Taxing Owner-Managers: The Equity and Efficiency Gains from Reform

Kate Smith and Helen Miller*

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Abstract

We develop a dynamic model of business owner-managership to study the equity and efficiency effects of capital tax reforms. We model owner-managers' choices in a rich tax 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. However, this ignores tax rate differentials 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 return 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 discouraging marginal investments.

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*Smith is at the London School of Economics and the Institute for Fiscal Studies; Miller is at the Institute for Fiscal Studies. **Correspondence**: k.e.smith2@lse.ac.uk and helen_m@ifs.org.uk.

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 returns are almost always taxed at lower rates than labour income. This approach 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) income shifting and (ii) investment disincentives that arise from the design of the tax base i.e. the definition of taxable income and gains.

In this paper, we develop an empirical dynamic model 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. Our main contribution is to show that there exist practically implementable reforms that raise revenue progressively *and* improve efficiency by (i) reducing income shifting 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 taxes, set at different rates. Typically, the tax rates on capital gains are lower than those on dividends, which are, in turn, lower than those on self-employed profits. This creates incentives for owner-managers to incorporate, disguise labour income as capital returns, and retain income within the firm. Policymakers also choose the definition of taxable income and gains through the design of capital allowances and other parts of the tax base, thereby determining investment incentives. Tax systems tend to disincentivise investments financed by new corporate equity, which is the main source of financing for closely-held businesses. Optimal tax models often abstract from these features, providing insights into the trade-offs that characterise optimal policy, but less direction on the impact of changes to existing tax systems. Our paper fills this gap by providing new quantitative evidence on the effects of reforms to systems that are far from optimal. Doing so requires us to quantitatively evaluate the size of various inefficiencies created by the tax system: reforms can improve some distortions, while exacerbating others. For example, increasing the capital gains tax rate reduces the incentive to shift income, but also discourages investment—which of these two effects dominates is an empirical question.

We develop a model of business owner-managership that captures key margins of behaviour and allows the study of policy-relevant counterfactuals. Heterogeneous individuals choose whether to start a business and its legal form; investment in productive capital and their own labour supply, which jointly determine profit; consumption and savings in personal and company assets. Owner-managers face productivity shocks and borrowing constraints, such that some invest inefficiently low amounts. 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, and various features of the tax base; (ii) income shifting and tax-motivated incorporation alongside business entry, investment and labour supply and (iii) the wide heterogeneity across owner-managers. To the best of our knowledge, we are the first to incorporate all three features in a structural model,[1] which is key to quantifying the effects of tax reforms. To make the problem tractable, we abstract from some features of firm dynamics—in a final section, we demonstrate the robustness of our findings.

We estimate the model using data on UK owner-managed businesses, linking administrative personal tax records to corporate tax records and company accounts. Although policymakers may want to target certain policies at, say, entrepreneurs or the returns to capital, these characteristics cannot be distinguished with tax rules (Gordon and Sarada, 2018).[2] In practice, owner-managers' observed characteristics are endogenous to the tax system,[3] and 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.

Policy reforms to personal and corporate taxes over our period of study create variation in incentives at both the intensive and extensive margins. Although it is well known that business owners respond to tax incentives by income shifting,[4] we know much less about its efficiency costs and how it is affected by non-marginal, counterfactual reforms to various parts of the tax system. Estimating the long-run elasticities needed to evaluate counterfactual

[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] 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.

[3] This creates issues with defining "entrepreneurial" businesses on the basis of characteristics such as incorporation (Levine and Rubinstein, 2017) or making a loss (Cullen and Gordon, 2007).

[4] 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.

reforms using reduced-form analysis alone is challenging (Sarin et al., 2021). We instead use evidence on how incomes, profits and legal form respond to tax changes to estimate and validate our structural model. Low tax rates on capital gains lead to substantial income shifting over time, which is captured by the model. 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. Another key dimension of our model is the choice of business legal form and its responsiveness to tax incentives—our model-implied estimates of the reduced-form elasticity of incorporation are line with the existing literature.

One of the main concerns of policymakers considering increases to capital taxes is that this will deter investment. There is an extensive literature studying how tax affects investment,[5] with a key lesson from this work being that it is the effective tax rate on *marginal* investments (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 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 model a wide variety of tax base parameters and choices, and 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). Although the existing literature finds that investments from retained equity are not affected by personal taxes, this is not the case for investments made out of new equity—a key source of finance for closely-held businesses.

Our framework allows us to quantify the relative magnitude of different distortions created by the tax system, and thus the efficiency effects of counterfactual reforms. 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 reforms. First, a small increase to the headline personal tax rates on all forms of business income (akin to considering an increase in 'the' capital tax rate) raises revenue progressively, but reduces efficiency by discouraging investment and business owners' labour supply.[6] This is consistent with the existing literature, and suggests that policymakers face an equity-efficiency trade-off when raising capital taxes.

However, 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.

[5] 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).

[6] 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.

