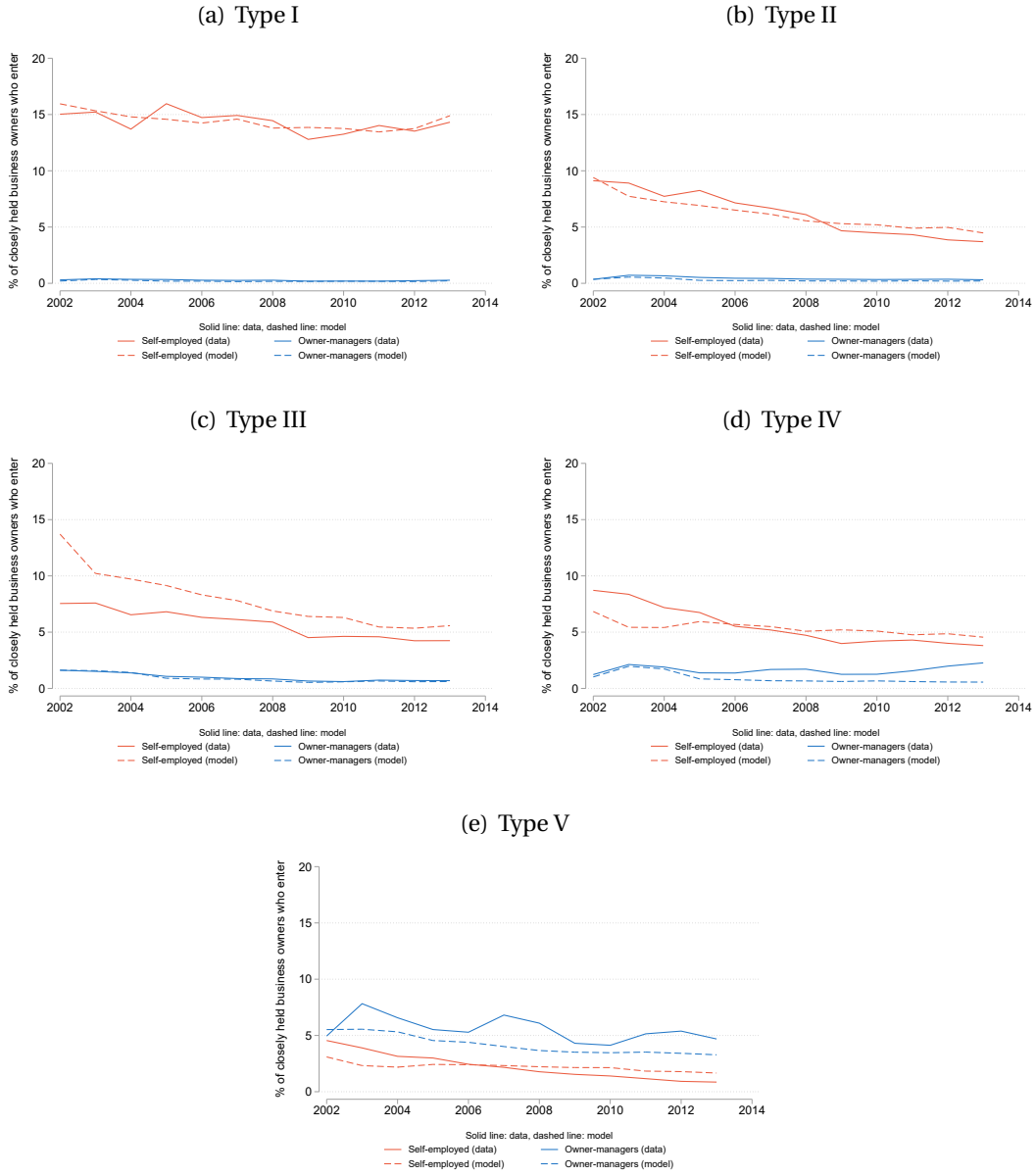


(b) Bunching by OM



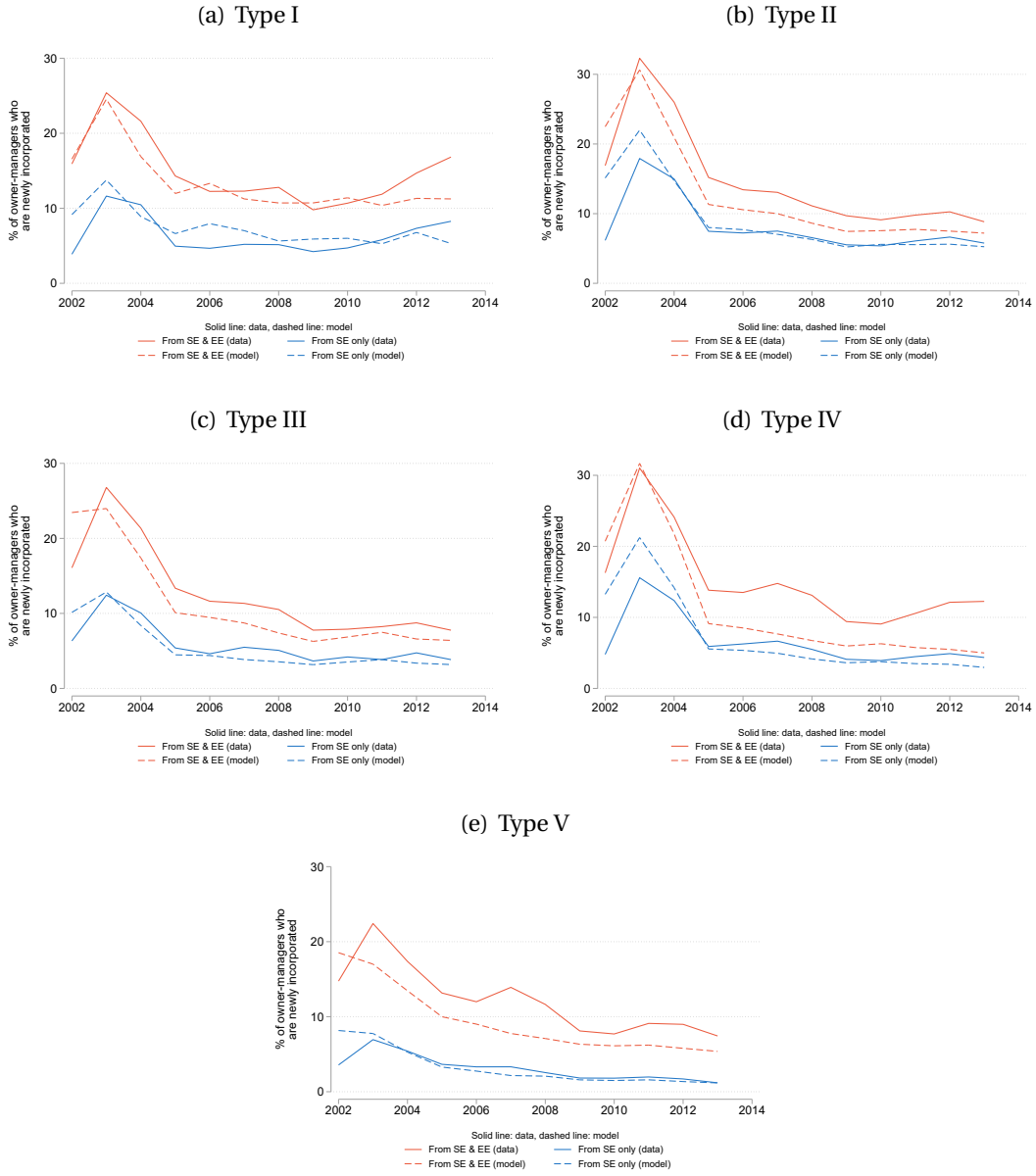
Notes: The left hand panel shows bunching around the primary threshold in the data and simulated from the model for the self-employed, and the right hand panel shows bunching around the primary threshold for owner-managers.
Source: Authors' calculations using HMRC administrative datasets and model simulations.

Figure E.5: *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.6: *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.