The efficiency and equity effects of capital tax reform

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Abstract

It is common for policymakers to set low rates of tax on capital incomes and gains to boost investment and entrepreneurship, but this encourages tax avoidance and has important equity implications. We provide a new framework for studying the equity-efficiency effects of capital tax reforms. We develop and estimate a dynamic model of the choices made by business owner-managers in a rich tax policy environment, allowing for both real and shifting responses to tax. Increasing all capital tax rates by the same amount raises revenue progressively but comes at an efficiency cost – this is consistent with the existing literature. However, this assumes a single capital tax rate and holds the tax base fixed – we show that relaxing these assumptions reveals the existence of implementable reforms that boost equity *and* efficiency. First, reducing the differentials between the tax rates on different types of capital returns lowers income shifting and the associated distortions to the intertemporal allocation of resources. Second, further efficiency gains are achieved by reforming the tax base, which allows the policymaker to raise revenue from taxing inframarginal investments, while not distorting marginal investments.

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1 Introduction

Closely-held businesses are important for economic growth (Haltiwanger et al., 2017) and central to the design of capital taxes – for example, their owners receive more than half of taxable capital gains in the US and the UK (Saez et al., 2021; Adam et al., 2024). Capital is almost always taxed less than labour income – this is commonly defended as a way to boost investment and entrepreneurship, but comes with an equity cost given the concentration of capital returns at the top of the income distribution (Smith et al., 2019; Delestre et al., 2022). Existing models of capital tax design tend to study the equity-efficiency trade-off associated with changing a single capital tax rate while holding the tax base fixed (see Stantcheva (2020) for a review). However, this abstracts from the efficiency implications of (i) shifting between different tax bases (e.g. dividends, capital gains) and (ii) the disincentives to invest in certain assets because of the way these bases are defined.

In this paper, we develop a framework that allows for both of these features and show that this leads to new quantitative findings about the equity and efficiency effects of capital tax reforms. We estimate a dynamic model of business ownership that includes multiple capital tax rates and bases, key margins of behavioural response and empirical evidence on the magnitude of these responses. Taking current tax systems as a starting point, we quantitatively evaluate the effects associated with changing different aspects of capital taxation. Our main contribution is to show that there exist practically implementable reforms that raise revenue progressively *and* improve efficiency by (i) reducing income shifting across capital tax bases and (ii) removing investment disincentives. It is only by modelling the different capital tax rates and design of the base that we can quantify these efficiency gains.

Most tax systems have multiple capital tax bases. For example, capital gains are almost always taxed more lightly than capital income (e.g. dividends), which encourages income shifting. Policymakers also choose *what* is subject to tax through the design of the tax base (such as investment allowances), which dictate investment incentives. In almost all countries, there is a disincentive to invest out of new corporate equity: projects that are viable before tax are made loss making by the tax system. Optimal tax models often assume away these features, providing insights into the equity-efficiency trade-offs that exist *at* the frontier, but less direction on how to get there. Our paper helps to bridge this gap.

To do this, we develop a quantitative dynamic model in which heterogeneous individuals choose whether to start a business and its legal form, investment in capital, their own labour supply, as well as consumption and savings in personal and company assets. Owner-managers face borrowing constraints, such that some (but not all) invest inefficiently low amounts. The dynamic set-up is important to properly capture the incentives to shift in-

come over time (by retaining profits in the company) that arise because capital gains are taxed less than dividend income. It also matters because the tax base reforms we study affect incentives to invest out of new versus retained equity, which impacts saving choices. The innovations of our approach are to jointly model: (i) the large differences in the headline tax rates on different forms of income and gains; (ii) various features of the tax base; and (iii) the wide heterogeneity across owner-managers, including that their incomes are inherently "mixed", reflecting some combination of returns to investment, risk-taking and labour supply. To the best of our knowledge, we are the first to incorporate all three features in a structural model.[1] In doing so, we contribute to the evidence documented in three existing strands of the literature by developing tractable methods to model each feature and providing new insights on their implications for counterfactual reforms.

First, evidence clearly shows that business owners respond to rate differentials by changing their legal form (i.e. whether to incorporate) and by shifting income across tax bases (because owners can choose whether to take income as salary, dividends or capital gains).[2] Low tax rates on capital gains – combined with the fact that they are taxed on realisation – leads to large income shifting over time. Although there is much evidence on the existence of income shifting, we know less about its efficiency costs and how it is affected by non-marginal, counterfactual reforms to various parts of the tax system. We model the range of headline tax rates across labour and capital incomes, corporate profit and capital gains and allow for a wide range of responses to them, including "real" (investment, entry, exit, labour supply) and "avoidance" (income shifting) margins.[3] Shifting income across time distorts the intertemporal allocation of resources by encouraging people to delay consumption. We allow both for productive capital and a separate corporate cash asset to accommodate the fact that tax-motivated increases in retained profits do not necessarily translate into increased business investment.

Second, a very large body of work studies how tax affects investment.[4] It is the effective tax rate on *marginal* investments – which is determined by the tax base – that affects incentives over the scale of investment (King and Fullerton, 1984). Broadly, the tax base governs where a tax sits on the spectrum between a comprehensive income tax (in which

[1] This represents a significant advance on existing structural models of business ownership, such as Evans and Jovanovic (1989), Cagetti and De Nardi (2006, 2009), Hamilton et al. (2019), Hincapié (2020), Jones and Pratap (2020), Catherine (2022), Guvenen et al. (2023).

[2] See MacKie-Mason and Gordon (1997), Goolsbee (1998) and Tazhitdinova (2020) on tax motivated incorporation; Gordon and Slemrod (2000), Alstadsæter and Fjærli (2009), le Maire and Schjerning (2013), Harju and Matikka (2016), Miller et al. (2024), Bilicka et al. (2024), Bach et al. (2024) on tax motivated income shifting.

[3] McGrattan (2012) demonstrates the importance of accounting for multiple capital tax rates in the context of a general equilibrium study of the role of fiscal policy in the Great Depression.

[4] Examples include: Hall and Jorgenson (1967), Feldstein (1982), Auerbach and Hassett (1992), Gentry and Hubbard (2000), Cullen and Gordon (2007), Devereux and Liu (2015), Zwick and Mahon (2017), Ohrn (2018), Chen et al. (2019), Moon (2020), Curtis et al. (2021).

marginal investment returns are subject to full headline rates) and an expenditure tax (in which marginal investments are untaxed). We provide a parsimonious way to capture a wide variety of tax base parameters and choices by modelling the net present value of the stream of all available allowances (including for capital depreciation, inflation and finance costs) at the point at which an investment made. We capture important variation in incentives across financing source by separately modelling personal assets (the source of new equity) and corporate cash assets (the source of retained equity). New equity is a key source of financing for owner-managed business. Although personal taxes on capital incomes do not affect incentives to invest out of retained equity (Yagan, 2015), this does not apply to investments funded from new equity, which are discouraged in most tax systems.

Third, owner-managers are a heterogeneous group, with income that is inherently mixed i.e. reflecting returns to both labour supply and capital investment. Policymakers may want to target certain policies at entrepreneurs or at the returns to capital, for example, but these characteristics cannot be distinguished with tax rules (Gordon and Sarada, 2018).[5] Studying only a subset of business owners – such as those that incorporate (Levine and Rubinstein, 2017) or make a loss (Cullen and Gordon, 2007) – will miss that owner-managers' observed characteristics are endogenous to the tax system and that, in practice, any policies will necessarily apply much more broadly. We study all owner-managed businesses so that we can assess the full impact of tax policies applied to this group, while allowing for a rich distribution of observed and unobserved heterogeneity in preferences and productivities. We model business income as a function of owners' labour supply and capital investment, capturing its mixed nature. We allow the parameters of the model to vary across types of business, which we estimate using a data-driven clustering approach (Bonhomme et al., 2022). This means we are able to fit the wide variation in activities and responses to tax we see in the data, and to study how counterfactual reforms affect subgroups differentially.

Key to our approach is accounting for the richness of the policy and economic environment – this is important not only for studying how people respond to incentives, but because it better reflects the nature of policymakers' choice sets, which include a range of tax rates and bases. We estimate the model using data on UK owner-managed businesses. We link administrative personal tax records to corporate tax records and company accounts. Policy reforms to personal and corporate taxes over our period of study (2001-14) create variation in incentives at both the intensive and extensive margins. Estimating the long-run elasticities needed to evaluate counterfactual reforms using reduced-form analysis alone is

[5] How income is treated for tax purposes does not neatly capture its source. For example, for unincorporated business owner-managers (and for pass through entities in the US), labour income taxes apply to income that partly reflects the return to capital while for those running companies capital income and gains can (and often will) reflect entirely the ("disguised") returns to labour supply.

challenging (Sarin et al., 2021); we instead use well-identified reduced-form evidence on the responsiveness of incomes, profits and legal form to tax to estimate and validate our structural model (as suggested by Stantcheva (2020)).

We demonstrate our key finding – that poorly-designed current systems mean there is considerable scope for improving both equity *and* efficiency – by showing the effects of three counterfactual reforms. First, a small increase to the top headline tax rates of all capital taxes[6] (akin to considering an increase in "the" capital tax rate) raises revenue progressively (16% comes from the top 1% of owner-managers), but reduces efficiency by discouraging investment and business owners' labour supply.[7] Second, a revenue-equivalent increase in the *capital gains tax rate alone*, such that the differential with taxes on capital incomes is reduced, improves both equity *and* efficiency. Although a higher tax on capital gains reduces investment and labour supply, this is outweighed by smaller distortions to the choice of legal form and to the intertemporal allocation of resources. This means that overall efficiency improves, with the revenue raised significantly outweighing the amount that it would cost to lump-sum compensate individuals. Third, if the same revenue is raised both by increasing the headline capital gains tax rate alongside more generous deductions for investment spending, efficiency improves further,[8] while equity benefits are not unwound. The key insight is that tax base reforms that remove marginal investments from tax allow policymakers to raise revenue from taxing returns to *infra*marginal investments (and returns that reflect disguised labour income) without distorting the overall level of investment.

We describe a specific UK reform that would be in the spirit of the third counterfactual. We show that removing a preferential 10% capital gains tax rate for business owners while introducing a new upfront tax relief for equity investment, would raise revenue (equivalent to 7.5% of total CGT revenue) and increase investment (by 4.6% among high-income incorporated businesses). These lessons also apply much more generally. Reforms that have both efficiency and equity gains could be enacted in the many countries that have lower tax rates on the capital income and/or gains of business owners, and that discourage investment out of new equity.[9] Our model is sufficiently flexible to speak directly to the trade-offs involved with changing different policies. For example, increasing the tax rate on dividend income brings it closer to the taxation of labour income (reducing distortions

[6] Those on corporate profit, self-employment profit, dividends and capital gains.

[7] This aligns with the findings of, for example, Guvenen et al. (2023), who argue for lower capital tax rates, at the expense of greater inequality, in order to avoid deterring investment by productive entrepreneurs.

[8] An alternative way to express this is through the Marginal Value of Public Funds (Hendren, 2016), which is well below 1 for increases in the capital gains tax rate (either in isolation or accompanied by base reform), indicating that individuals value lower CGT rates less than it costs the government to provide them.

[9] For example, in the US "qualified small business stock" can be exempt from capital gains taxes and, as in almost every tax system, there is a tax deduction for debt interest costs but no equivalent for the (opportunity) cost of equity finance (OECD, 2024).

to legal form), but widens the discrepancy with capital gains (increasing the incentives to shift income). Qualitatively, our framework can shed light on the mechanisms associated with moving different policy levers; quantitatively, it could be adapted and estimated in different settings.

Our paper is related to the large literature on optimal capital tax design, much of which focuses on the implications of different mechanisms for the optimal level of capital taxation.[10] These papers provide valuable lessons about the way different mechanisms affect the trade-offs associated with the overall level of capital taxation, but they cannot speak to other reforms that are central to policy debates. We show that exercises that vary the average capital tax rate (while abstracting from income shifting and the effects of the tax base) can be a misleading guide to the impact of other policies. For example, increasing the CGT rate reduces the inefficiencies from income shifting but worsens distortions to investment, with the overall impact on efficiency therefore theoretically ambiguous – our model allows us to quantify the relative magnitude of these effects.

The sufficient statistics literature connects theories of optimal capital taxation with empirical observations on the distribution of capital and key elasticities (Saez and Stantcheva, 2018). Although this can accommodate richer features of the policy environment, a challenge for this approach includes getting credible estimates of long-run responses. Furthermore, using these elasticities as sufficient statistics for optimal taxation implies a fully structural approach, such as assuming iso-elastic preferences (Kleven, 2020). We estimate a structural model (which makes these assumptions explicit) informed by credible reduced-form evidence, allowing us to estimate long-run responses and simulate large reforms that simultaneously change different parts of the tax system. The reforms we study are inspired by optimal tax theory; broadly, reforms that improve both equity and efficiency involve reducing the tax rate on marginal investments while increasing the tax rates on capital incomes and gains (that reflect economic rents and disguised returns to labour) towards tax rates on labour income.[11] We provide quantitative evidence on the benefits of such reforms.

In the next section we describe the taxation of owner-managed businesses, with Section 3 presenting our data and a set of stylized facts. Sections 4 describes our dynamic model of business ownership, with estimates and model fit in Section 5. In Section 6 we conduct a series of counterfactual experiments, and a final section concludes.

[10] In a recent review, Bastani and Waldenström (2020) highlight that while some papers support no tax on capital income, others argue for a positive rate but with little to guide whether the optimal rate is higher or lower than the rate on labour income. Results differ depending on what is assumed about the economic environment, the sources of taxpayer heterogeneity and the policy environment.

[11] This set of reforms is in line with the recommendations of the Mirrlees Review (Mirrlees et al., 2011), which argued that, in the absence of any consensus on optimal capital tax, a good benchmark would be a system that is neutral with respect to saving, does not distort physical investment, and that taxes "excess" returns to capital (including economic rents, risk premia and disguised labour income) at the same rate as labour income.

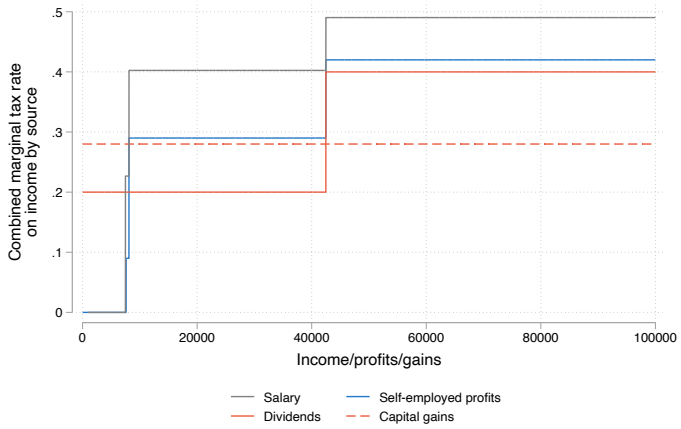
2 The taxation of owner-managers

Our population of interest are the owner-managers of closely held businesses i.e. those that have substantial control over the business ("owners") and whose labour is a key input into production ("managers"). This population of private businesses encompasses start-ups that operate with a small number of shareholders, as well as individuals using a business legal form to supply their own labour, such as gig economy workers and accountants. We study this wide set of businesses because, even where policy interest is in those that are "entrepreneurial" or that are using substantial capital, the tax system, including preferential rates for business owners, applies much more widely.

2.1 Headline tax rates on labour and capital income

Business owner-managers sit at the intersection of the personal and corporate tax systems and have significant scope to move between those systems. An owner's choices over the legal form of their business (i.e. whether or not to incorporate) and how to take income out of a business determines their tax treatment. This, in turn, affects *real* decisions such as how much to invest, to work and to save. Figure 2.1 illustrates the marginal tax rates applied to salary income, self-employed profits, dividends and capital gains in 2013-14 in the UK. These are combined rates that include all taxes levied at the business and personal level.

Figure 2.1: *Marginal tax rates by income source, 2013-14*



Notes: The figure shows the marginal tax rates (shown on the horizontal axis) for salary income, self-employed profits, dividend income and capital gains in the 2013-14 tax year. Tax rates are combined and, where applicable, include income tax, social security contributions (employee and employer), and corporate tax. We assume that capital gains are on a corporate asset and receive the preferential tax rate of 10% available to business owners. There are higher marginal rates above £100,000, which we describe elsewhere in the paper and in detail in Appendix B.

Choice between labour and capital income. Incorporated owner-managers can choose whether, and how much, to pay themselves in salary and how much income to take out of the com-

pany in the form of returns to capital i.e. dividends or capital gains. The latter do not necessarily reflect returns to investment – they often reflect returns to the owner-managers' labour supply.[12] "Returns to capital" are first subject to corporation tax and then to personal taxes at the point that income is distributed to owners.[13] Dividends are almost always taxed at lower combined rates than salary income – Figure 2.1 illustrates this for the UK, and Hourani et al. (2023) shows this is true in most OECD countries. The self-employed are subject to personal taxes in the year that income arises and have much less scope to move income across bases. They nonetheless pay lower rates on their (mixed) income than those on salary income due to lower social security contributions.