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. There is less incentive for individuals to incur incorporation costs and defer consumption purely to reduce their tax burden. This means that overall efficiency improves, with the revenue raised significantly outweighing the amount that it would cost to lump-sum compensate individuals. It is nonetheless important to emphasise that this reform still leads to significant declines in investment for some businesses.

Our third reform demonstrates that even larger efficiency gains are possible when increases in the capital gains tax rate are combined with tax base reform. Removing the disincentive to invest using new equity leads to increases in investment and the entry of high-investment business types, despite the higher headline capital gains tax rate. The key insight is that 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. This broad principal—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, funding source). Even in the UK, where 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 large efficiency gains to correcting these distortions.

In order to make our model computationally tractable, we abstract from various other features of firm dynamics. We use additional simulations to show that our results are robust to allowing for incorporated owner-managers to face lower costs of financing investment and for asymmetry in the tax treatment of losses across legal forms. We also discuss how other channels, such as investment in intangible assets and spillovers from innovation could affect our conclusions. We would require the social benefits from innovation to primarily arise from owner-managers' labour, and to be substantially larger than has been estimated in the existing literature, to overturn our result that capital gains tax rises alongside base reform improves efficiency. Ultimately, our findings suggest that reforms along the lines we suggest could improve equity and efficiency 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. Extending our framework to account for positive spillovers, entrepreneurial learning and risk-taking is a promising avenue for future work, as it would allow for a greater understanding of the nature of market failures that affect owner-managed businesses and the best way for policy to target them.

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.[7] 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 many of the reforms that are central to policy debates. We show that exercises that vary the average capital tax rate can be a misleading guide to the impact of other policies e.g. this would lead a policymaker to conclude that raising the capital gains tax rate comes at an efficiency cost. Our results highlight that in systems with preferential capital gains tax rates, accounting for the gains from reducing income shifting more than outweighs the distortions to investment, such that efficiency actually rises.

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).[8] Although this can accommodate richer features of the policy environment, a challenge for this approach is 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 insights from 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.[9] We provide quantitative evidence on the benefits of such reforms.

In the next section we describe the taxation of owner-managed businesses, and in Section 3 set out our dynamic model of business ownership. Sections 4 and 5 present our data and tax variation and model estimates. Section 6 contains our analysis of counterfactual tax reforms and implications for equity, efficiency and other aspects of firm behaviour. A final section concludes, with an Online Appendix providing further detail.

[7] 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.

[8] A nice example of this is Piketty et al. (2014), who characterise the optimal top labour tax rate as a function of the elasticities of labour supply, tax avoidance, and compensation bargaining. They also emphasise that the optimal tax system should be designed to minimize tax-avoidance opportunities through a combination of tax enforcement, base broadening, and tax neutrality across income forms, which leaves only the real response of labour supply as the factor limiting top optimal tax rates.

[9] 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"). Here we outline the key features of the way that they are taxed, which motivates our modelling choices and counterfactual analysis. Although the specific details vary across countries, the key features we highlight below are common.

2.1 Tax rate differentials

Business owner-managers sit at the intersection of the personal and corporate tax systems and have significant scope to move between those systems. The variation in tax rates across types of income creates incentives to shift between bases. This, in turn, has implications for real decisions such as how much to invest, to work and to save.

Across legal form. Owner-managers choose the legal form of their business e.g. whether or not to incorporate. This has implications for how they are taxed: in general, incorporation tends to offer greater flexibility to shift income across tax bases, as well as access to lower tax rates on dividends and capital gains. Despite the tax advantages to incorporating—which have been growing over time (Zawisza et al., 2024)—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 and improved access to financing, 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.

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 company in the form of returns to capital i.e. dividends or capital gains. These "returns to capital" often reflect returns to the owner-managers' labour supply.[10] Income distributed as dividends or capital gains is first subject to corporation tax and then to personal taxes at the point that income is distributed to owners.[11] Dividends are almost always taxed at lower combined rates than salary income (Hourani et al., 2023). Unincorporated owner-managers (the self-employed) are subject to personal income taxes when income arises and have much less

[10]Some countries require that the salary portion of a shareholder's remuneration is a "reasonable compensation" of their labor input; however, these are often difficult to enforce. They do not apply in the UK.

[11]"Pass-through" taxation instead treats the profit of corporations as flowing directly to its owners. This applies to S-corporations in the US. The treatment of incorporated owner-managers in the UK is more similar to that of US C-corporation owners.

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.

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.[12] 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. 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.

2.2 Tax base and investment incentives

Much attention is paid to headline tax rates, but the definition of the tax base—what is subject to tax—is equally as important, particularly for determining investment incentives. To see this, it is helpful to think about the returns on investment consisting of the "normal" return that covers the cost of making an investment, and "excess" returns on top of this. An investment is profitable if the net-of-tax return covers the cost—"marginal" investments are defined as those that receive the normal rate of return. If the full costs of investment can be deducted from tax, then the net-of-tax return for marginal investments is unchanged, which means they still go ahead. Investments that make excess returns are also still profitable, because, although the net-of-tax return has been reduced, it still exceeds the cost.

In practice, there are many types of deductions that governments offer in relation to investment costs.[13] The specific and complex rules that dictate the tax base can be captured in a parsimonious way through λ, which denotes the net present value of all available allowances, accounting for all levels of tax. Practically, there are 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

[12] 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.

[13] One broad approach is cash-flow treatment (also referred to as "full expensing"), which allows the upfront financial outlay associated with an investment to be immediately deducted from taxable income (Meade Committee, 1978; Kay and King, 1990). Another approach is to provide streams of allowances (such as capital allowances that are (loosely) related to depreciation alongside deductions for debt interest payments). These can be designed in a way that is equivalent to full expensing— an An Allowance for Corporate Equity (ACE) does this for corporation tax (Bond, 2000; Devereux and Vella, 2020), while the equivalent for personal taxes is a Rate of Return Allowance (RRA) (Sørensen, 2005, 2007).

they are below 1, but there are cases when they are above 1, which effectively means that investment is subsidised.

An important feature of many tax systems is that investments made from *new* corporate equity are discouraged (i.e. $\lambda < 1$). This is because even when there is full expensing at the business level, there is often no deduction for the cost of this form of financing *at the personal level*. This is particularly relevant in our setting because new equity is a key source of financing for owner-managers.[14] Note that investments made out of retained equity are not discouraged by personal taxes (Zodrow, 1991). Conditional on funds being held within the company, the choice between productive investment and holding corporate cash is unaffected by personal taxes, because the same personal tax applies when the money is eventually withdrawn regardless of how it was deployed inside the company.

2.3 Tax reforms and their potential effects

We assess two main types of reforms to the taxation of business owner-managers, both motivated by the prescriptions of optimal tax theory (Mirrlees et al., 2011). First, reducing the tax rate differentials across income types, and second, the removal of investment disincentives created by the tax base. Features of the tax system interact: for example, preferential rates of capital gains tax increase the incentive to incorporate, which means more individuals are subject to the investment disincentives created by the design of the tax base. It is therefore important to model the combined effects of different policies.

The equity and efficiency effects of these reforms depend on the set of individuals targeted by the reform and how they respond. We consider four main sources of inefficiency: (i) changes in investment, (ii) changes in labour supply, (iii) changes to legal form (both business entry and incorporation), and (iv) distortions to the intertemporal allocation of consumption (retaining profits may necessitate deferring consumption). These choices are determined jointly and dynamically. We develop a model that allows for these main dimensions of response; however, this necessitates abstracting from others. We return to discuss the implications of this in Section 6.

3 A dynamic model of business ownership

In this section, we set out a dynamic model of business ownership motivated by our tax reforms of interest and the main ways that owner-managers may respond.

[14]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.

3.1 Decision-maker

The decision-making unit is an individual (i) who makes choices to maximise their utility over their life (time periods are years and indexed by t). We allow for heterogeneity across different types of individuals, which we index by j. We estimate type membership using a clustering approach (see Section 4.2). These types are determined before the start of working life and remain fixed. Below we make clear which parameters are common and which are allowed to vary across j.

3.2 Preferences

Individuals derive utility from consumption and leisure over their lifecycles, with a per-period utility function:

$$u(c_{it}, l_{it}) = \frac{c_{it}^{1-\nu_c} - 1}{1-\nu_c} + \chi \frac{l_{it}^{1-\nu_l} - 1}{1-\nu_l} \tag{3.1}$$

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.

3.3 Occupational legal forms

In each period of working life,[15] individuals can either become a business owner-manager 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, the returns they make from supplying labour and investing, and how they are taxed.

Start-up 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, $F_i^{start} \sim \mathcal{N}(F_{j,m}^{start}, F_{j,sd}^{start})$. 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 include 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 also assume that in order

[15]We model individuals between the ages of 30, with certain retirement at age 60. Over the remaining thirty years of life they consume their remaining assets and receive a state pension each year.

to start a business individuals must have a minimum level of assets, $\underline{a}_j^{start}$, which we allow to vary across the types.

Incorporation costs. 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, $F_i^{inc} \sim \mathcal{N}(F_{j,m}^{inc}, F_{j,sd}^{inc})$. This is a utility cost incurred when the agent moves from either employment or self-employment into incorporation. This could include costs associated with higher reporting or compliance requirements, in addition to any benefits from limited liability. In Section 6.5, we show robustness of our results to extending the model to account for two key differences between the legal forms: different financing costs and asymmetric tax treatment of losses.

Switching costs. We allow for i.i.d. preference shocks associated with switching between legal forms each period; the standard deviation of these switching costs is denoted by σ_j^{ζ}.

3.4 Income

Individuals' income is derived from their own labour supply, $h_{it} = L - l_{it}$ (L denotes the time endowment), and, for owner-managers, their capital investment in the business, k_{it}.