Choice between capital income and gains. Incorporated owner-managers also have significant flexibility to choose whether to distribute profits as dividends or capital gains. They can retain profits in their company and realise them in the form of capital gains when the business is closed or sold.[14] Capital gains are often taxed at even lower rates than dividend income: the UK provides a preferential capital gains tax rate to business owners, and the US gives generous capital gains tax relief through the Qualified Small Business Stock exclusion. Figure 2.1 shows that, in the UK, capital gains are taxed less than dividend income above the higher rate threshold (c.£40,000), creating a strong incentive for high-income incorporated owners to retain profits until shares are sold or the company is liquidated. It is worth noting that distributing income as capital gains is generally more restrictive than as dividends, with the latter able to be paid out on a much more regular basis.

Choice over legal form. The greater flexibility to shift income across tax bases, in addition to the lower tax rates on dividend and capital gains, provides an incentive to incorporate. Zawisza et al. (2024) shows that these tax incentives have been growing over time in many countries. Despite the tax advantages to incorporating, we do not expect everyone to do so. There are also important non-tax differences between legal forms; for example, incorporation provides benefits such as limited liability, but often comes with higher costs and reporting requirements (OECD, 2015). The decision over whether, and when, to incorporate depends on these various tax and non-tax factors. In turn, movements between legal forms

[12]The UK has no equivalent rules to those that apply to shareholders of US S-corporations that require that the salary portion of a shareholder's remuneration is a "reasonable compensation" of their labor input.

[13]In the UK, there is no "passthrough" taxation akin to the tax treatment of S-corporations in the US; the treatment of incorporated owner-managers in the UK is more similar to that of US C-corporation owners.

[14]When an incorporated business owner chooses to liquidate the shares on company dissolution (or sell all or part of their company), the resulting gains are subject to capital gains tax (CGT). Broadly, capital gains are calculated as the difference between the current value of the shares (which is the net value of all assets, including accumulated retained profits) and the value of capital put into the business.

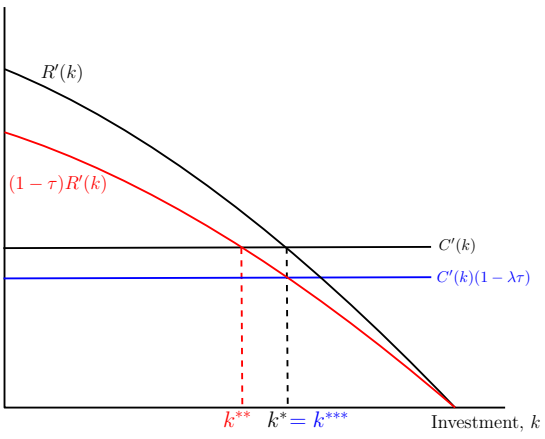
and choices about how to take income out of a company will affect tax paid (and revenue raised by the government) and the incentives to work and invest by business owners.

2.2 The tax base and investment incentives

A key decision made by owner-managers is how much to invest in their business – both in terms of how much cash to put into the business and how much to invest in business assets. Investment incentives are dictated by the tax base and headline rates.

We illustrate the importance of the tax base in a simple, stylized example in Figure 2.2. An owner-manager is considering making an investment, denoted by k. This investment yields a gross return, $R(k)$. There are costs associated with making the investment, which we capture through the function $C(k)$. The optimal choice of investment is where the marginal return equals the marginal cost i.e. $R'(k^*) = C'(k^*)$. If investment returns are taxed at rate τ, but there are no deductions for the cost of investment, then the net-of-tax marginal return shifts down to the red line in Figure 2.2, and the optimal choice of investment falls to k^{**} (defined by $R'(k^{**})(1-\tau) = C'(k^{**})$). If we now allow some fraction λ of investment costs to be deducted from taxable income, this shifts down the marginal cost curve to the blue line. Optimal investment is now given by $R'(k)(1-\tau) = C'(k)(1-\lambda\tau)$: when $\lambda = 1$, investment is not distorted by tax ($k^* = k^{***}$).

Figure 2.2: *Impact of the tax base on investment incentives*



Notes: The figure shows a stylized model of optimal investment choices and how they are impacted by tax. Notation is described in the text.

In practice, there are many types of deductions that governments offer in relation to investment costs, and various approaches to reform in this area (i.e. various ways to achieve $\lambda = 1$). One broad approach is to allow the upfront financial outlay associated with an investment to be immediately deducted from taxable income; this is a key element of a

"cash-flow tax",[15] which does not discourage investment. Many tax systems have elements of cash-flow treatment – this is often referred to as "full expensing" when applied at the business level. But even where these treatments exist, they are usually incomplete, applying only to certain assets or at one level of tax – corporate but not personal, for example. The other broad way that governments allow for the deduction of investment costs is through streams of allowances that can be used when calculating taxable profits. Most commonly, governments set capital allowances (loosely related to depreciation) alongside deductions for debt interest payments but with no equivalent allowance for the opportunity cost of equity finance (which creates the well-known debt-equity bias). It is possible to design these streams of allowances such that they are equivalent, in net present value terms, to 100% upfront deductions, and thus avoid investment distortions.[16]

The specific and complex rules that practically dictate the tax base can be captured in a parsimonious way through λ, which, in more general terms, will be the net present value of all available allowances, accounting for all levels of tax.[17] In actual tax systems there will be many λs because tax rules vary with the source of financing, legal form, type of asset and other factors. It is extremely rare for governments to design policy such that all λs are equal to 1 – most commonly they are below 1, but there are cases when they are above 1 (e.g. with full expensing plus a deduction for debt interest, which subsidises investment).

In our setting, we focus on the taxation of investments made out of *new* corporate equity – a key source of financing for owner-managers. Under the current system, investments financed in this way are discouraged ($\lambda < 1$). The key driver of this is that there is no deduction for the cost of this finance *at the personal level*.[18] In this context, providing deductions for new equity investments at the personal level moves λ to 1 and removes marginal investments from tax. This allows the policymaker to increase τ, raising revenue on infra-marginal investments (which include economic rents and disguised labour income) while

[15] The benefits of cash-flow taxes have long been known; see Brown (1948), Kaldor (1955), the Meade Committee (1978), Bradford and US Treasury Tax Policy Staff (1984) and Kay and King (1990)

[16] An Allowance for Corporate Equity (ACE) is effectively a stream of allowances that ensure that the full costs of investment can be deducted from corporation tax (Bond, 2000; Devereux and Vella, 2020) – this has been introduced in at least 11 countries. A Rate of Return Allowance (RRA) is the equivalent for personal taxes (Sørensen, 2005, 2007); an RRA is in operation in Norway.

[17] A large body of empirical work, building on Hall and Jorgenson (1967), has developed sophisticated measures of the impact of tax on the "user cost of capital" (the minimum pre-tax rate of return required by investors). The impact of tax is commonly summarised by the Effective Marginal Tax Rate (EMTR), with many papers studying the impact of changes in the EMTR on investment decisions – see footnote 4.

[18] For incorporated owner-managers, the UK effectively provides full expensing at the business level, such that costs are fully deductible from corporate tax. But there are no equivalent deductions at the personal level, such that costs are not fully offset against overall tax. Investments made out of *retained* equity are not discouraged by personal taxes. The "trapped" nature of retained equity means that personal taxes do not affect the decision over to whether invest out of it – personal taxes will be paid *regardless* of whether the money is withdrawn from the company today or retained, invested and withdrawn at a later date. This is the "new view" of dividend taxation; see Zodrow (1991) for further discussion.

not distorting the overall level of investment. We illustrate the importance of tax base design in this particular (important) case, but our insights are not limited to this exercise – we discuss the broader implications of our findings in Section 7.

3 Data and stylized facts

3.1 Administrative data on owner-managers

We use data on owner-managed businesses in the UK over the period 2001-16. We focus on closely held businesses that are run by one or two individuals, to avoid the need to model individual incomes when ownership structures are more complex.[19] Of all companies that have five or fewer shareholders, 83% have fewer than two. We measure company ownership using information from company accounts in 2014 – some of these companies could go on to grow and attract more owners in future.

We combine information from three sources: personal tax records, corporate tax records, and company accounts.[20] All business owners are required to submit a personal tax return. These data provide information on: individuals' taxable income (amount and whether it is from salary, self-employment, dividends, or capital gains); whether the individual is self-employed or incorporated; age and sex. We also have information on business turnover, profit, use of capital allowances, industrial classification, and, for companies, the number of directors and shareholders, company assets and liabilities. The information on unincorporated business activities is included on the owner's personal tax record, whereas for incorporated businesses we have to match the personal tax records of the owner to the corporate tax records and accounts of the company. This match was conducted for businesses active in 2014 (we observe the histories of these businesses). The bottom panel of Table 3.1 provides descriptive statistics for the matched and unmatched samples. The match and our snapshot picture of ownership means that we have a selected sample of all the owner-managed business that operate over 2001-16; we account for this selection in estimation (Section 5). Further details on the data and match provided in Appendix A.

We supplement the administrative data with survey data from the Longitudinal Small Business Survey (LSBS) collected by the UK's business department, and the Wealth and Assets Survey (WAS), also described in Appendix A.

[19] These are the the self-employed who are sole proprietorships (i.e. it excludes those operating through partnerships) and incorporated businesses that have two or fewer directors and shareholders. The analogous set of US businesses are sole proprietorships, S-Corps and C-Corps with 2 or fewer owners.

[20] 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).

Table 3.1: *Descriptive statistics for UK owner-managed businesses, 2001-16*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Annual personal taxable income						
	Num.	Num. years:				Growth (%) when:		Annual bus. income		Mean investment
	individuals	SE	INC	Mean	s.d.	SE	INC	Mean	s.d.	/mean bus. income
Full sample, 2001-16										
SE only	8804011	4.5		11206	4120	7.3				
INC only	1277739		4.3	39383	9160		4.5			
SE and INC	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
INC only (matched)	359812		5.0	41018	12240			47571	22642	0.011
INC only (unmatched)	182769		5.5	39172	10974					
SE and INC (matched)	190025	4.0	4.4	30954	12529			30201	18050	0.031
SE and INC (unmatched)	108047	3.2	4.7	26741	11857					

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

3.2 Wide heterogeneity in the activities of owner-managed businesses

Owner-managed businesses are extremely heterogeneous in various dimensions: the industries they operate in, the extent to which they invest or employ people, whether they grow and so on (e.g. (e.g. Hurst and Pugsley, 2011; Humphries, 2019)). Start-ups and most entrepreneurs will operate as closely-held businesses (at least initially), but many others use a closely-held business form, including low-income "gig economy" workers and high-income individuals primarily selling their own labour (such as consultants and accountants).

Although policymakers are often interested in using policy to incentivise "entrepreneurs", this group is challenging to precisely define in principle, and impossible to identify through tax rules. Some papers proxy entrepreneurship, using, for example, whether the business makes a loss (Gordon and Sarada, 2018) or incorporation (Levine and Rubinstein, 2017). However, these are only imperfect proxies and are endogenous to the tax system.

We study the full group of closely held businesses and explicitly account for heterogeneity when analysing the effect of tax. "Non-entrepreneurial" businesses are important in their own right,[21] and, by including them, we are able to evaluate the trade-offs that come with policies (such as preferential capital gains rates) that may be intended for "entrepreneurs" but are available to all business owners. We use a data-driven approach to group together similar businesses, and then allow for heterogeneity in the model parameters across these "types". This means we can: (i) assess the impact of tax policy on all the relevant businesses, while allowing for heterogeneous responses, and (ii) study policy impact on different subgroups of businesses. We follow the approach of Bonhomme et al. (2022) and use a k-means clustering approach to determine type membership.

We classify owner-managers on the basis of their mean business income and mean investment as a share of mean business income. We focus on heterogeneity in investment for several reasons. First, the distribution of investment is highly skewed (see Table A.3): some businesses make substantial investments – these are more likely to be incorporated and are less likely to exit. But they are the minority of businesses: the median business reports zero investment and 60% of newly established self-employed businesses cease trading by their fifth year. Second, investment is also correlated with innovative activity: data from the LSBS suggests that among the 25% of owner-managed businesses that plan on investing, more than half of these also plan to launch new products or services. Third, investment may be limited by credit constraints faced by some businesses.

[21] Collectively (across all business types), business owner-managers make up 20% of the UK workforce (Adam and Miller, 2021) and have grown in number over the past two decades (Cribb et al., 2019).

Table 3.2 describes each of the five types we identify, with further details in Appendix C.[22] A substantial majority of owner-managers are low-income primarily self-employed that do minimal investment, such as domestic service workers. At the other end of the extreme are high income business with relatively low levels of investment, reflecting the fact that much of the income of these businesses comes from the labour supply of the owner-manager. More than 40% of these owner-managers are in business services (see Table C.1). The middle types do the most investment, have wider distributions of mean business income, and are more likely to be in agriculture and manufacturing. Type II and III also contain the largest fractions of businesses that are both high-growth and long-lived, which we define businesses that average more than 20% annual income growth and survive at least 10 years. Although only around 10% of all owner-managers, it is therefore likely that types II and III contain many of the businesses that are of interest to policymakers.

Although we do not cluster on legal form, Table 3.2 shows that there is substantial variation across the types in the share of owner-managers that are incorporated. This reflects the fact that incorporated businesses have higher incomes and do more investment (see Table 3.1). However, it is important to recognise that the choice of legal form is endogenous to the tax system, which we now describe.

Table 3.2: *Summary of types from clustering procedure*

(1) Type	(2) Description	(3) % business owners	(4) % type incorp.	(5) Mean income	(6) Mean invest/ mean income	(7) % high-growth long-lived
I	Low income, low invest, mainly SE	64.7	2.7	7049	0.01	3.9
II	Mid-low income, mid invest, mixed	10.0	9.8	12242	0.20	5.8
III	Mid income, high invest, mixed	2.0	16.7	13064	0.54	9.7
IV	High income, low invest, mixed	18.6	27.6	29387	0.04	4.3
V	V high income, low invest, mainly INC	4.7	74.6	81408	0.04	4.8

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 incorporated in 2013/14. Column (5) shows the mean business income of each type and column (6) shows the ratio of mean investment to mean business income. Column (7) shows the share of businesses in each type that are "high-growth and long-lived", which we define as those that average more than 20% annual income growth and survive at least 10 years. Further details on clustering are provided in Appendix C.
Source: Authors' calculations using HMRC administrative datasets.

[22] We use two heuristic methods to determine the optimal number of types, K, as five, and treat this as known throughout. First, we find the K at which the decline in the sum of squared residuals flattens, and second, we use a measure of predictive strength based on cross-validation. These give the same optimal K. Further details available in Appendix C.

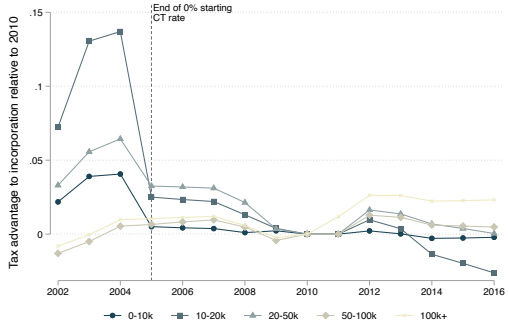
3.3 Tax rate differentials lead to income shifting

Section 2 summarises the wide variation in headline tax rates, which creates incentives to shift income between legal forms, across tax bases, and over time. Here we illustrate owner-managers responsiveness to these incentives with two examples.

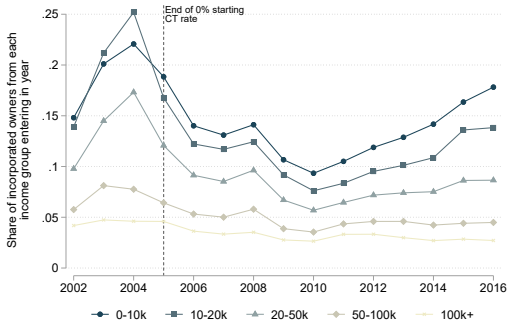
Choice of legal form is, in part, determined by tax differentials. This choice is not fixed at business start-up: Table 3.1 shows that of the 11 million UK owner-managers active at some point between 2001 and 2016, 10% had a period of self-employment followed by incorporation. Individuals that spend time both self-employed and incorporated have the highest rates of investment, and grow faster than the exclusively self-employed or incorporated (when in the equivalent legal form). In 2003-4, the tax advantage to being incorporated (relative to self-employment) widened due to a 0% starting rate of corporation tax on profits of up to £10,000; this created a strong incentive for both new and existing business owners to incorporate.[23] Figure 3.1 shows that this led to a clear increase in incorporation rates in 2003 and 2004, which was primarily driven by those receiving up to £50,000 in personal taxable income, the group who benefited most from the corporate tax cut.[24] Figure A.1 shows that around half of this increase was from new entrants to business ownership, and the remainder from moves from self-employment into incorporation.