Investment. At the start of each period, owner-managers choose how much to invest in productive capital, k_{it}, which cannot exceed their total stock of assets. For incorporated owners, if investment is greater than the stock of company assets, a_{it}^c, they inject new equity from their personal assets into the company, denoted by $\tilde{k}_{it} = \max\{0, k_{it} - a_{it}^c\}$. We assume that capital depreciates at rate δ.[16] 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.[17]

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 AR(1)

[16]We can also interpret δ as including the implicit price of renting capital on the spot market. Under our timing convention, capital investment is a within-period decision: k is chosen, used in production, and the undepreciated portion $(1-\delta)k$ is returned to the asset stock, all within the period. The financial return r^c is earned between periods on end-of-period asset balances, which already reflect the resolved investment.

[17]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. 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.

stochastic component to productivity, η_{it}, which means that their productivity is uncertain:

$$\ln \omega_{it} = \begin{cases} \psi_i + \alpha_1 \text{age}_{it} + \alpha_2 \text{age}_{it}^2 + \eta_{it} & \text{if } d_{it} = SE, INC \\ \psi_i + \alpha_1 \text{age}_{it} + \alpha_2 \text{age}_{it}^2 & \text{if } d_{it} = EE \end{cases} \tag{3.2}$$

$$\text{with} \quad \eta_{it} = \phi_j \eta_{it-1} + \varepsilon_{it}, \quad \varepsilon_{it} \sim \mathcal{N}(0, \sigma_{j,\epsilon}^2), |\phi_j| < 1. \tag{3.3}$$

Mixed business income. Income from being an owner-manager is:

$$\tilde{z}_{it} = \omega_{it} h_{it}^{1-\theta_j} \left(\max\{1, k_{it}\}\right)^{\theta_j} \tag{3.4}$$

$$z_{it} = \tilde{z}_{it} - \delta k_{it}. \tag{3.5}$$

θ_j governs the importance of capital, relative to labour, in production, and is allowed to vary across types.[18] $\tilde{z}_{it}$ 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. 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.

Income when employed. For individuals not running a business (i.e. in salaried employment), we assume that they receive log wage equal to their latent productivity plus the age trend.[19] Their income is equal to the number of hours they choose to work times their wage, $z_{it} = h_{it} \exp(\psi_i + \alpha_1 \text{age}_{it} + \alpha_2 \text{age}_{it}^2)$.

3.5 Tax system

Here we summarise the details of how we model the key features of the tax system, as outlined in Section 2. See Appendix D for details of how we model the piecewise linear structure of each of the taxes, as well as the deductibility of investment spending.

Variation in 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

[18] We take the max over 1 and k_{it} to allow for the fact that some business owners make zero capital investments and generate income solely through supplying their own labour.

[19] 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 present value of the wages that the agent could earn are instead absorbed into the upfront start-up costs, F_i^{start}, though this means these unobserved wage differentials do not dynamically impact subsequent exit decisions.

tax liability, $\mathcal{T}^p(y_{it}, d_{it}, d_{it+1})$, depends on their personal taxable income, y_{it} and their legal form this period, d_{it} (as well as their legal form next period, d_{it+1}, see below for explanation). 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; see Figure A.2, which illustrates how these differentials vary across the income distribution.

Variation in rates across the business lifecycle. 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 A.2), 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 with incomes above y^{HRT}, on average, to retain 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.

3.6 Savings and consumption

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}. The self-employed and employees hold only personal assets i.e. $a^c_{it} = 0$. Individuals choose how much to save: all individuals can save in a personal asset, s^p_{it}, with incorporated owner-managers able to retain profits by saving in their company asset, s^c_{it}. Consumption is given by:

$$c_{it} = \begin{cases} z_{it} - s^c_{it} - \mathcal{T}^c(\pi_{it}) & -\mathcal{T}^p(y_{it}, d_{it}, d_{it+1}) - s^p_{it} \quad \text{if} \quad d_{it} = INC \\ z_{it} & -\mathcal{T}^p(y_{it}, d_{it}, d_{it+1}) - s^p_{it} \quad \text{if} \quad d_{it} = SE, EE. \end{cases} \tag{3.6}$$

Assets held in personal accounts and company accounts attract rates of return, r^p and r^c, respectively, and evolve as follows:[20]

$$a^p_{it+1} = (1 + r^p)(s^p_{it} + a^p_{it}) \tag{3.7}$$

$$a^c_{it+1} = (1 + r^c)(s^c_{it} + a^c_{it}). \tag{3.8}$$

We rule out borrowing by imposing $s^p_{it} \geq -a^p_{it}$ and $s^c_{it} \geq -a^c_{it}$. The restriction that business owners cannot use uncollaterized debt to finance investment is motivated by the fact that most owner-managers use their own funds to finance their business.[21]

3.7 Recursive formulation

Individuals make choices each period to maximise their expected utility over their remaining years of life. Here we state the recursive formulation of 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 this set by $\Omega = \{j, \text{age}, d, a, \tilde{a}^c, \psi, \eta, F^{inc}, F^{start}\}$.

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.

Intensive margin choices

The set of choices available to agents depends on their legal form, d. Individuals choose how many hours to work, $h = L - l$, either as an employee or in running their business. Owner-managers choose how much to invest in productive capital, k. 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':

$$V(\Omega|d') = \max_{k,l,a',\tilde{a}'_c} \left\{ u(c,l) + \beta \mathbb{E}\left[V(\Omega'|\Omega, a', \tilde{a}^{c'}, d')\right] \mathbb{1}_{age<60} + V^T(a')\mathbb{1}_{age=60} \right\} \tag{3.9}$$

subject to (3.1) – (3.6). The solution to this problem gives the policy functions for $k, l, a', \tilde{a}^{c'}$. For the self-employed and employees, $\tilde{a}^{c'} = 0$, and for employees, $k = 0$.

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

[21] Only 3% of new businesses started used a loan from a financial institution and 84% of owner-managed businesses have no debt (Wealth and Assets Survey). See also the statistics in footnote 14.

The optimal choice of capital is jointly determined with the choice of labour supply, and depends on an 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 owner-managers:

$$k^* = \left(\frac{\rho}{\theta \omega h^{1-\theta}}\right)^{1/(\theta-1)} \text{ where } \rho = \begin{cases} \delta \text{ if } k^* \leq a^c \\ \delta + \frac{\tau_p(1-\lambda^{INC,p})}{(1-\tau_c)(1-\tau_p)} \text{ if } k^* > a^c \end{cases} . \tag{3.10}$$

ρ is the *user cost of capital* i.e. marginal revenue product of capital at the optimal choice $\left(\frac{\partial \tilde{z}^*}{\partial k}\right)$. When the user cost equals the depreciation rate ($\rho = \delta$), then investment is not affected by tax. This is 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. This distortion is larger the higher the tax rate, τ_p.

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)). 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.

Extensive margin choices

The choice of legal form next period is then to $\max_{d' \in \mathcal{D}_d} V(\Omega|d') - F_{dd'} + \zeta_{d'}$, where $\mathcal{D}_d$ denotes the set of legal forms next period available to legal form d this period.[22] $F_{dd'}$ denotes the utility costs of moving from legal form d to d':

$$F_{dd'} = F^{start} \mathbb{1}_{d=EE, d'=\{SE,INC\}} + F^{inc} \mathbb{1}_{d=\{EE,SE\}, d'=INC}$$

We assume that $\zeta_{d'}$ is distributed type I iid extreme value, with variance σ_ζ^2. This allows us to apply the log-sum result of McFadden (1973) to integrate over these shocks:

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

[22] Based on empirical transition frequencies, we rule out direct moves from incorporation to self-employment i.e. $\mathcal{D}_{INC} = \{INC, EE\}$.

where γ is a constant of integration that differences out.

The decision to start a business is determined by the net-of-tax income an individual expects to make as a business owner, in addition to the other costs/benefits reflected in F^{start}. Business owner productivity is uncertain, with individuals only observing a noisy signal of what their productivity will be when they enter next period.[23] The decision to incorporate is affected by the net incorporation costs/benefits, F^{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, in turn, affects 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.

4 Data and estimation

We estimate the model using data on owner-managed businesses in the UK. This population 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.

4.1 Administrative data

We use data covering the period 2001–16 and focus on closely-held businesses that are run by one or two individuals.[24] 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). Companies with two or fewer shareholders account for 83% of closely held companies (defined as those with 5 or fewer shareholders), and 77% of fixed assets held by this group. We measure company ownership using information from company accounts in 2014—some of these companies could go on to attract more owners in future.

We combine information from three sources: personal tax records, corporate tax records, and company accounts. All business owners are required to submit a personal tax return, which contains 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

[23]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.

[24]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.

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 4.1 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. Further details on the data and match provided in Appendix B.

4.2 Types of owner-manager

Owner-managed businesses are 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. 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 all closely-held businesses and explicitly account for heterogeneity when analysing the effect of tax. We use a k-means clustering approach (Bonhomme et al., 2022) to classify owner-managers on the basis of their mean business income and mean investment as a share of mean business income, 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 the effects of policies on different subgroups of businesses. Crucially, this means that 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 apply to all business owners.

Table 4.2 summarises the five types of business that we identify. A substantial majority of owner-managers are low-income, primarily self-employed, that do minimal investment, such as domestic service workers (type I). At the other extreme are high income businesses 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) and are much more likely to be

Table 4.1: *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.

incorporated. Types II and III do the most investment, have wider distributions of mean business income and contain the largest fractions of businesses that are both high-growth and long-lived. Investment is correlated with innovative activity (McGrattan and Prescott, 2014; Griffith et al., 2006) and may also be limited by credit constraints—understanding how policy affects this margin of heterogeneity is therefore valuable. Although only around 10% of all owner-managers, it is therefore likely that types II and III contain many of the businesses that are targeted by policymakers.