Figure 3.1: *Responsiveness of incorporation decisions to tax differentials*

(a) Changes in the tax advantage to incorporation



(b) Entry of incorporated business owners



Notes: The left hand panel shows difference in the average tax rate (total tax/total business income) for a self-employed individual relative to an incorporated business owner in different income bands over 2002-16. Tax includes social security contributions, personal and corporate income taxes, and assumes that incorporated owners do not retain profits in the company. The right hand panel shows the share of incorporated business owners within each taxable income band that are newly present in the year shown on the horizontal axis.
Source: Various government sources and authors' calculations and authors' calculations using HMRC administrative datasets. Exact rates and thresholds provided in Appendix B.

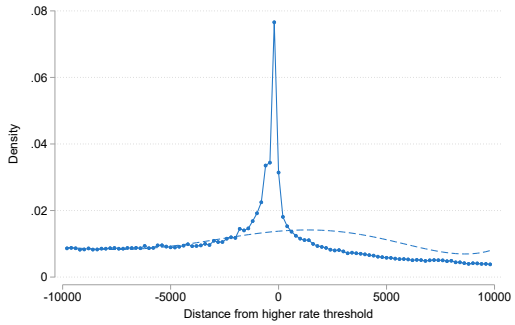
[23] The 0% starting rate of corporate tax remained until 2006, but only on profits not distributed to shareholders. The relevant rate for the small businesses we study is that on profits distributed to shareholders which, from 2005 onwards, were taxed at the small company rate (ranging between 19 and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

[24] We use the full sample of business owners, not just those that were active in 2013-14, which requires us to group owners on the basis of personal taxable income (not business income) as we only observe incorporated business income for the matched sample (those active in 2013-14).

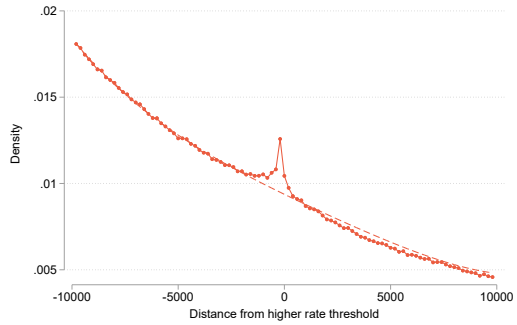
Owner-managers also have significant scope to shift income across tax bases and over time. This contributes to a high taxable income elasticity, illustrated in Figure 3.2, which shows bunching in taxable income around the higher rate threshold (c. £40,000) for self-employed and incorporated owner-managers.[25] The excess mass is larger for incorporated business owners than for the self-employed: those running incorporated businesses can choose when to pay themselves dividends and realise capital gains.[26] There is a strong incentive for high income incorporated owners to retain profits and defer capital gains realisation until shares are sold or they company is liquidated. Miller, Pope, and Smith (2024) show that this tax-induced retention is large, with half of those generating £150,000 per year retaining more than £50,000 each year. This form of shifting accounts for around half of the bunching shown in Figure 3.2(a), with the remaining excess mass due to short-term shifting to smooth income volatility. There is no evidence that owner-managers reduce the amount of business income they create when faced with higher tax rates.[27]

Figure 3.2: *Bunching around tax thresholds*

(a) Incorporated, HRT (c.£40,000)



(b) Self-employed, HRT (c.£40,000)



Notes:
We group individuals in income bins of £200 and exclude a window of £1400 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.

Properly modelling the endogenous (and joint) choices over legal form and income shifting is important, both to accurately estimate revenue effects *and* because it has implications for "real" decisions. Increasing the capital gains tax rate not only reduces the incentive to

[25] 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.

[26] The taxable income of the self-employed is nonetheless more elastic than for employees, likely driven by having fewer constraints on labour supply (Chetty et al. (2011), Bastani and Selin (2014)), but also more scope for avoidance and evasion behaviour (Kleven et al. (2011)).

[27] Miller et al. (2024) also show that increased marginal tax rates on incomes above £100,000 after 2010 led to a large fall in the taxable income of the treated group, but no statistically significant changes in corporate profit (see Figure 5.2(e)). The higher income owners who faced increased tax rates responded by retaining more profit in their companies, but not by reducing the amount of business income they created.

shift from capital income into gains, but also reduces the benefit to incorporation. Focusing *only* on incorporated businesses could lead us to overestimate the effect of tax reforms on the total number of businesses, if we conclude that switching in legal form reflects business entry and exit. Deductibility of capital spending varies across legal form, which affects investment and labour supply incentives. It is also important to allow for the fact that retained profits are not necessarily invested in productive capital, but are often held as cash or other liquid assets.

3.4 Owner equity is a key source of finance

In Section 2 we set out how the tax base and headline tax rates govern investment incentives. A key feature of many tax systems is that marginal investments financed from new corporate equity are subject to tax and therefore discouraged.

Most business owner-managers use their own assets to finance their business i.e. they use new equity but not from third parties. For example, data from the Longitudinal Survey of Small Businesses show that over 90% of UK owner-managed businesses (defined in the same way as our sample) did not seek *external* finance (whether from debt or equity) in the previous 12 months. The Wealth and Assets Survey shows that of those starting new businesses between 2014 and 2016, 64% used their own money to finance the business, with a further 25% requiring no start-up funds. Only 3% used a loan from a financial institution and 84% of owner-managed businesses have no debt. This is not to say that no business owner-managers benefit from borrowing, but to highlight that the primary source of finance used by this group are their own assets. This is consistent with the previous literature that has emphasised the impact of credit constraints for entrepreneurs; for example, Evans and Jovanovic (1989), Cagetti and De Nardi (2006), Kaboski and Townsend (2011). To accurately capture the role of new equity (and the differences in its treatment relative to retained equity) we need to allow for owner-managers to hold a distinct corporate asset in addition to their personal assets.

It is also important to note that individuals' expectations about the returns they might make on their investments interact with their choice of legal form. Under the current UK system, the self-employed face no tax on marginal investments ($\lambda = 1$), but a higher rate on inframarginal investments. In comparison, incorporated owner-managers face a lower tax rate, but that applies to both marginal and inframarginal investments ($\lambda < 1$). For owner-managers planning to make investments that just break even or make low returns, it is better to be self-employed, whereas for those who expect larger returns, it will be beneficial to incorporate because this confers lower tax rates on the excess returns they make.

4 A dynamic model of business ownership

In this section, we set out a dynamic model of business ownership motivated by the stylized facts presented above. The decision-making unit is an individual (i) who maximises an intertemporal utility function (time periods are years and indexed by t) by choosing: whether to start a business and its legal form (either self-employment or incorporated); capital investment in their business; labour supply; consumption; and savings in personal and company assets.

Heterogeneity. We allow for heterogeneity in (some) preferences and the productivity process across five business types, which we index by j. We estimate type membership using the clustering approach described in Section 3.2. This means that we can capture the wide variation in economic activities of owner-managed 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. Below we make clear which parameters are common and which are allowed to vary across j.

4.1 Preferences

Individuals derive utility from consumption and leisure over their lifecycles. We also allow for there to be utility costs/benefits associated with starting a business and incorporation.

Utility. Individuals per-period utility function is:

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

where c_{it} and l_{it} denote consumption and hours of leisure, respectively. 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. These parameters are assumed to be common across the types.

Start-up and incorporation costs. We allow for there to be utility costs (or benefits) associated with starting a business. Each individual's cost is denoted by F_i^{start}, and is drawn from a normal distribution with type-specific means and standard deviations, $F_i^{start} \sim \mathcal{N}(F_{j,m}^{start}, F_{j,sd})$. This is incurred when the agent moves from employment into either self-employment or incorporation (we allow the means of the distributions to depend on whether the individual starts an unincorporated or unincorporated business.) These costs could in-

clude the non-pecuniary benefits from business ownership, as well as any permanent differences in the wage individuals can get as an employee and their productivity as a business owner (we describe how we model both of these below).

We also allow for there to be utility costs (or benefits) associated with incorporation. Each individual's incorporation cost is denoted by F_i^{inc}, and is drawn from a normal distribution with type-specific means and standard deviations, $F_i^{inc} \sim \mathcal{N}(F_{j,m}^{inc}, F_{j,sd})$. 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 iid preference shocks associated with switching between legal forms each period; the standard deviation of these switching costs is denoted by, σ_ζ, and is common across types.

4.2 Productivity

Productivity. Each individual has a latent productivity, $\psi_i \sim \mathcal{N}(\mu_{j,\psi}, \sigma_{j,\psi}^2)$, drawn from a normal distribution with type-specific parameters. There is also a common component that depends on an individual's age_{it}. If they are a business owner-manager, there is a stochastic component to productivity, η_{it} (captured through an AR(1) process), which means that their productivity is uncertain:

$$\ln \omega_{it} = \psi_i + \phi_1 \text{age}_{it} + \phi_2 \text{age}_{it}^2 + \eta_{it} \tag{4.2}$$

$$\text{with} \quad \eta_{it} = \rho \eta_{it-1} + \varepsilon_{it}, \quad \varepsilon_{it} \sim \mathcal{N}(0, \sigma_{j,\epsilon}), |\rho_j| < 1. \tag{4.3}$$

For those individuals not running a business, they receive a wage equal to their latent productivity plus the age trend i.e. it does not have a stochastic component.[28]

'Mixed' business income. Individual's income from running their own business is derived from their own labour supply, $h_{it} = L - l_{it}$ (L denotes the time endowment), and their capital investment in the business, k_{it}:

$$\tilde{z}_{it} = \omega_{it} h_{it}^{1-\theta_j} \left(\max\{1, k_{it}\}\right)^{\theta_j} \tag{4.4}$$

$$z_{it} = \tilde{z}_{it} - \delta k_{it}. \tag{4.5}$$

θ_j governs the importance of capital, relative to labour, in production, and is allowed to vary across types. We take the max over 1 and k_{it} to allow for the fact that many business

[28] We do not have data on owner-managers' income when they are employees, so we cannot separately identify a richer relationship between business owner productivity and employee wages. Any differences in the wages that the agent could earn as an employee will instead come through the start-up costs, F_i^{start}. This will not affect our conclusions as long as this differential does not change under the counterfactual policy experiments we perform.

owners make zero capital investments and generate income solely through supplying their own labour. $\tilde{z}_{it}$ denotes income before deducting the value of depreciated capital, δk_{it}, with z_{it} denoting income net of capital costs.

The form of the production function is motivated by the fact that the primary source of labour for most owner-managed businesses is from the owner themselves. The Longitudinal Small Business Survey finds that 81% of owner-managed businesses have no employees, and a further 15% have between 1 and 9. For the minority of businesses that do have employees, we measure the productivity of the owner-manager, ω_{it}, net of the costs of employing these other workers.

4.3 Tax system and incentives

As we have discussed, owner-managers sit at the intersection of the personal and corporate tax systems, and are thus affected by a variety of different tax rates and bases including those on: self-employment profits, corporate profits, dividend income and capital gains. These interact in important ways, creating variation in incentives that translates into real changes in behaviour (with important policy implications). We summarise these here; see Appendix D for details on how we model the piecewise linear structure of each of these four taxes, as well as the deductibility of investment spending.

Variation in tax rates across legal forms. The incomes of incorporated owner-managers are subject to both corporate and personal taxes, while the self-employed and employees pay only personal income taxes. An incorporated owner-manager's corporate tax liability is denoted by $\mathcal{T}^c(\pi_{it})$, where π_{it} denotes taxable corporate profit. An individual's personal tax liability, $\mathcal{T}^p(y_{it}, d_{it}, d_{it+1})$, depends on their personal taxable income, y_{it}, their legal form this period, d_{it}, and their legal form next period, d_{it+1}: an incorporated owner can pay themselves in dividends, which are taxed more lightly than self-employment income, which in turn is taxed more lightly than employee's wages.

Our setting is such that, at all levels of taxable income, y_{it}, incorporation is the most lightly taxed form, followed by self-employment, followed by employment. However, the magnitude of these differentials varies across the income distribution.

Variation in tax rates across the business lifecycle. Another margin of variation in tax liability occurs across the business lifecycle. Notably, incorporated owner-managers can take income as capital gains when they liquidate or sell their businesses (captured in the model by a choice to exit business ownership next period, $d_{it+1} = EE$). For incomes above a certain threshold, y^{HRT}, capital gains is taxed more lightly than dividend income (see Figure 2.1),

such that $\mathcal{T}^p(y_{it}, INC, EE) < \mathcal{T}^p(y_{it}, INC, INC)$ for $y_{it} > y^{HRT}$. This creates an incentive for incorporated owner-managers to engage in intertemporal income shifting by retaining profits in their companies until they exit business ownership. The incentive to shift over time further strengthens the tax advantage to incorporation described above.

Variation in investment incentives. Investment incentives are governed, in part, by the ability to deduct capital spending from the tax base, as we discuss in Section 2. We model these using the parameters, $(\lambda^{SE}, \lambda^{INC,c}, \lambda^{INC,p})$, which denote deductibility of capital costs from the personal income of the self-employed, corporate profit, and the personal income of incorporated owner-managers, respectively. In our setting, the self-employed can fully deduct capital spending from their personal taxable income ($\lambda^{SE} = 1$), such that there is no tax on marginal investments. Incorporated owner-managers are able to deduct investment spending from *corporate* tax ($\lambda^{INC,c} = 1$), but they cannot deduct it from personal taxes ($\lambda^{INC,p} = 0$). This means that marginal investments funded from new equity are discouraged. This weakens the incentive to incorporate for those owner-managers who expect to make low returns on their investments.

4.4 Extensive margin choices

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

The decision to start a business is determined both by the net-of-tax income an individual expects to make as a business owner, in addition to the other costs/benefits associated with starting a business that are reflected in F_i^{start}. Business owner productivity is uncertain, with individuals only observing a noisy signal of what their productivity will be when they enter next period.[29] The decision to incorporate will be affected by the net incorporation costs/benefits, F_i^{inc}, and the relative tax treatment of the two legal forms (including the tax during business life, tax on business dissolution and investment allowances), which will, in turn, affect the choices over investment, labour supply and savings. Individuals can choose to exit business ownership if they receive a bad productivity shock, ϵ_{it}, which will lead to persistently lower incomes.

[29] We assume that employees observe the productivity that they would have had as a owner-manager, η, *if they had operated a business that period*. This is a signal of their productivity as an owner-manager next period, and therefore informative for their decision to enter or not.

4.5 Intensive margin choices

Individuals start each period with a stock of assets, denoted by $a_{it} = a^c_{it} + a^p_{it}$. Incorporated owner-managers have the option to hold assets within the company, a^c_{it}, or in their personal accounts, a^p_{it}. Self-employed agents and employees hold only personal assets i.e. $a^c_{it} = 0$.

Investment. At the start of each period, owner-managers choose what fraction of assets to invest in productive capital, k_{it}. For incorporated owners, if investment is greater than the stock of company assets, they inject new equity from their personal assets into the company, denoted by $\tilde{k}_{it} = \max\{0, k_{it} - a^c_{it}\}$. We assume that capital depreciates at rate δ.[30] At the end of each period, the value of undepreciated capital is added to the stock of either company (for those incorporated) 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.[31]

The optimal choice of capital is jointly determined with the choice of labour supply, and depends on individual's productivity, the importance of capital in generating business income, and tax incentives. This is highlighted by the condition for optimal interior capital choice for incorporated owners:

$$k^* = \left(\frac{B}{\theta\omega h^\alpha}\right)^{1/(\theta-1)} \text{ where } B = \begin{cases} \delta \text{ if } k^* \leq a^c \\ \delta + \frac{\tau_p(1-\lambda^{INC,p})}{(1-\tau_c)(1-\tau_p)} \text{ if } k^* > a^c \end{cases}. \tag{4.6}$$

Investment is not distorted by tax if individuals invest such that the marginal product of capital (B) equals the the cost of capital, δ (equivalent to choosing k^* in Figure 2.2). This will be the case if optimal investment is less than the stock of company assets ($k^* \leq a^c$) – personal taxes do not distort investments made out of retained equity. Alternatively, if individuals can deduct the cost of new equity investments from their personal taxable income ($\lambda^{INC,p} = 1$), then investment is also not discouraged. However, when $\lambda^{INC,p} < 1$ (and in the baseline, $\lambda^{INC,p} = 0$), this is not the case: optimal investment is distorted downwards (k^{**} in Figure 2.2). This distortion is larger the higher the tax rate, τ_p.

Note also that the actual choice of k is subject to the further constraint that it not exceed assets on hand: $k = \min\{k^*, a\}$.

Labour supply. Individuals choose how much labour to supply in running their businesses by trading off the disutility cost against the (net-of-tax) income that they make. It is jointly

[30] We can also interpret δ as including the implicit price of renting capital on the spot market.

[31] Chen et al. (2019) describe how the lumpy nature of firm-level investments may affect the impact of different types of tax policy on investment choices.

determined with the decision over how much to invest, and also depends on productivity and tax incentives (see Appendix D for details). If the individual is an employee, then they supply a fixed number of hours per year, $\bar{h}$. As discussed above, they earn a constant wage equal to their latent productivity plus the age trend, such that their annual income is $z_{it} = \bar{h} \exp(\psi_i + \phi_1 \text{age}_{it} + \phi_2 \text{age}_{it}^2)$.