Table 4.2: *Summary of types from clustering procedure*

(1) Type	(2) Description	(3) % of OMs	(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.

4.3 Tax variation

We exploit different sources of variation in tax incentives to help identify the model parameters and validate our estimates.

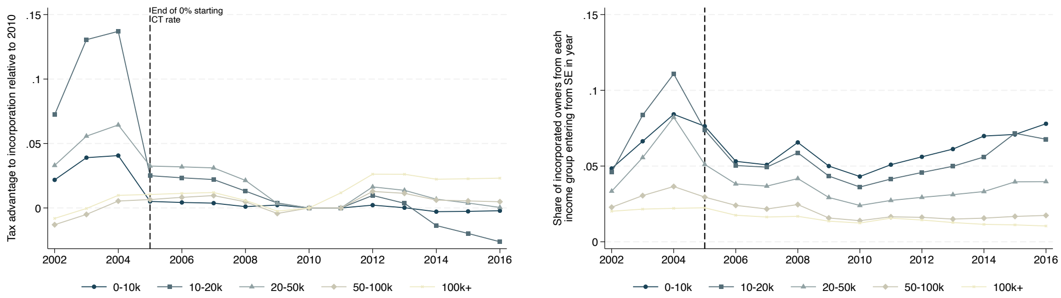
Across legal forms

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 owner-managers to incorporate.[25] Figure 4.1(b) shows that this led to a clear increase in switching from self-employment into incorporation 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.

[25] 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%).

Figure 4.1: *Responsiveness of incorporation decisions to tax differentials*

(a) Changes in the tax advantage to incorporation (b) Switching in legal form



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 switched from self-employment 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 A.

Across types of capital income

Owner-managers also face variation in tax rates from kinks in the progressive income tax schedule; for example, the marginal tax rate on dividend (self-employed) income increases by 25 (20) percentage points at the higher rate threshold (c. £40,000). Figure 4.2 illustrates bunching in taxable income at this threshold for both incorporated and self-employed owner-managers.[26] The excess mass is larger for incorporated business owners because they can more easily shift from dividend income (which is subject to an increased rate above the higher rate threshold) into capital gains (not subject to a higher rate) by retaining profits until the company is liquidated or sold.[27]

Miller, Pope, and Smith (2024) provide further analysis of this intertemporal income shifting by incorporated owner-managers. Around half of the bunching at the higher rate threshold is driven by short-term shifting to smooth income volatility, with the remainder driven by the systematic retention of profits within companies to take advantage of preferential capital gains tax treatment. Figure 4.3(a), reproduced from their paper, illustrates this: average annual retained profits increase significantly when business income exceeds the higher rate threshold. Half of incorporated owner-managers that make £150,000 in business income each year retain more than a third of this in their companies. Similar patterns

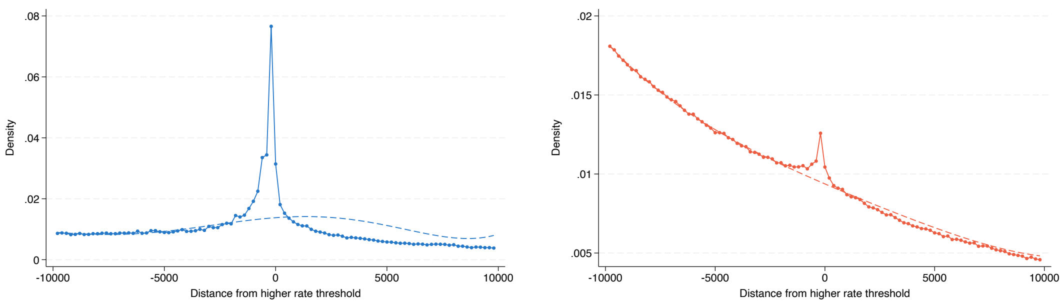
[26]We use the sample of business owners active in 2014 and the method developed by Chetty et al. (2011): we fit a flexible polynomial to the density, omitting a window either side of the threshold and imposing the constraint that the bunching mass comes from the right of the threshold.

[27]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)).

are evident when individuals face changes in their personal tax rates. Figure 4.3(b) (also reproduced from the original paper) shows that higher marginal tax rates on incomes above £100,000 after 2010 led to a large fall in the taxable income of the treated group. This is driven by increased retained profits, rather than a fall in business profit. Below we show that our estimated model can replicate these patterns.

Figure 4.2: *Bunching around tax thresholds*

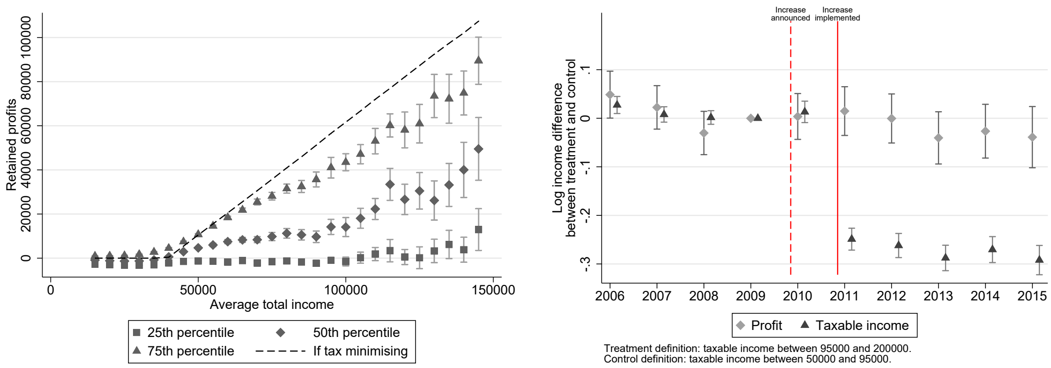
(a) Incorporated, HRT (c.£40,000) (b) Self-employed, HRT (c.£40,000)



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.

Figure 4.3: *Intertemporal income shifting*

(a) Retained profits (b) Increased top rates



Notes: The left hand panel reproduces Figure 5.6 from Miller, Pope, and Smith (2024). It shows the 25th, 50th and 75th percentiles of average annual retained profits for incorporated owner-managers, conditional on the average total income of their business (profit net of corporate tax). The right hand panel reproduces Figure 5.5(a) from Miller, Pope, and Smith (2024). It shows the estimated coefficients from a difference-in-differences specification that compares the profit and taxable income of treated (those with average pre-reform incomes between £95,000 and £200,000) and control (those with average pre-reform incomes between £50,000 and £95,000) incorporated owner-managers.
Source: Authors' calculations using HMRC administrative datasets and model simulations.

4.4 Calibrated parameters

We lack data on consumption and hours worked, so we set $\nu_c = 0.8$ and $\nu_l = 1.5$, informed by estimates from the existing literature—we shows sensitivity of our results to these parameters.[28] 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, $\mu_{j,\psi}$ 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). Since labour supply is endogenous, 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).

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). We set the minimum level of assets required to start a business, $\underline{a}_j^{start}$, to the 25th percentile of annual investment for each type—this ranges from £0 for type I to just over £1500 for type III. 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 2.08% (with the return net of tax given by $r_c = \tilde{r}_c(1 - \tau_c)$).[29] The leisure endowment, L, is 5840. Individuals receive a state pension equal to £5880 on retirement.

We parametrise, and solve the model for, three tax regimes. 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 place), 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 (see Appendix D). We set the optimization error threshold, ς_o, to 2% and discuss the sensitivity of our results to this below.

4.5 Moment conditions and identification

We estimate the remaining parameters using the method of simulated moments. We have a total of 60 parameters and 137 moments. We allow for heterogeneity in the model parameters across the five business types, with the exception of the discount factor. The parameters are jointly identified, but here we describe the moments that help pin down each parameter (conditional on the values of the other parameters). In Appendix E, we conduct a series of

[28]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 (Holt and Laury, 2002, 2005; Harrison et al., 2005; Andersen et al., 2008). Attanasio et al. (2018) jointly estimate $\nu_c = 0.8$ and $\nu_L = 1.8$.

[29]These are the average returns on time deposits for households and private non-financial corporations over the period, estimated by the Bank of England. We assume individuals do not pay tax on personal savings, reflecting the wide access to tax-free savings vehicles such as ISAs.

moment informativeness tests to provide additional information on the variation in the data driving the parameter estimates.

Discount factor. We match the the 50th, 75th and 90th percentiles of retained profits for businesses with average business income above the higher rate threshold. This helps us pin down β: 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.

Start-up and incorporation costs. Entry rates of self-employed business owners each year help to pin down the mean and standard deviation of the start-up costs, $F_m^{start}, F_{sd}^{start}$. 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}^{inc}, 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 entry and 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 processes. 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 using the fact that the differences between the average incomes of incorporated versus unincorporated owner-managers is partly driven by dispersion in latent productivity, σ_ψ. 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.

4.6 Numerical procedure and estimation

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, see Appendix D. The GMM techniques that we use are standard, and are 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. All agents, including those simulated to be employees, are included in the counterfactual calculations. 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 (3) in Table 4.2).

5 Model estimates and validation

5.1 Parameter estimates

Table 5.1 presents the parameters estimated using the method of simulated moments. The top panel shows the estimates of the utility parameters. We estimate an annual discount factor, β, equal to 0.972, which is in line with estimates in the literature. The parameters that govern the start-up and incorporation costs are expressed in utils, so we convert these to a monetary annual equivalent to aid interpretation.[30] 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 costs of starting an unincorporated business is £3600, with a standard deviation of £5100. The median cost of incorporating is £5000, with a standard deviation of £4550. 9% of individuals in type V get positive benefits from incorporating. For the majority of individuals though, substantial incorporation costs are necessary to rationalise why many agents choose to remain self-employed when there are substantial tax savings to incorporating (as in Tazhitdinova (2020)).