Savings and consumption. Individuals choose how much to save: all individuals can save in a personal asset, s_{it}^p, with incorporated owner-managers able to retain profits by saving in their company asset, s_{it}^c. Consumption is given by:

$$c_{it} = \begin{cases} z_{it} - s_{it}^c - \mathcal{T}^c(\pi_{it}) & - \mathcal{T}^p(y_{it}, d_{it}, d_{it+1}) - s_{it}^p \quad \text{if} \quad d_{it} = INC \\ z_{it} & - \mathcal{T}^p(y_{it}, d_{it}, d_{it+1}) - s_{it}^p \quad \text{if} \quad d_{it} = SE, EE. \end{cases} \tag{4.7}$$

Assets held in personal accounts and company accounts attract rates of return, r^p and r^c, respectively, and evolve as follows:[32]

$$a_{it+1}^p = (1 + r^p)(s_{it}^p + a_{it}^p) \tag{4.8}$$

$$a_{it+1}^c = (1 + r^c)(s_{it}^c + a_{it}^c), \tag{4.9}$$

where s_{it}^p and s_{it}^c denote saving in the personal and company assets, respectively. We rule out borrowing by imposing $s_{it}^p \geq -a_{it}^p$ and $s_{it}^c \geq -a_{it}^c$. The restriction that business owners cannot use uncollaterized debt to finance investment is motivated by the empirical evidence that most owner-managers use their own funds to finance their business presented in Section 3.

Optimization errors. We allow for the fact that owner-managers may make errors when optimizing 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)). Following Chetty (2012), we assume that agents only reoptimize labour supply (and, for incorporated owner-managers, the share of assets held in the company) if the utility gain from doing so, as a fraction of annual business income, is greater than ς_o.

4.6 Recursive formulation of the individual's maximisation problem

Individuals make choices each period to maximise their expected utility over their remaining years of life. Here we make explicit the state variables and recursive formulation of

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

the individual's problem, using prime to denote next period's variables and dropping the subscripts to simplify notation.

The state variables are: latent type (j): individual's 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 $\Omega = \{j, \text{age}, d, a, \tilde{a}^c, \psi, \eta, F^{inc}, F^{start}\}$.

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 utility from 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.

Working life. During working life, the set of choices available to agents depends on their legal form, d. Owner-managers choose how much to invest in productive capital, k, and how much leisure to take, l, with the remainder denoting hours of labour supplied in running their business, $h = L - l$ (L denotes the time endowment). Employees supply a fixed number of hours of labour, denoted by $\bar{h}$. All types of agents choose how much to save, a', with incorporated owners also choosing how much to save in their company asset, $\tilde{a}'_c$. We let $V(\Omega|d')$ denote the value associated with maximising each of these variables, conditional on the choice of legal form next period, d':

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

subject to (4.1) – (4.7). The solution to this problem gives the policy functions for $k, l, a', \tilde{a}^{c'}$. For the self-employed, $\tilde{a}^{c'} = 0$, and for employees, $\tilde{a}^{c'} = 0$, $l = L - \bar{h}$, and $k = 0$.

The choice of legal form next period is then to $\max_{d' \in \mathcal{D}_d} V(\Omega|d') + \zeta_{d'}$, 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^2_ζ. This allows us to apply the log-sum result of McFadden (1973) to integrate over these shocks:

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

where γ is a constant of integration that differences out.

The model cannot be solved analytically, so we use numerical techniques to solve for the policy and value functions. We exploit both the intertemporal (the Euler equation) and

intratemporal (for capital choice and labour supply) conditions for optimization. The full solution algorithm is described in Appendix D.

5 Estimation and model fit

To estimate the model, we use the data introduced in Section 3, from company accounts, personal and corporate tax records. Our sample consists of the set of owner-managers active in 2013-14. This includes all those who are self-employed, and incorporated owners 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 3.1 summarises these businesses. Note that these are a selected sample of the population of owner-managed businesses that operate over the entire period 2001-2014. We explicitly account for this selection in estimation by constructing the moments simulated from the model using simulated data that is selected in the same way as our sample. 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. We allow variation in the model parameters across the business types we identify using the clustering approach described in Section 3.2 (see Appendix C for details).

We first calibrate a number of parameters using data and existing evidence from the literature. We then estimate the remaining parameters using the method of simulated moments, taking the parameters set in the first step as given.

5.1 Calibrated parameters

Utility function. We set the coefficient of relative risk aversion, $\nu_c = 0.8$.[33] 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.[34] 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 business owner-managers reported in the UK Labour Force Survey (LFS).

[33] We do not have data on consumption or total assets from the tax records, which makes it challenging to identify the curvature of utility with respect to consumption.

[34] See, for example, Holt and Laury (2002, 2005), Harrison et al. (2005), Andersen et al. (2008).

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

Productivity. Due to the endogeneity of labour supply, we estimate the parameters governing the productivity process using the method of simulated moments. However, we set the coefficients on age and age squared in the productivity process equal to those estimated by Attanasio et al. (2018).

Budget constraint. We parametrise, and solve the model for, three tax regimes.[35] The first covers the period before 2003 and 2005-10, the second covers the period 2003-4 (when the 0% starting rate of corporation tax was in operation), 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.[36] 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.

5.2 Moment conditions and identification

We estimate the remaining parameters using the method of simulated moments i.e. minimizing the distance between moments of the data with analagous moments constructed from data simulated from the model. We have a total of 53 parameters and 88 moments. The moments that we use include: the mean and standard deviation of business income for the self-employed and incorporated; the share of the variation in business income explained by individual fixed effects; the correlation between business income and its lag; mean investment as a share of mean business income; percentiles of the retained profit distribution for incorporated businesses with average business income above the higher rate threshold; the initial and average share of business owners that are incorporated; average entry rates of self-employed and incorporated; incorporation rates on average and over the 0% starting rate of corporation tax; bunching at the higher rate threshold by the self-employed.

[35] See Appendix B for more details on the tax system, and Appendix D for how we model it.

[36] 36% of incorporated businesses have 2 shareholders and 2 directors. Much of this is due to the strong incentives to split business income with a spouse – for around 2/3 of these companies, the shareholders have the same surname. We account for this in the model by assuming that, with probability = 0.36, the effective thresholds in the personal tax schedule for incorporated business owners are double their statutory value.

We allow for heterogeneity in the model parameters across the five latent types, with the exception of four parameters – the discount factor, curvature of utility in leisure, the optimization error threshold and dipersion of the logit shocks. The parameters are jointly identified, but here we describe the variation in the data that helps pin down each parameter (conditional on the values of the other parameters). In Appendix E, we conduct a series of moment informativeness tests to provide additional information on the variation in the data driving the parameter estimates.

Utility function. The 50th, 75th and 90th percentiles of retained profits for businesses with average business income above the higher rate threshold are helpful for pinning down the discount factor. Intuitively, all else equal, a higher discount factor means that individuals are more patient, and therefore more willing to defer consumption until company liquidation, which confers a tax saving. This argument applies to incorporated owners with average business income above the higher rate threshold because the self-employed cannot retain and low-income incorporated owners have no incentive to do so. The optimization error threshold, ς_o, and the curvature of utility in leisure, ν_L both affect the degree of bunching at tax thresholds. However, ς_o also affects the relative business income levels of the incorporated and the self-employed, because incorporated owners have more margins of response to the tax rates they face (notably, they can retain profits in addition to adjusting labour supply). Conditional on a given level of optimization error, a higher value of ν_L implies more elastic labour supply, which corresponds to more bunching for the self-employed at tax kinks.

Start-up and incorporation costs. Entry rates of self-employed business owners each year help to pin down the mean of the start-up cost, F_m^{start}. We allow for a differential start-up cost for incorporated owners, which, along with the mean of the incorporation costs, F_m^{inc}, and the dispersion in the start-up and incorporation costs, F_{sd}, are jointly pinned down by the rate of incorporation (from self-employment) and the entry of new incorporated business owners (from employment). The change in incorporation rates when the 0% starting rate of corporate tax was in place 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 sensitivity of extensive margin shifts to tax changes.

Productivity and income production. Labour supply is endogenous and unobserved in the data, which means we cannot estimate the parameters governing productivity and the business income function in the first stage. Instead, we use information on the distribution of

business incomes to help pin down these parameters (conditional on the agents' preferences, ν_c, ν_l, χ). The mean business incomes of self-employed and incorporated business owners are informative about the mean of the latent productivity distribution, μ_ψ. The standard deviations of business income are informative about the standard deviations in latent productivity, σ_ψ, and dispersion of productivity shocks, σ_ϵ; we distinguish between the different types of variation by matching the share of log business income due to individual fixed effects in a variance decomposition. To identify the persistence of productivity shocks, we match the coefficient on lagged business income from a regression of log business income 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 business income 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 3.2).

5.3 Parameter estimates

Table 5.1 presents the parameters estimated using the method of simulated moments. We estimate an annual discount factor, β, equal to 0.98, which is line with estimates in the literature. We estimate an optimization error threshold of 2.5% – i.e. individuals have to get a utility gain of more than this to adjust their behaviour in response to changes in the marginal tax rate that they face. We estimate ν_L equal to 1.56. This corresponds to median compensated wage elasticities of hours of 0.64 for the lowest income type I, falling to 0.39 for the highest income type V. The implied Marshallian elasticities are substantially lower, with a median of 0.04, indicating sizeable income effects. We estimate the standard deviation of the logit shocks to be 4 – these explain roughly 25% of the transitions between legal forms, with the rest driven by the inclusive values, $V(\Omega|d')$.

The second panel of the table summarise the parameters that govern the start-up and incorporation costs.[37] These are expressed in terms of utils, so we convert these to a monetary annual equivalent to aid interpretation. 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

[37] We estimate the share of business owners that are incorporated in the first year (shown in the last row of the second panel) by matching the share of incorporated businesses in the first year of our data.

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. We calculate Δc_i^{EEtoSE}, which captures the costs of starting an unincorporated business, $\Delta c_i^{EEtoINC}$, which captures the costs of starting an incorporated business, and $\Delta c_i^{SEtoINC}$, which captures the costs of incorporating an existing self-employed business. 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. The median value of Δc_i^{EEtoSE} is £450, but with substantial variation: 43% of individuals are estimated to get *benefits* from starting an unincorporated businesses. The median costs of starting an incorporated business are substantially higher, at £4300, but again, there is wide variation in these costs, with 7% of individuals getting positive benefits from starting an incorporated businesses, and 2% preferring to start an incorporated rather than unincorporated business. Finally, the median costs of switching from self-employment to incorporation are estimated to be £5200. Incorporation costs of this size are necessary to rationalise why many agents choose to remain self-employed when there are substantial tax savings to incorporating.

Table 5.1: *Parameters estimated in the second stage*

		Type				
	Parameter	I	II	III	IV	V
Utility function						
Discount factor	β			0.980		
				(2.0e-04)		
Curvature of utility in leisure	ν_l			1.561		
				(6.3e-03)		
Optimization error threshold	ς_o			0.025		
				(2.4e-04)		
Dispersion of logit shocks	σ_ζ			4.000		
				(3.1e-02)		
Start-up and incorporation costs						
Mean of start-up cost	F^{start}	-0.21	8.69	40.00	4.32	11.65
		(9.1e-02)	(2.3e-01)	(1.2e+00)	(1.0e-01)	(4.1e-01)
Additional start-up cost for INC	$F^{start} \times d' = INC$	-9.31	-9.20	-8.22	-13.18	-17.64
		(8.5e-02)	(1.2e-01)	(3.0e-01)	(9.0e-02)	(4.1e-01)
Mean of incorporation costs	F_m^{inc}	54.82	49.29	51.36	40.67	38.81
		(2.9e-01)	(3.2e-01)	(5.1e-01)	(1.5e-01)	(1.5e-01)
Std. dev. of switching costs	F_{sd}	19.23	14.16	17.12	9.60	14.03
		(1.4e-01)	(1.7e-01)	(8.6e-01)	(1.2e-01)	(3.7e-01)
Latent variable governing initial INC share		-6.23	-6.60	-6.09	-6.11	-5.87
		(2.9e-02)	(2.7e-02)	(4.7e-02)	(1.8e-02)	(3.0e-02)
Productivity and income function						
Mean of latent productivity	μ_ψ	0.519	1.536	1.146	2.295	3.226
		(2.8e-03)	(6.5e-03)	(1.4e-02)	(2.5e-03)	(2.1e-03)
Std. dev. of latent productivity	σ_ψ	0.790	0.373	0.832	0.015	0.011
		(2.2e-03)	(4.5e-03)	(1.5e-02)	(3.2e-03)	(1.8e-03)
Std. dev. of productivity shocks	σ_ϵ	0.417	0.372	0.392	0.280	0.277
		(1.7e-03)	(2.1e-03)	(3.7e-03)	(2.1e-03)	(1.0e-03)
Persistence of productivity	ρ	0.554	0.510	0.354	0.708	0.576
		(1.6e-03)	(3.0e-03)	(4.4e-03)	(4.5e-03)	(2.6e-03)
Importance of capital in production	θ	0.000	0.038	0.149	0.008	0.008
		(.)	(9.9e-05)	(9.0e-04)	(1.2e-05)	(4.0e-05)

Notes: Details of the estimation process are described in Appendix D.

The final panel of the table presents the estimates of the productivity and income function parameters. Estimated mean productivity is higher for the higher income 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 (Figure E.2). We estimate θ between 0.0075 (for type IV) and 0.149 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. When $\theta = 0$ (for type I) i.e. capital is not used in the production process, individuals reduce their labour supply as assets increase, all else equal. However, for higher values of θ at low levels of assets, an increase in assets leads to higher labour supply, in order to take advantage 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.

5.4 Model fit

Table 5.2 summarises the moments that are targeted in estimation. The model does a good job of fitting the data. This is both in terms of the intensive margin i.e. the mean and standard deviations of business incomes, variance decomposition and persistence of income, and the extensive margin i.e. share of businesses that are incorporated, entry and incorporation rates. The fit for retained profits, which helps to pin down the discount factor, and the excess bunching mass, is good.

Figure 5.1 shows that the model matches the increase in incorporation during the years when the 0% starting rate of corporation tax was in place. We use the model to consider a counterfactual world in which the 0% starting rate of corporation tax had not been in place. 33% 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. This indicates that increasing the tax advantage to incorporation acted primarily to shift people from self-employment to incorporation, rather than leading more people to enter business ownership.[38] 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 incorporated business owners.

Figure 5.2 provides additional validation of the model by showing fit of moments that are not targeted in estimation. Panel (a) shows that we do a good job replicating the excess bunching mass of incorporated owner-managers at the higher rate threshold. This is

[38] This is also evident in the aggregate data, in that we see no increase in the number of new owner-managed businesses during the period that the 0% starting rate of corporation tax was in place, see Figure A.2.

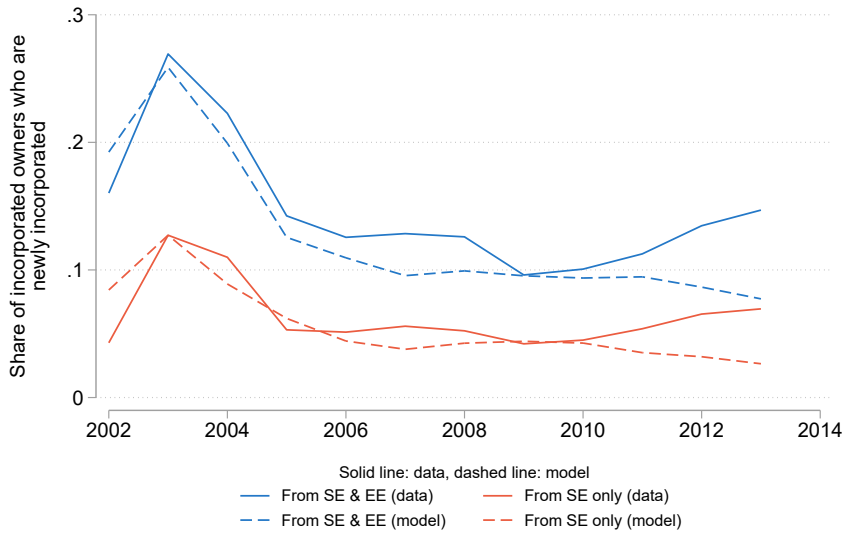
Table 5.2: *Targeted moments*

		Type				
		I	II	III	IV	V
Type-specific moments						
Mean bus income - SE	Data	7458	11983	10959	27177	77754
	Model	5770	13488	12335	28087	69239
Mean bus income - INC	Data	8831	18484	26959	35824	84894
	Model	9798	19154	34128	31129	72600
Std. dev. bus income - SE	Data	6958	11386	18589	15185	44852
	Model	8379	13125	18737	18714	44852
Std. dev. bus income - INC	Data	11257	21774	41415	23781	48093
	Model	11315	15816	32215	19768	46063
Share of income variation due to perm. comp.	Data	0.65	0.54	0.62	0.34	0.23
	Model	0.61	0.45	0.58	0.39	0.31
Coeff. on AR(1) of log bus income	Data	0.22	0.28	0.19	0.33	0.38
	Model	0.19	0.29	0.20	0.34	0.27
Mean investment/mean bus income	Data	–	0.20	0.54	0.04	0.04
	Model	–	0.17	0.61	0.03	0.03
INC share - average	Data	0.03	0.08	0.15	0.23	0.67
	Model	0.03	0.07	0.14	0.22	0.57
INC share - in 2002	Data	0.03	0.04	0.08	0.11	0.44
	Model	0.02	0.04	0.10	0.13	0.41
Entry rate - average for INC	Data	0.00	0.00	0.01	0.02	0.05
	Model	0.00	0.00	0.01	0.01	0.03
Entry rate - average for SE	Data	0.14	0.06	0.05	0.05	0.02
	Model	0.14	0.05	0.05	0.06	0.01
Incorporation rate - average	Data	0.13	0.11	0.10	0.12	0.10
	Model	0.13	0.11	0.10	0.10	0.08
Incorporation rate - 2002	Data	0.16	0.17	0.16	0.16	0.15
	Model	0.18	0.22	0.23	0.24	0.20
Incorporation rate - 2003	Data	0.25	0.32	0.27	0.31	0.22
	Model	0.23	0.34	0.25	0.34	0.17
Incorporation rate - 2004	Data	0.22	0.26	0.21	0.24	0.17
	Model	0.19	0.21	0.16	0.24	0.13
Incorporation rate - 2005	Data	0.14	0.15	0.13	0.14	0.13
	Model	0.14	0.09	0.09	0.09	0.08
Incorporation rate - SE only to INC	Data	0.06	0.06	0.05	0.05	0.02
	Model	0.06	0.06	0.04	0.03	0.02
Common moments						
p.50 retained profits for high-income businesses	Data			2791		
	Model			3289		
p.75 retained profits for high-income businesses	Data			12607		
	Model			13864		
p.90 retained profits for high-income businesses	Data			28706		
	Model			26385		
Excess bunching mass at HRT for SE	Data			0.83		
	Model			0.78		

Notes: The table shows the 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.

substantially more than the bunching by the self-employed that we target directly in estimation, because incorporated owners have scope to adjust retained profits as well as labour supply. Panel (b) compares the share of businesses that are high-growth and long-lived in the data and from our model. We overshoot the shares for types I-III and undershoot for types IV and V, but the model nonetheless captures the overall pattern that the highest investment type IIIs have the largest share of high-growth long-lived businesses. Panels (c) and (d) show how the distribution of retained profits (for incorporated owners) varies with the average total income of the company.[39] We match the conditional 75th percentiles and medians quite well, but overshoot the 25th percentiles at high levels of income. One possible explanation for this is that we assume a discount factor that is common for everyone. The final two panels in Figure 5.2 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 (2024). 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.

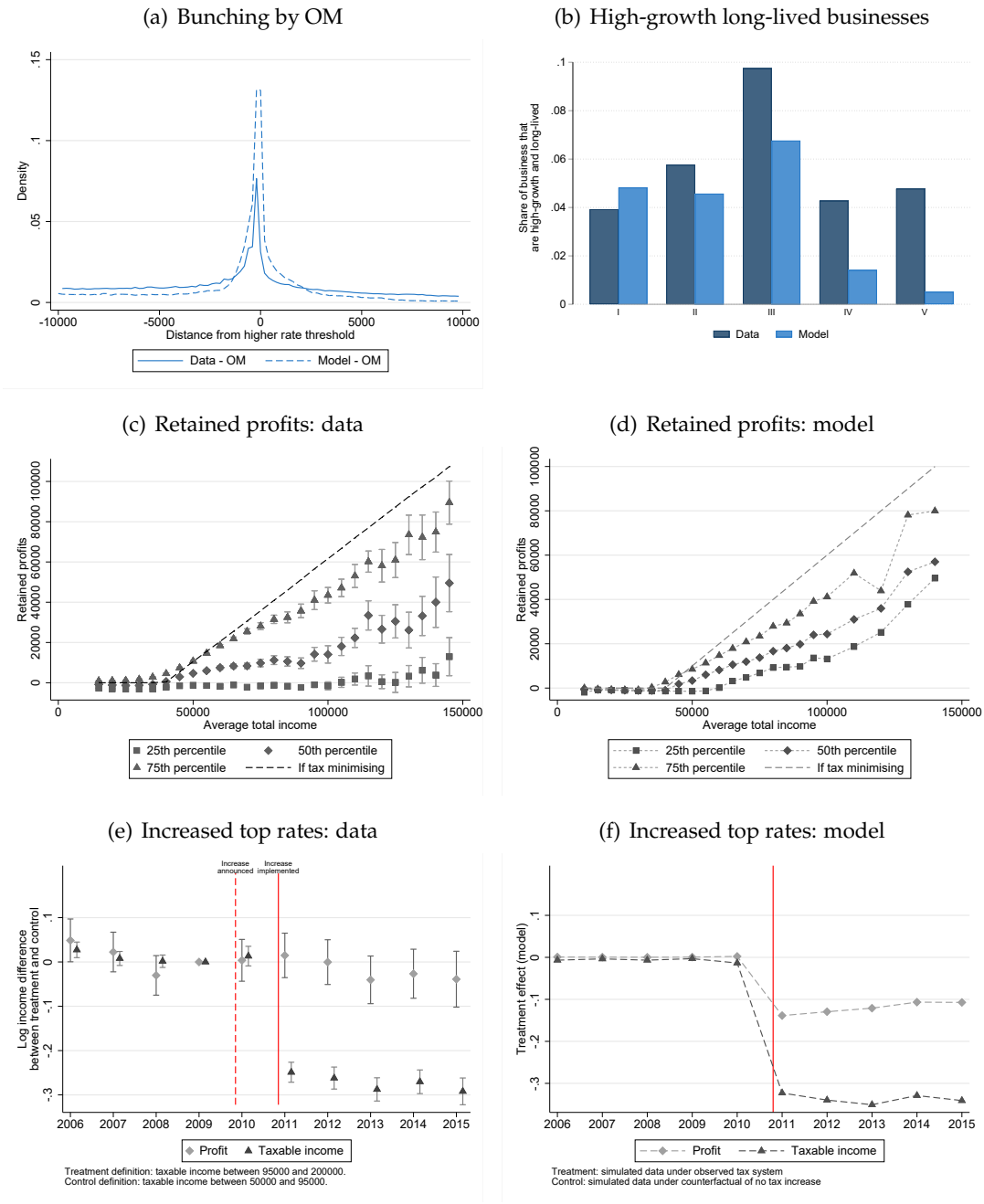
Figure 5.1: *Incorporation rates in the data and model*



Notes: The blue lines show the share of incorporated business owners who are newly incorporated (from both self-employment and employment) in each year in the data (solid) and simulated from the model (dashed). The red lines show the share of incorporated business owners newly incorporated from self-employment only. Details of the estimation process are provided in Appendix E.
Source: Authors' calculations using HMRC administrative datasets and model simulations.

[39]Total income is equal as business income net of corporate tax – this is equal to incorporated owners' personal taxable income if they neither retained nor withdrew profits from the company.

Figure 5.2: *Model validation*



Notes: The top left hand panel shows bunching around the higher rate threshold by owner-managers in the data and simulated from the model. The top right hand panel shows the share of owner-managed businesses that are high-growth and long-lived – defined as those that average more than 20% income growth per year and last for longer than 10 years – in the model and the data. The middle left hand panel reproduces Figure 5.6 from Miller, Pope, and Smith (2024), 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 (2024). 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 world in which there were no higher rates of tax on top incomes from 2011 onwards.
Source: Authors' calculations using HMRC administrative datasets and model simulations.

5.5 Capital constraints

We model owner-managers as only able to make investments up to the value of their total assets. This restriction is motivated by both the empirical evidence on the lack of borrowing

by business owner-managers, and the existing literature that has emphasised the importance of credit constraints for this group. An implication of these borrowing constraints is that some individuals have marginal products of capital (MPK) that exceed the depreciation cost of capital – i.e. investment is inefficiently low.

Capital constraints are driven by two things: (i) insufficient total assets, and (ii) insufficient company assets. The latter leads to inefficiently low investment because of the tax disincentive to invest out of new equity. This can be seen directly in the first order condition for capital choice, equation (4.6): in the baseline world, when $\lambda^{INC,p} = 0$, investment financed from new equity is reduced because its return is taxed with no equivalent deduction for the cost of investment. We can gauge the importance of this by looking at the share of businesses that are capital constrained (i.e. have a MPK above the depreciation rate), but whose owners have (i) high total assets, (ii) a small share of assets in the company and (iii) who face a non-zero personal tax rate. Almost all of those in type V that are capital constrained suffer from this i.e. they have high assets but the disincentive against new equity leads to inefficiently low levels of investment (Table E.1). Almost 15% of type III businesses are capital constrained, and, of this, 16% is due to the tax disincentive to invest new equity, with the remainder driven by insufficient total assets. For other types, the discincentive against new equity does not significantly affect investment.

6 Quantifying the equity and efficiency effects of tax reforms

Many governments use tax policy, including lower headline tax rates on capital incomes and gains, to try to encourage entrepreneurial entry and investment. But, as discussed above, this has a range of unintended consequences (such as tax avoidance), while lower headline rates cannot remove investment disincentives that are caused by the tax base. In this section, we use our framework to consider the effects of reforming taxes on owner-managed businesses, highlighting the importance of modelling the range of tax instruments at governments' disposal. We demonstrate that, given the design of current tax systems, there are an important class of policies that improve both equity and efficiency.

6.1 Increasing the average capital tax rate

Many quantitative models that study capital tax design consider the impact of varying a single capital tax rate, which is proxied by taking the average across different forms of capital income. We perform a similar exercise in our framework by simulating a 1 percentage point increase in the corporate tax rate, and top rates of tax on self-employment profits, dividend income and capital gains. The first column of Table 6.1 summarises the effects of

this change, with Figure 6.1 providing further detail on the effects across the distribution of baseline business incomes.

Table 6.1: *Comparing the aggregate effects of different capital tax reforms*

	Average capital tax rate increase	CGT rate increase	CGT rate increase + base reform
pp change in rate	1.0	5.7	5.7
% change in tax revenue	1.5	1.5	1.5
Equity & efficiency			
Change in Suits Index (x100)	0.6	0.7	0.6
% revenue from top 1% of owner-managers	16.0	31.0	34.7
Fiscal externality (£m/year)	-12.7	142.8	174.0
Revenue left after lump-sum compensation (£m/year)	-19.0	151.5	154.8
Marginal Value of Public Funds (MVPF)	1.07	0.25	0.11
Extensive margin			
% change in total businesses	-0.0	-0.0	-0.0
% change in incorporated businesses	-3.1	-1.3	-0.8
% change in unincorporated businesses	0.3	0.1	0.0
Intensive margin: all			
% change in annual investment	-0.4	-0.2	0.8
% change in k-constrained businesses	2.1	7.2	-23.5
% change in hours worked	-0.1	-0.0	0.1
% change in business income	-0.3	-0.0	0.2
Intensive margin: high income incorporated			
% change in annual investment	-1.7	-1.3	4.6
% change in k-constrained businesses	9.6	26.8	-83.3
% change in hours worked	-1.5	-0.3	1.0
% change in business income	-1.6	-0.4	0.9

Notes: The first column shows the effect of a 1 percentage point increase in the corporate tax rate, and top rates of tax on self-employment profits, dividend income and capital gains. The second column shows the effect of a revenue-equivalent increase in the capital gains tax rate (of 5.7 percentage points), and the third column shows this increase in the CGT in addition to tax base reform that removes the disincentive to invest using new equity. The Suits Index is a measure of tax progressivity (see Suits (1977)) between 0 and 1. The fiscal externality is the change in revenue due to behavioural responses ($dB = dR - dM$). High income incorporated businesses are those that incorporated with mean business income above £40,000 in the baseline world. k-constrained businesses are defined as those with a marginal product of capital greater than the depreciation rate.
Source: Model simulations.

This small increase in the average capital tax rate leads to a 1.5% increase in the revenue from business owner-managers (approximately £190m per year), and does so in a progressive manner. We measure tax progressivity using the Suits (1977) index, which is a measure analagous to the Gini coefficient that compares the cumulative tax burden across income levels to the cumulative income share. Increases in the Suits index, which ranges between -1 and 1, reflects increasing tax progressivity i.e. a greater proportion of the tax burden is

borne by higher income individuals. The average capital tax rate increase leads to a 0.006 rise in the Suits index. To put it another way, 16% of the revenue raised comes from the top 1% of business owner-managers.

Raising revenue progressively by increasing all capital tax rates leads to an efficiency loss i.e. there is an equity-efficiency trade-off. One way to measure the efficiency loss is through the fiscal externality, which captures the impact of individuals' behavioural responses on the revenue raised. We find that individuals change their behaviour in such a way that the revenue raised is £12.7m lower than it would have been in the absence of behavioural change. The subsequent panels of the table highlight the reasons for the fall in efficiency: annual investment falls and there is an increase in the number of capital-constrained businesses. There is also a reduction in the average number of hours worked by business owner-managers, and this, in combination with the fall in investment, leads to lower business income created. Another way to express this efficiency loss is that it would cost £20m per year more to lump-sum compensate owner-managers for the higher rates of tax than the revenue raised.[40] This is just another example of the widely-studied equity-efficiency trade-off associated with increasing capital taxes.

6.2 Reducing tax differentials

The reform above, and those studied in most models of optimal capital tax, focuses on the government's choice over a single policy instrument. We relax this assumption and demonstrate that, given the distortions caused by current tax design, tax systems are not at the equity-efficiency frontier.

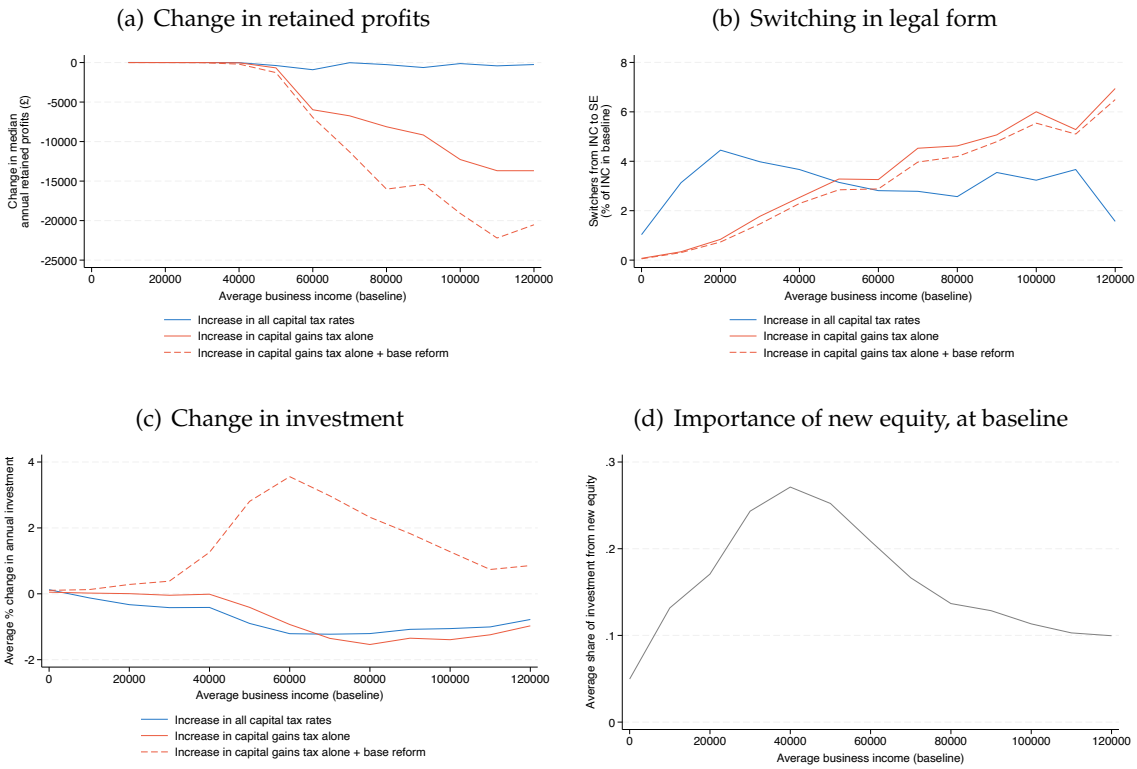
Consider a reform that increases the tax rate on capital gains, which reduces the differential with other tax rates. Capital gains is one of the most lightly taxed forms of income: in the UK, gains made on business assets are taxed at only 10%. This is not unique to the UK, with many countries taxing capital gains more lightly than labour and capital income, often with the rationale of encouraging investment and entrepreneurship. However, this comes at the cost of encouraging income shifting and distorting choices over legal form.

The second column of Table 6.1 shows the effect of increasing the capital gains tax rate to raise equivalent revenue to the 1pp increase in all capital tax rates described above. This raises revenue in a more progressive manner than the average rate rise – there is a bigger increase in the Suits index, and 31% of the revenue raised comes from the top 1% of owner-managers. This is because low rates of capital gains tax disproportionately benefit those at

[40] This is the traditional notion of Hicks-Kaldor efficiency (Hicks, 1940; Kaldor, 1939) which captures Pareto improvements, but relies on lump-sum transfers. Although these are not feasible to implement in practice (Hendren (2020)), it nonetheless provides a useful benchmark.

the top of the income distribution – there is only an incentive to take capital gains for those with profits above £40,000 per year (below this, dividend income is taxed more lightly).

Figure 6.1: *Differential impact across the distribution of business incomes*



Notes: The top left panel shows the change in annual retained profits (for incorporated businesses) across the distribution of average business income in the baseline world. The top right panel shows the switching from the incorporated to unincorporated legal form by bins of average business income in the baseline world, under each revenue-equivalent policy reform (described in the notes to Table 6.1). The bottom left panel shows the percentage change in annual investment under each reform, across the distribution of average business income in the baseline world. The bottom right panel shows the average share of investment financed from new equity across the distribution of average business income in the baseline world.
Source: Model simulations.

The biggest difference between the two reforms, however, lies in the implications for efficiency. We show above that an increase in the average capital tax rate that preserves rate differentials leads to a small efficiency loss. Increasing just the CGT rate also leads to lower investment and labour supply, which act to reduce efficiency. However, these behavioural responses are more than offset by lower rates of income shifting and tax-motivated incorporation, such that, overall, raising the CGT rate actually *increases efficiency*. This highlights the importance of modelling multiple headline tax rates and the myriad of ways individuals can respond to tax – failure to do so would miss these potential efficiency gains.

Raising the CGT rate by 5.7 percentage points generates a positive fiscal externality of £143m per year i.e. owner-managers respond to the tax in such a way that the tax revenue actually rises through these behavioural responses. Figure 6.1 illustrates the mechanisms

driving this. Increasing the capital gains tax reduces the incentive to shift income over time by retaining profits within the company until exit. Figure 6.1(a) shows that, on average, those with business income (at baseline) of approximately £60,000 per year reduce their annual retained profits by just over £5000 each year. For those earning £120,000 per year, retained profits falls by almost £15,000 each year. Reduced shifting means owner-managers take more income as dividends during company life, which acts to increase tax revenues. Another implication of the reduced incentive to retain profits is that it lowers the benefits to incorporation (the means by which individuals can easily shift income over time). Figure 6.1(b) shows that raising the CGT rate leads to more individuals choosing self-employment rather than incorporation, particularly at higher income levels.[41]

Both of these forms of shifting distort behaviour in ways that generate real utility costs: it leads individuals to delay consumption longer than they would otherwise have done, and to pay incorporation costs they would have preferred to avoid. We can quantify this by calculating the revenue left after compensating individuals for the increased CGT rate. The total cost of lump-sum compensation is £40m per year, leaving £150m per year left. This illustrates how tax rate differentials can create sizeable distortions with large utility costs. Fixing these can therefore have first order benefits for welfare.

Increasing the CGT rate is not without costs, however. It does reduce average investment, and there is a 27% increase in the number of capital-constrained businesses. These declines in investment are concentrated among those businesses with high income at baseline. Reduced incentive to invest also leads to a reduction in labour supply and a fall in business income. In this specific case, the magnitude of these investment effects are small relative to the reduced distortions due to income shifting and change in legal form, hence the overall improvement to efficiency from increasing the CGT rate. This need not be the case however, and highlights the importance of empirically quantifying the different forces at play.

6.3 Reforming the tax base

We describe in Section 2 why the design of the tax base is of critical importance for investment incentives. Many countries have tax systems that discourage investment, in particular, that financed out of new equity. As demonstrated above, these investment disincentives are worse at higher headline tax rates. We now quantify the benefits to tax base reforms that remove these disincentives.

[41] The increase in the average capital tax rate also leads to lower rates of incorporation, because raising both the corporate tax and personal income tax leads to a greater increase in the effective tax rate paid by incorporated owner-managers relative to self-employed ones.

The third column of Table 6.1 shows the impact of increasing the CGT rate alongside moving to a cash flow treatment of new equity investments (in a way that is revenue-equivalent to the first two counterfactual reforms).[42] This effectively sets $\lambda = 1$ for incorporated owner-managers (recall that under the existing UK system it is already the case that $\lambda = 1$ for unincorporated owner-managers), and thus removes tax distortions to their investment choices. This reform raises revenue in a similarly progressive manner to the CGT rate rise in the absence of base reform, while leading to even larger gains in efficiency. The reductions in income shifting and distortion to legal form under the CGT rate rise alone persist when we also reform the tax base. There are even larger falls in retained profits, because removing the distortion to investing out of new equity means that owner-managers have less incentive to retain profits to use for future investments. This acts to raise tax revenue (because profits are instead paid out as dividends, which are taxed at a higher rate), which offsets the cost of providing the deductions for new equity investment. All together, the fiscal externality due to individuals' behavioural responses leads to £30m more revenue a year than the CGT rise alone.[43]

The biggest impact of reforming the tax base is on investment. Annual investment among all owner-managers increases by 0.8%, and among high income incorporated businesses by 4.6%. To emphasise: this is under a counterfactual scenario in which the tax rate on capital gains has *increased*. There is an 83% reduction in the number of capital constrained businesses. This is because owner-managers for whom new equity is the marginal source of funds now face no discincentive to invest, such that they invest up until the point where their marginal product of capital equals the depreciation rate. In the baseline world, they invest only up until the net-of-tax marginal product of capital equals the depreciation rate, leading to inefficiently low levels of investment. This mechanism is evident in the heterogeneous investment effects shown in Figures 6.1(c) and (d). The largest increases in investment are for those with average business income at baseline around £60,000 per year (panel (c)), who are the group for whom new equity is the most important source of investment funds (panel (d)). Owner-managers at higher levels of baseline business income have greater stocks of retained profits, which they then use to fund investment. The increases in investment due to the reform to the tax base also lead to greater labour supply among owner-managers, which together lead to a 0.2% increase in business income for all owner-managers, and a 0.9% increase among high-income incorporated owner-managers.

[42] We allow owner-managers to deduct the upfront costs of new equity investments from personal taxes. An equivalent approach is to provide a stream of allowances linked to the initial investment (Adam and Miller, 2021).

[43] Absent behavioural responses, the combination of the higher CGT rate and base reform would raise £28m per year less in revenue than the CGT rise alone. However, individuals' behavioural responses offset this mechanical revenue cost to mean that it is effectively "free" from the government's perspective.

This exercise illustrates how careful design of the tax system, which takes seriously the policy instruments available to government and the ways that people respond to them, can lead to first-order improvements to welfare. Our results highlight that it is possible to raise revenue more progressively, and in way that leads to improvements in efficiency and increases in investment, by reforming the tax base as well as altering tax rates.

6.4 Marginal Value of Public Funds

Another way to compare the effects of the policy reforms is to compute the Marginal Value of Public Funds (MVPF). The MVPF is the ratio of a policy's benefits to its recipients, divided by the net cost to the government, which includes the impact of behavioural responses (Hendren, 2016). The beneficiaries of lower capital tax rates are those individuals that pay less tax as a result – to a first order, they value £1 additional tax savings at £1. The total benefits from lower capital taxes are therefore given by the mechanical revenue effect from increasing them. The cost to the government is measured by the actual revenue raised, accounting for individuals' responses to the tax.

Increasing the average capital tax rate has an MVPF of 1.07 i.e. the fall in utility to owner-managers from increasing capital tax rates in this way is greater than the tax revenue raised. However, for the CGT rate increase (both alone and alongside base reform), the MVPFs are well below 1. Generally, the MVPFs associated with tax policy changes are above 1, because raising revenue creates distortions that lead to negative fiscal externalities (Hendren and Sprung-Keyser, 2020).[44] In this case, though, raising the capital gains tax rate actually reduces the distortions to the timing of income withdrawal and individuals' choice of legal form. This means that owner-managers willingness to pay for these lower rates rates is less than it costs the government to provide them. Another way to put this is that, if the government wants to transfer revenue to high-income owner-managers, there are much more efficient ways to do so.

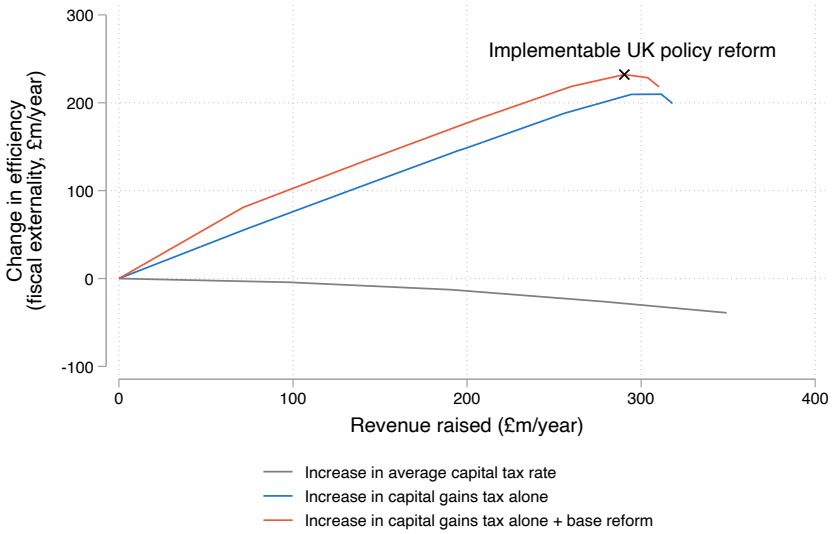
6.5 The equity-efficiency frontier

Above we use incremental changes to illustrate the mechanisms underpinning the differential impacts associated with changing different parts of the tax system. Here we show that these apply for larger changes, and discuss a specific package of reforms to the UK system that could be implemented in many other countries.

[44] An exception to this is Msall and Naess (2024) who study the removal of stepped-up basis at death in capital gains tax policy in Norway. They also find an MVPF below 1, driven by the fact that the policy creates big distortions to the timing of capital gains realizations.

Figure 6.2 traces out a measure of the efficiency cost of raising revenue (the fiscal externality) against the overall revenue raised from changing: (i) the average capital tax rate (grey line), (ii) the capital gains tax rate alone (blue line), and the (iii) capital gains tax rate alongside base reform that moves to a cash-flow tax or equivalent (red line). All three types of reform raise revenue in a progressive manner - see Figure E.3 - such that the lines illustrate the equity-efficiency trade-off associated with the reforms. The red and blue lines show that policy makers are not constrained to move along the grey line – the equity-efficiency frontier is much further out. We can improve the efficiency of the tax system by reducing tax differentials (as in the blue line, where tax rates on capital gains moves towards tax rates on income) and when the tax base is reformed to reduce or remove investment disincentives (as in the red line).

Figure 6.2: *Comparing the efficiency impacts of capital tax reforms*



Notes: The figure shows the changes in the fiscal externality against the change in tax revenue under increases in the taxes on capital income (ranging from 0.5pp to 2pp), and under increases in the CGT rate alone and the CGT rate accompanied by tax base reform (with the increases ranging from 2pp to 14pp).
Source: Model simulations.

The point denoted 'X' on the figure corresponds to a specific counterfactual UK policy. The preferential 10% capital gains tax rate for business owners ("Entrepreneurs Relief") is removed, such that gains on business assets are taxed at the same rate as other capital gains (20%) – which is still less than dividends for those with high incomes. At the same time, the disincentive to invest out of new equity is removed. Adam and Miller (2021) set out how this tax base reform could be achieved, in practice. One option is to provide individuals with what the authors termed a "Personal Shareholding Account". This would provide a cash-flow treatment for company owner-managers: money invested in a company could

be deducted, upfront, from personal income taxes, while any money withdrawn from the company would be taxed at the personal level. Taken together, these reforms would raise £290 million per year in revenue, which is approximately 7.5% of the annual revenue raised from capital gains tax over the period we study.[45]

There are limits to the benefits achieved by these particular reforms. As the capital gains tax rate approaches the tax rate on dividend income, it raises less and less revenue because much of the tax advantage to income shifting has been eliminated. This highlights the fact that after eliminating existing distortions to the type and timing of income and to investment incentives, there is a real trade-off between equity and efficiency that cannot be avoided. Nonetheless, our results highlight that the UK (and many other countries) tax systems are far from this point, and that there is significant value in addressing existing distortions. Our framework, which takes seriously both the policy instruments available to government, and the myriad of ways that people may respond to tax incentives, provides a means by which to trace out the equity and efficiency gains from different reforms.

7 Summary and conclusions

In this paper we show that the details of tax policy design matter, and have first-order impacts on our understanding of the equity-efficiency trade-offs associated with reforms. We develop a new framework that focuses on the effects of rate and base reforms to existing systems, rather than what is the optimal capital tax rate under a set of assumptions about the base. The application to the taxation of owner-managers is important in its own right, and we study issues – preferential rates of capital gains tax and disincentives to invest out of new equity – that are extremely common. Our results speak to debates about the taxation of private business wealth. For example, in the US there have been calls for an annual wealth tax. Part of the motivation for this often relates to the large stock of retained earnings held in private companies and the apparent lack of political appetite to increase capital gains tax. This is, at least partly, driven by concerns about the effects on investment. Our paper sets out an approach to capital gains tax reform that both raises revenue from the top of the distribution and improves investment incentives.

Our findings have broader policy lessons. First, differentials between tax rates matter, especially in contexts where individuals can easily move between tax bases or shift income over time. This is not limited to changes in legal form or to shifts between labour and capital tax bases within business owner settings. For example, income shifting is also important in

[45] See Office for Budget Responsibility (2024). In 2013/14 the government collected £3.9bn from capital gains tax; the average annual amount collected over 2002 to 2014 is £3.7bn.

the context of saving in tax-deferred retirement vehicles, or in choosing between inter-vivos and at-death gifts. Our paper highlights the importance of accounting for the behavioural changes induced by tax differentials – which can reflect not only relabelling, but also real changes in behaviour – when evaluating tax reforms.

Second, the tax base is a crucial component of tax policy. The broad principal that we have emphasised – allowing the costs of investment to be fully deductible from all layers of tax to ensure productive efficiency – dates back to Diamond and Mirrlees (1971). Despite this, we know of no government that is neutral towards all types of investment (i.e. across asset type, legal form, source of funding). Even in the UK setting, in which there is *already* neutral treatment of most investments made by owner-managers at the business level and it is only at the personal level that distortions arise, there are significant efficiency gains to correcting these distortions. Doing so directly increases investment, and allows the government to raise more revenue by increasing tax rates on inframarginal investments. Our approach to modelling the tax base provides a tractable way to study other reforms, such as: a move to full deductions at the business level (as happened for some investments under the 2017 US Tax Cuts and Jobs Act); "bonus depreciation" allowances (Zwick and Mahon, 2017); investment subsidies (i.e. $\lambda > 1$), such as the UK's temporary "Super Deduction" .

Third, at some point, the "win-wins" such as those we identify in this paper will be exhausted, and policymakers will be left with real trade-offs between the equity benefits of raising rates and the efficiency costs of doing so. Evaluating this will depend on the government's social preferences and the value of foregone work. Some will favour higher capital tax rates for equity reasons (e.g. Stiglitz, 2012; Piketty, 2014) and others will favour lower rates, even at the expense of higher inequality, if, for example, the people or effort that are incentivised are thought to be important for growth. But our paper demonstrates that there is significant scope for policymakers to improve welfare before they have to face that trade-off, and if they assume that they are already at the equity-efficiency frontier, they will miss valuable reform options.

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Appendix

A Data

This paper uses administrative data from corporate and personal tax records provided by Her Majesty's Revenue and Customs (HMRC - the UK's 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 business owners is from the universe of self–assessment income tax records, available from 2000-01 to 2015-16. All company directors and those with self-employment income are required to submit a self-assessment tax return.[46] These data include information on the taxable incomes of the individuals, the source of that income (e.g. whether it is from salary, dividends or capital gains) and some basic demographic characteristics (age and gender). For the self-employed, it records information on business expenses, such as the use of capital allowances.

Company data

Information on the activities 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

[46] Not all UK adults are required to complete a self-assessment tax return. In addition to the self-employed and company directors, those with substantial dividend, property or foreign income and those with incomes above £100,000 are also required to do so. Around 9-10 millions do so each year, out of an adult population of 40 million.

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

corporate tax record is matched to company accounts for the same company with the same start and end date (i.e. in most cases companies file corporate tax records and company accounts that cover the same time period). Those tax records that do not match to company accounts are disproportionately likely to be in the first or last year a company is trading.

The UK tax year runs from April 6th to April 5th. Companies can choose to submit tax returns that cover any period of up to twelve months. In 10% of cases a tax return covers less than twelve months; in the majority of these cases, this is the first or last year a company is trading. Of the remaining 12 month accounts, around 25% begin in April. Table A.1 sets out the information provided on the number of directors and number of shareholders for companies that file accounts covering 12 months at least once between April 6th 2012 and April 5th 2015. In 2% of cases information on the number of directors is missing and in 23% of cases the number of shareholders is missing. Miller, Pope, and Smith (2024) show that those with missing shareholder information are disproportionately younger, lower income 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 small 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, Pope, and Smith (2024), 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 business income. This is because directors of companies with very low or negative business income are less likely to be successfully matched. Above £5000, the distribution of business income 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.

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 owner-managed businesses (defined as either self-employed or companies with two or fewer owners) interviewed over the period 2015 to 2017.

The survey asks businesses abour 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.

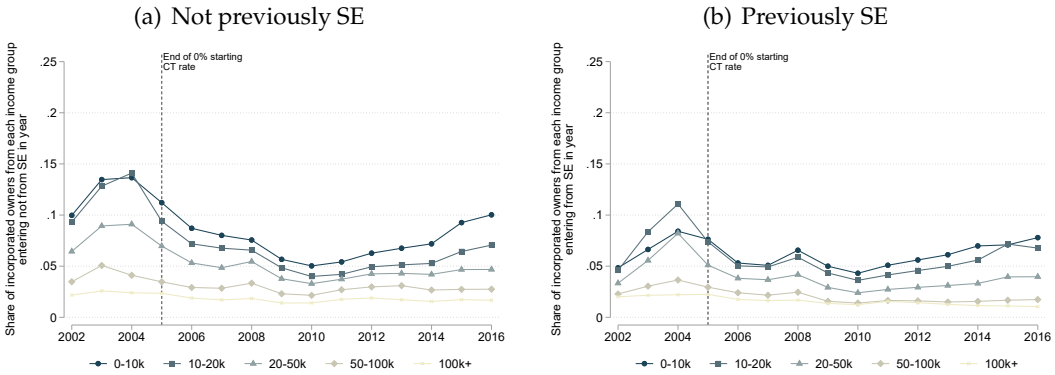
A.3 Additional tables and figures

Table A.3: *Top 10 industries*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	% of	% within		Median		Investment			
	business	industry		business income		Median		Mean	
	owners	SE	INC	SE	INC	SE	INC	SE	INC
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 owner-managers in each industry. Columns (2) and (3) show the percentage of owner-managers that are self-employed or incorporated within each industry. Columns (4) and (5) show the median annual business income for the self-employed and incorporated within each industry. Columns (6)-(9) show the median and mean annual investment spending for the self-employed and incorporated. All statistics are computed for 2014.
Source: Authors' calculations using HMRC administrative datasets.

Figure A.1: *Incorporation rates, 2001-16*



Notes: The left hand panel shows the share of incorporated owners 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 A.2: *Entry of owner-managed businesses, 2002-16*

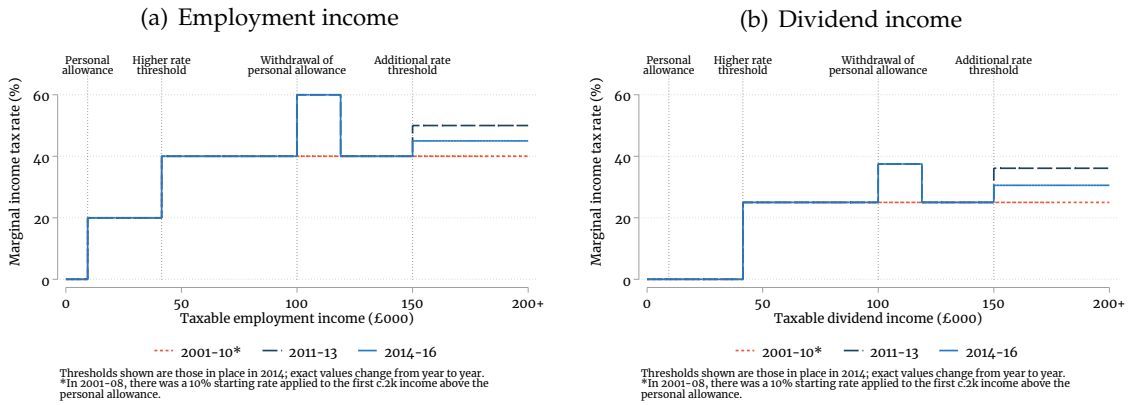
Notes: The red line shows the number of new owner-managed businesses as a fraction of the previous year's total. The blue line shows the number of new owner-managed businesses minus the number of exiting businesses as a fraction of the previous year's total.
Source: Authors' calculations using HMRC administrative datasets.

B Tax system

B.1 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 capital gains, corporate, and personal income tax systems respectively. Figure B.1 illustrates the marginal tax rates schedules for employment and dividend income over the period we study.

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 Table B.3.

Table B.1: *Statutory capital gains thresholds and rates*

(1) Tax year	(2) Capital gains allowance (£)	(3) Marginal rate (%) if taxable income is:	
		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.

Table B.2: *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.3: *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 (including social security contributions) 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).

B.2 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 small 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 owner-managed businesses would have been able to claim a 50% first year allowance for all of their plant and machinery investments, meaning that half of the expenditure could be deducted in the calculation of corporate profit in the year the investment was made, while the remainder would be deducted on a declining balance basis (25%). As an example, for an investment of £100, £50 would be deducted in the first year, £12.50 in the second year (25% of £50), £9.38 (25% of £37.50) in the third year and so on.

C Additional details on clustering

We use a two-step procedure, following Bonhomme et al. (2022), 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 business income, and (ii) business owners' average annual investment as a share of average annual business income. These variables are tightly related to the parameters that govern the productivity process and income 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 business income and mean investment as a share of mean business income. Each individual's average is calculated over the time that he/she is in the sample.

C.2 Number of clusters

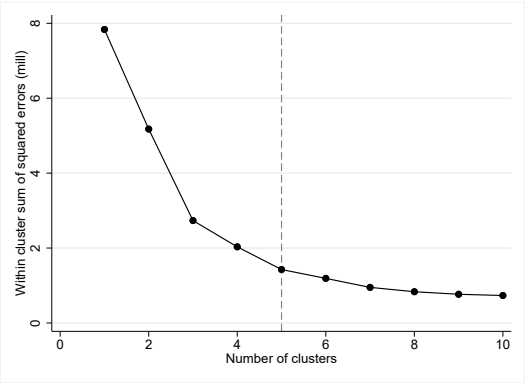
In order to select the number of clusters we use heuristic methods. Our goal is to approximate the heterogeneity, while limiting the total number of clusters.

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.

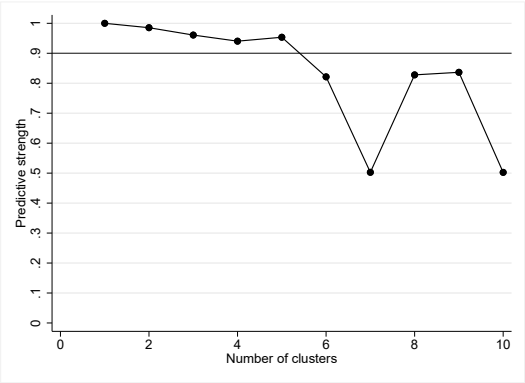
The second method we use is based on predictive strength, as suggested by Tibshirani and Walther (2005). The basic idea of this approach is to: (i) cluster the test data set into K clusters, (ii) cluster the training data into K clusters, and then (iii) measure how well the training set cluster predicts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

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 administrative datasets.

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.

C.3 Distributions within latent types

Figures C.2 and C.3 show the marginal distributions of mean business income, and mean investment as a share of mean business income, within each latent type (referred to as clusters above). These are the variables on which we cluster. The types are ordered by the mean income levels, with type I having the lowest income levels, and type V the highest. For types I, IV and V there is a mass point at zero investment as a share of business income, and for all these types, investment is relatively low. Types II and III do the most investment, as a share of business income, with the average investment as a share of business income equal to 0.20 for type II and 0.54 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.

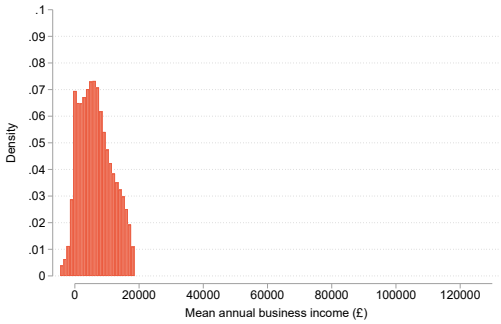
Table C.1: *Industry distribution by type*

	% 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

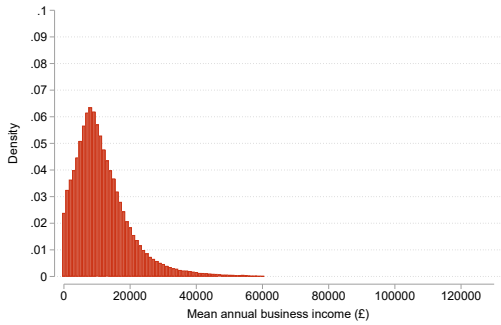
Notes: Each column shows the distribution of business owners within each type across the top 10 industries.
Source: Authors' calculations using HMRC administrative datasets.

Figure C.2: *Distributions of mean business income by type*

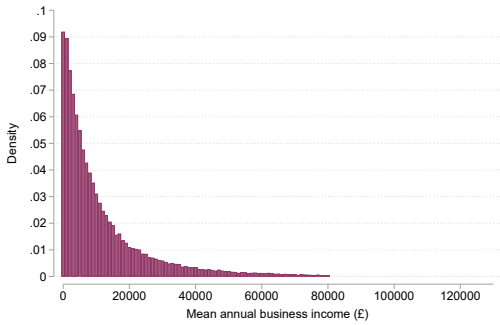
(a) Type I



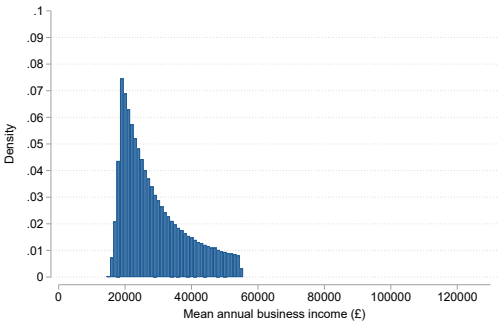
(b) Type II



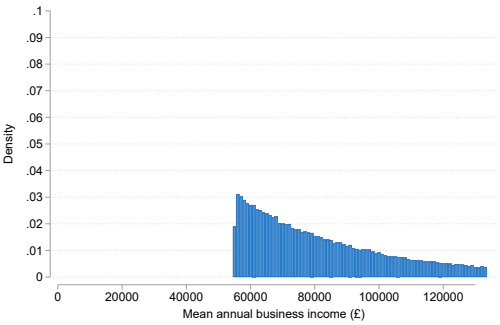
(c) Type III



(d) Type IV



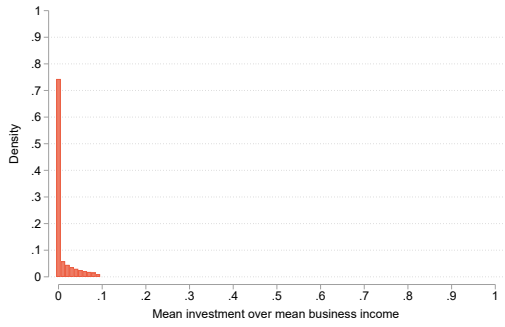
(e) Type V



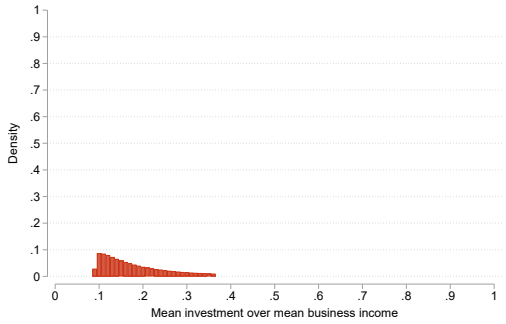
Notes: Each panel shows the distribution of mean business income by the different latent types.
Source: Authors calculations using HMRC administrative datasets.

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

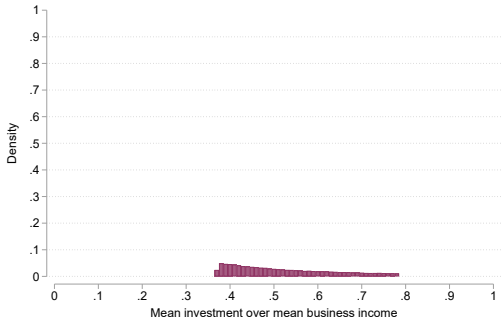
(a) Type I



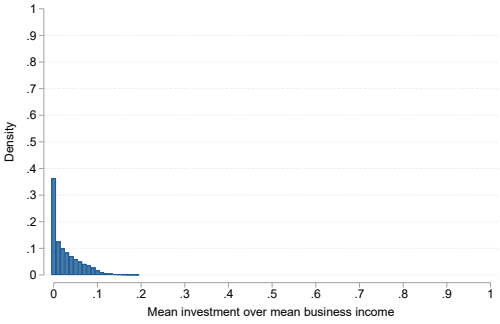
(b) Type II



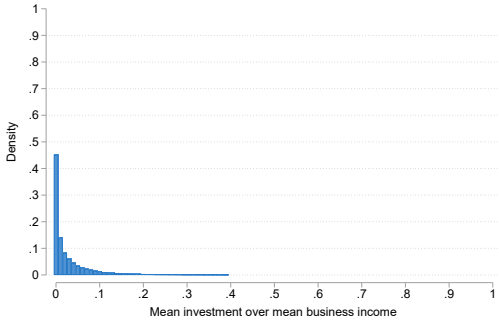
(c) Type III



(d) Type IV



(e) Type V



Notes: Each panel shows the distribution of mean investment as a share of mean business income by the different latent types.
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), capital investment, and labour supply, conditional on the choice of legal form next period.

We then calculate the expected value of choosing the different legal forms next period, and maximise over this choice.

D.1 Details on taxation in the model

Tax liability depends on the individual's legal form. The incomes of incorporated owner-managers are subject to both corporate and personal income taxes, while the self-employed and employees pay only personal income taxes (including social security contributions).

Corporate tax. Taxable corporate profit (i.e. the corporate tax base), π_{it}, is equal to the business income of the owner-manager (before netting off capital costs), minus any salary the owner pays themselves, $\tilde{y}_{it}$,[48] and allowable deductions for capital spending:

$$\pi_{it} = \tilde{z}_{it} - \tilde{y}_{it} - \lambda^{INC,c}\delta k_{it}. \tag{D.1}$$

The parameter $\lambda^{INC,c}$ governs the deductibility of capital spending. In our setting, $\lambda^{INC,c} = 1$, i.e. capital spending can be fully deducted , which means that there is no tax on marginal investments at the corporate level. Corporate tax liability is denoted by the piecewise linear function, $\mathcal{T}^c(\pi_{it})$.

Personal tax. The definition of personal taxable income (i.e. the personal tax base) depends on an individual's legal form. For employees, it is simply equal to their income, $y_{it} = z_{it}$.

For the self-employed, it is equal to their business income (before netting off capital costs) minus allowable deductions for capital spending:

$$y_{it} = \tilde{z}_{it} - \lambda^{SE}\delta k_{it} \quad \text{if} \quad d_{it} = SE. \tag{D.2}$$

λ^{SE} governs the deductibility of capital spending for the self-employed. As for corporate tax, in our setting, $\lambda^{SE} = 1$, which means that capital spending can be fully deducted such that there is no tax on marginal investments.

An incorporated owner-manager's personal taxable income is equal to their business income (net of capital costs) minus: (i) corporate tax liability; (ii) any retained profits (which will be positive when income earned in a year is retained in a company and negative when profits from previous years are withdrawn); (iii) deductions for new equity injections:

$$y_{it} = z_{it} - \mathcal{T}^c(\pi_{it}) - (s^c_{it} - \tilde{k}_{it}) - \lambda^{INC,p}\tilde{k}_{it} \quad \text{if} \quad d_{it} = INC. \tag{D.3}$$

[48] If an incorporated owner wishes to withdraw y_{it} from his company, the tax-efficient way to do this is take a fixed salary equal to $\tilde{y}_{it} = \min(y_{it}, \underline{y})$, where $\underline{y}$ denotes the point at which personal taxes are levied, and the rest as dividends or capital gains.

$\lambda^{INC,p}$ governs the deductibility of new equity injections from personal tax.[49] In our setting, $\lambda^{INC,p} = 0$: new equity injections are *not* deductible from personal tax, such that marginal investments funded in this way are taxed (even when this is a full deduction for investment costs at the corporate level).

Personal tax liability is given by the piecewise linear function, $\mathcal{T}^p(y_{it}, d_{it}, d_{it+1})$. The rates (left implicit) depend on legal form this period, d_{it}, and on the choice of legal form next period, d_{it+1}. Dependence on next period's legal form choice is because incorporated owner-managers who are exiting have their income taxed as capital gains, while those continuing as owner-managers face the dividend tax rates.

D.2 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 incorporated, 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, the fixed cost associated with starting a business, and the fixed cost associated with incorporation. Total assets are placed on a grid with 22 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 5 points. The log of individual's latent productivity is placed on a grid with 4 elements using the method of Adda and Cooper (2003).[50] 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 start-up and incorporation fixed costs are assumed to be normally distributed, and we place these on grids with 4 points using the Adda and Cooper (2003) method.

[49] This treatment effectively allows investment financed through new equity to be deducted from personal tax by providing an upfront deduction for new equity injections. An alternative policy that could achieve the same effect is a rate of return allowance, which can be thought of as a stream of deductions 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).

[50] 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.

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 iteratively search over next period's share of assets held in the company using a grid with 4 points, such that the intervals on the final grid equal 0.008. Total assets next period, capital investment and labour supply are not placed on a grid; instead individuals can choose any feasible combination of these variables.

D.3 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 incorporated owners, 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: legal form next period, d', and the share of assets held in the company next period, $\tilde{a}^{c'}$.

The Euler equation is:

$$u_c(c,l) \geq \beta \mathbb{E}\left[\frac{\partial}{\partial a'}\left(V(\Omega'|\Omega, a', \tilde{a}^{c'}, d')\mathbb{1}_{age<60} + V^T(a')\mathbb{1}_{age=60}\right)\right]. \tag{D.4}$$

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

Optimal choice of k. The first order condition for the choice of k is given by $\frac{\partial U}{\partial c}\frac{\partial c}{\partial k} = 0$, which is an intratemporal decision (conditional on intertemporal optimization). This is because we have ruled out non-convex adjustment costs in capital. Taking the derivative of

c with respect to k, we have:

$$\frac{\partial c}{\partial k} = \frac{\partial z}{\partial k}(1-\tau_c)(1-\tau_p) + \tau_p(\lambda^{OM,p}-1)\frac{\partial \tilde{k}}{\partial k} = 0. \tag{D.5}$$

Substituting in the expression for the marginal product of capital ($\frac{\partial z}{\partial k} = \theta\omega h^{1-\theta}k^{\theta-1} - \delta$) and rearranging yields the expression for the interior choice of capital, k^*, in equation (4.6). Employees (and business owners in type I, for which we set $\theta = 0$) simply set $k = 0$.

Optimal choice of l. The first order condition for the choice of l is also an intratemporal one, and given by:

$$c^{-\nu_c}\left[\frac{\partial z}{\partial l}(1-\tau_c)(1-\tau_p)\right] + \chi l^{-\nu_l} = 0$$

where $\frac{\partial z}{\partial l} = -\omega\alpha h^{-\theta}k^{\theta}$. By substituting in this, and the expression for optimal k derived above (which depends on h) we recover a non-linear equation for the optimal choice of l. In the solution algorithm, we pre-solve for this optimal choice of l, for a fine grid over c, ω, and the range of marginal tax rates, τ_c and τ_p. In each step of the backward induction, we interpolate over c and ω, conditional on the marginal tax rates, to recover the optimal l. We then use this value of l to recover the optimal choice of k, as described above. We use a similar approach to solve both for the implied choice of l when individuals locate at kinks in the tax schedule and when they are liquidity constrained, but in these cases, we exploit the budget constraint rather than the first order condition for leisure.

Optimal choice of a'. The steps above recover the optimal c, k and l, associated with a given level of assets tomorrow, a'. We then recover the *implied* value of assets today, a, that is consistent with these choices. This is given by rearranging 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 denote these optimal conditional policy functions: $c(\Omega|d', \tilde{a}^{c'})$, $l(\Omega|d', \tilde{a}^{c'}, mtr)$, $a'(\Omega|d', \tilde{a}^{c'}, mtr)$ and conditional value function $V(\Omega|d', \tilde{a}^{c'}, mtr)$. 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 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 taxable corporate profit, $\pi(\Omega|d', \tilde{a}^{c'}, mtr)$, and personal taxable income, $y(\Omega|d', \tilde{a}^{c'}, mtr)$, 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 $y_{0.2} = y(\Omega|d', \tilde{a}^{c'}, mtr = 0.2)$ denote the implied taxable income when leisure is chosen given a marginal tax rate of 0.2, and analogously for $y_{0.4} = y(\Omega|d', \tilde{a}^{c'}, mtr = 0.4)$. 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, and the choice of legal form next period e.g. $c(\Omega|d', \tilde{a}^{c'})$.

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:

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

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 trivial (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, $V(\Omega|d')$, 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:

$$\max_{d' \in \mathcal{D}_d} V(\Omega|d') + \zeta_{d'} \tag{D.6}$$

$$\Rightarrow V(\Omega) = \mathbb{E}_\zeta \left[\max_{d' \in \mathcal{D}_d} V(\Omega|d') + \zeta_{d'} \right] = \gamma + \ln \left[\sum_{d' \in \mathcal{D}_d} e^{V(\Omega|d')/\sigma_\zeta} \right]. \tag{D.7}$$

The inclusion of 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.

D.4 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 additional rate threshold (£150,000). The rates at each segment of the tax system vary across employees, self-employed, and owner-managers. Incorporated owners 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 incorporated owners. We explicitly account for these when we solve the agent's problem (described above). Self-employed business owners can deduct the cost of capital from their mixed income, 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.5 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 incorporated owners. The draws for productivity, incorporation and start-up costs are drawn from their estimated distributions using Monte Carlo methods. Finally, the share of business owners that are incorporated in the first year is estimated in the MSM stage; this is pinned down by the share of incorporated businesses in the first year of our data.

Given the agents' state variables, the optimal choices are calculated from the first year of observation and then solved forward. Conditioning on the choice of legal form next period, we first 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 incorporated owners) share of assets held in the company next period. This allows agents to locate exactly at kinks in the tax schedule. We then calculate the implied value associated with each choice of legal form next period and take the maximum over these. Agents are simulated through the three different tax regimes; the movement between regimes is unexpected in each case.

E Additional estimation details

E.1 Depreciation rate

We estimate the depreciation of capital experienced by owner-managed 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 Method of simulated moments

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:

$$\hat{\theta}_j = \arg\min G_j(\theta_j)' W_j G_j(\theta_j) \tag{E.2}$$

$$\text{where } \theta_j = (\beta, \nu_L, \sigma_\zeta, \varsigma_o, \{F_m^{start}, F_{d=OM}^{start}, F_m^{inc}, F_{sd}, \mu_\psi, \sigma_\psi, \sigma_\epsilon, \rho, \theta, \varsigma_{OM}\}_j) \tag{E.3}$$

where ς_{OM} governs the share of business owners who are owner-managers in the first year of the simulated data, 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 inverse of the moments in the data squared, which converts the moments into percentage deviations.

The GMM objective function for dynamic models of the type featured here may have multiple local minima and no analytic derivatives. In practice, parameters estimated using the method of simulated moments 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 multiple steps. We adapt this to account for the fact that a large set of the parameters are type-specific, and therefore only affect the model fit for that type, conditional on the common parameters.

In the first step, we fix the values of the common parameters, $\beta, \nu_L, \sigma_\zeta, \zeta_o$, and draw 1000 candidate vectors for the type-specific parameters, $(F_m^{start}, F_{d=OM}^{start}, F_m^{inc}, F_{sd}, \mu_\psi, \sigma_\psi, \sigma_\epsilon, \rho, \theta, \varsigma_{OM})$, for each of the five types. These 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 using only the moments *for each type*, at each of the parameter vectors. We use the 1% with the smallest value of the objective function to generate a new hypercube on the parameter space for each type. We compute another 5×1000 candidate parameter vectors using these new bounds, and iterate on this procedure three times.

In the second step, we use the best parameter values for each type as starting values for a custom surrogate line search, similar to that used in Balke and Lamadon (2022). We

take 8 points in each dimension of the parameter space (including the common parameters), centered around the starting values, and evaluate the value of the objective function in each case. We fit a smoothing spline across these points for each parameter and use this to infer the value of the parameter that yields the minimum value of the objective function. We update the parameter that yields the biggest improvement on the objective function. We iterate until the improvement in the objective functions is below some tolerance.

We parallelize the evaluations of the candidate parameter vectors 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 (using a five-point stencil) to calculate the Jacobian of the moment conditions with respect to the parameters.

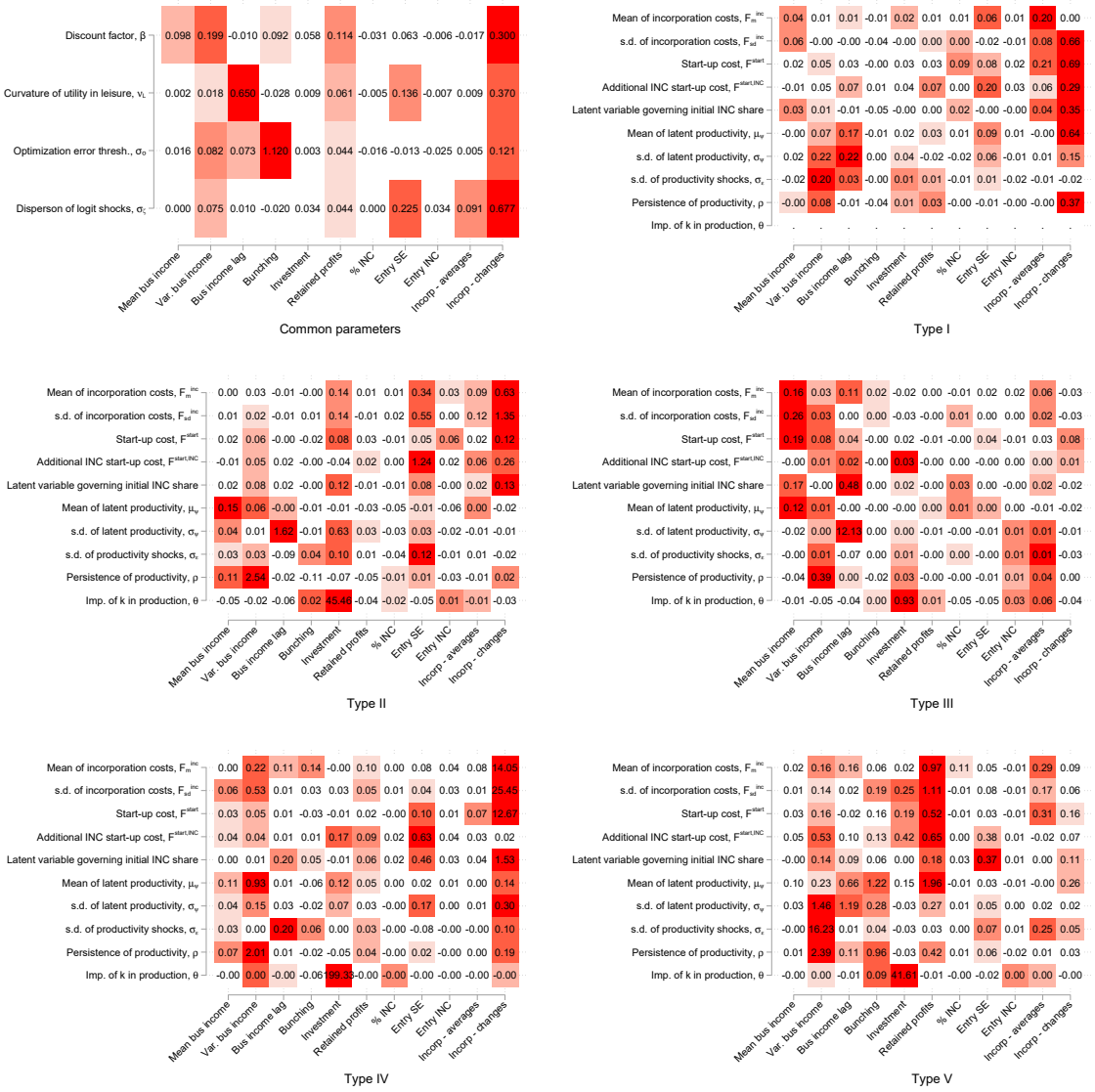
E.3 Moment informativeness

We calculate measures 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 scale this by the number of moments in each set). We compute the change in the asymptotic variance of each parameter for eleven sets of parameters: (i) mean business income of the self-employed and owner-managers; (ii) business income variance measures; (iii) correlation between business income and its lag; (iv) excess bunching mass; (v) investment as a share of mean business income; (vi) retained business income; (vii) share of business owners who are OM; (viii) entry by the self-employed; (ix) entry by owner-managers; (x) incorporation rates on average; (xi) incorporation rate changes over the 0% starting rate of CT.

Figure E.1 shows the measures for the common and type-specific parameters. A higher value indicates the set of moments is more informative for that parameter – darker reds highlight more informative set of moments for each parameter. The numbers indicate the fact that the moments jointly identify the model parameters, but some patterns do stand out. Incorporation and entry rates are relatively more important for the switching costs and dispersion of the logit shocks. The investment moments are crucial for pinning down the θs. The business income moments are generally more informative about the parameters governing the productivity process.

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

Figure E.1: *Moment informativeness*

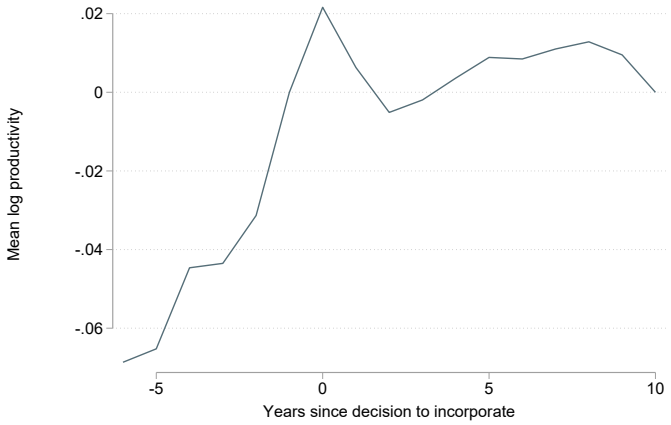


Notes: The number in the (j,k) cell shows the change in the asympotic variance of parameter j when the set of moments k are removed, relative to the baseline asympotic variance when all moments are included. The dark (medium, light) red cells indicate the most informative set of moments for each parameter.

E.4 Model properties

Figure E.2 shows the deviations in log productivity around the point business owners choose to incorporate.

Figure E.2: *Productivity around incorporation*



Notes: We plot mean log productivity (controlling for individual fixed effects) around the age at which the business owner chooses to incorporate across types II-V, since type I has such low rates of incorporation.
Source: Model simulations.

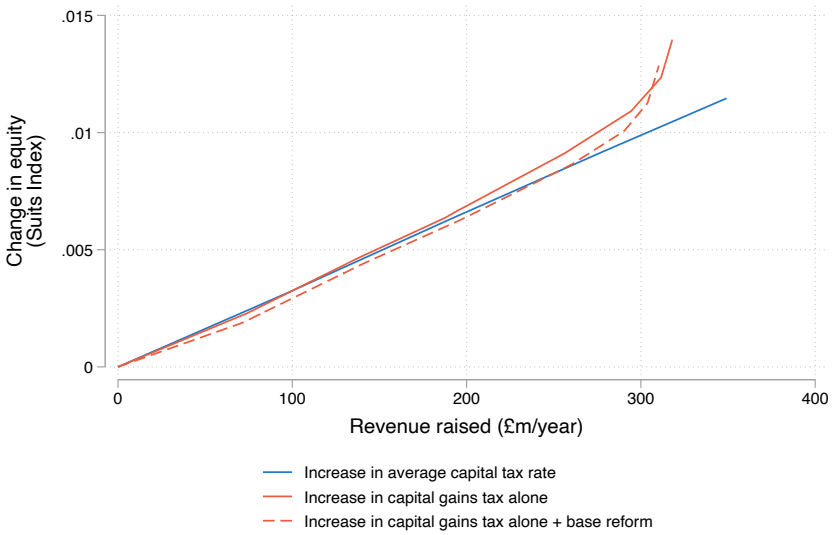
Table E.1: *Capital constraints by type*

	% businesses that are capital constrained	% businesses that are constrained due to insufficient company assets
I	0.0	0.0
II	2.5	0.1
III	14.6	2.3
IV	0.3	0.0
V	4.4	3.9

Notes: Business owners are defined to be capital constrained if their marginal product of capital exceeds the depreciation cost – the shares of business owner-years that suffer from this within each type are shown in the first column. The second column shows the share of business owner-years that are capital constrained and have total assets above £5000 but with less than 10% held in the company, and have a non-zero personal tax rate.
Source: Authors' calculations using HMRC administrative datasets.

E.5 Additional counterfactual results

Figure E.3: *Comparing the equity impacts of capital tax reforms*



Notes: The figure shows the the Suits index against the change in tax revenue under increases in the taxes on capital income (ranging from 0.5pp to 2pp), and under increases in the CGT rate alone and the CGT rate accompanied by tax base reform (with the increases ranging from 2pp to 14pp).
Source: Model simulations.