The second 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, and particularly so for types II and III. We estimate θ between 0.01 (for type IV) and 0.12 for (type III). Capital and labour are complementary in

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

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.

Table 5.1: *Parameters estimated in the second stage*

		Type				
	Parameter	I	II	III	IV	V
Utility function						
Discount factor	β			0.972		
				(2.5e-04)		
Mean of start-up cost	F^{start}	17.12	36.65	46.26	35.96	42.68
		(6.3e-02)	(2.2e-01)	(1.6e-01)	(8.9e-02)	(2.3e-01)
Additional start-up cost for INC	$F^{start} \times d' = INC$	-3.56	-1.32	-1.20	-2.32	-3.22
		(1.5e-02)	(9.2e-02)	(1.3e-01)	(3.3e-02)	(6.0e-02)
Std. dev. of start-up costs	F^{start}_{sd}	8.24	15.18	19.82	18.63	15.69
		(5.0e-02)	(1.6e-01)	(8.9e-02)	(9.4e-02)	(3.1e-01)
Mean of incorporation costs	F^{inc}_{m}	43.94	39.81	45.26	48.30	20.05
		(4.1e-02)	(1.9e-01)	(4.4e-01)	(1.9e-01)	(1.9e-01)
Std. dev. of incorporation costs	F^{inc}_{sd}	13.55	14.78	23.68	21.53	12.19
		(1.0e-02)	(1.7e-01)	(3.3e-01)	(1.3e-01)	(1.6e-01)
Inverse of logit shock dispersion	$1/\sigma_{\zeta}$	0.34	0.37	0.32	0.31	0.49
		(5.7e-04)	(2.7e-03)	(3.8e-03)	(1.6e-03)	(4.5e-03)
Productivity and income function						
Mean of latent productivity	μ_{ψ}	0.88	1.51	0.80	2.45	3.33
		(1.2e-03)	(5.3e-03)	(8.5e-03)	(4.0e-03)	(3.2e-03)
Std. dev. of latent productivity	σ_{ψ}	0.52	0.44	0.64	0.29	0.37
		(1.5e-03)	(3.1e-03)	(6.8e-03)	(2.0e-03)	(4.0e-03)
Std. dev. of productivity shocks	σ_{ϵ}	0.29	0.31	0.54	0.18	0.18
		(1.6e-03)	(2.0e-03)	(2.5e-03)	(7.1e-04)	(2.2e-03)
Persistence of productivity	ϕ	0.48	0.51	0.38	0.50	0.59
		(1.2e-03)	(2.1e-03)	(3.7e-03)	(2.4e-03)	(4.4e-03)
Importance of capital in production	θ		0.04	0.12	0.01	0.01
		(.)	(3.8e-04)	(2.4e-03)	(2.1e-05)	(4.5e-05)
Initial conditions						
Business owner share in first year		0.25	0.26	0.34	0.32	0.31
		(1.1e-03)	(3.2e-03)	(8.6e-03)	(2.2e-03)	(4.6e-03)

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

5.2 Model fit and validation

Targeted moments

Tables 5.2 and 5.3 summarise the moments that are targeted in estimation. The model fits the key behavioural moments well, including investment as a share of profits, retained profit distributions, and incorporation responses to tax changes. There is more variation in the fit quality for income levels and dispersion across the types, particularly for Types II and III, but broadly the model moments accord with the data.

Table 5.2: *Targeted moments – profits and investment*

		Type				
		I	II	III	IV	V
Mean bus income - SE	Data	7458	11983	10959	27177	77754
	Model	7513	16764	15717	31550	77786
Mean bus income - INC	Data	8831	18484	26959	35824	84894
	Model	10412	21587	19391	34572	80062
Std. dev. bus income - SE	Data	6958	11386	18589	15185	44852
	Model	5929	14116	21047	17306	47827
Std. dev. bus income - INC	Data	11257	21774	41415	23781	48093
	Model	7451	15746	23487	17040	46881
Coeff. on AR(1) of log bus income	Data	0.22	0.28	0.19	0.33	0.38
	Model	0.16	0.24	0.14	0.30	0.35
Mean investment/mean bus income	Data	–	0.20	0.54	0.04	0.04
	Model	–	0.20	0.51	0.04	0.04
p.50 retained profits for high-income businesses	Data			2791		
	Model			2287		
p.75 retained profits for high-income businesses	Data			12607		
	Model			16385		
p.90 retained profits for high-income businesses	Data			28706		
	Model			34586		

Notes: The table shows the intensive margin 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.

Behavioural responses to tax

Figure 5.1 demonstrates that the model does a good job in capturing key behavioural responses to tax. Panels (a) and (b) shows that the model captures the increase in incorporation during the years when the 0% starting rate of corporation tax was in place. Despite not being directly targeted in estimation, the model does a reasonable job at fitting the patterns by income group: lower income groups (those with incomes between £10,000 and £50,000) saw the largest increases in incorporation rates.

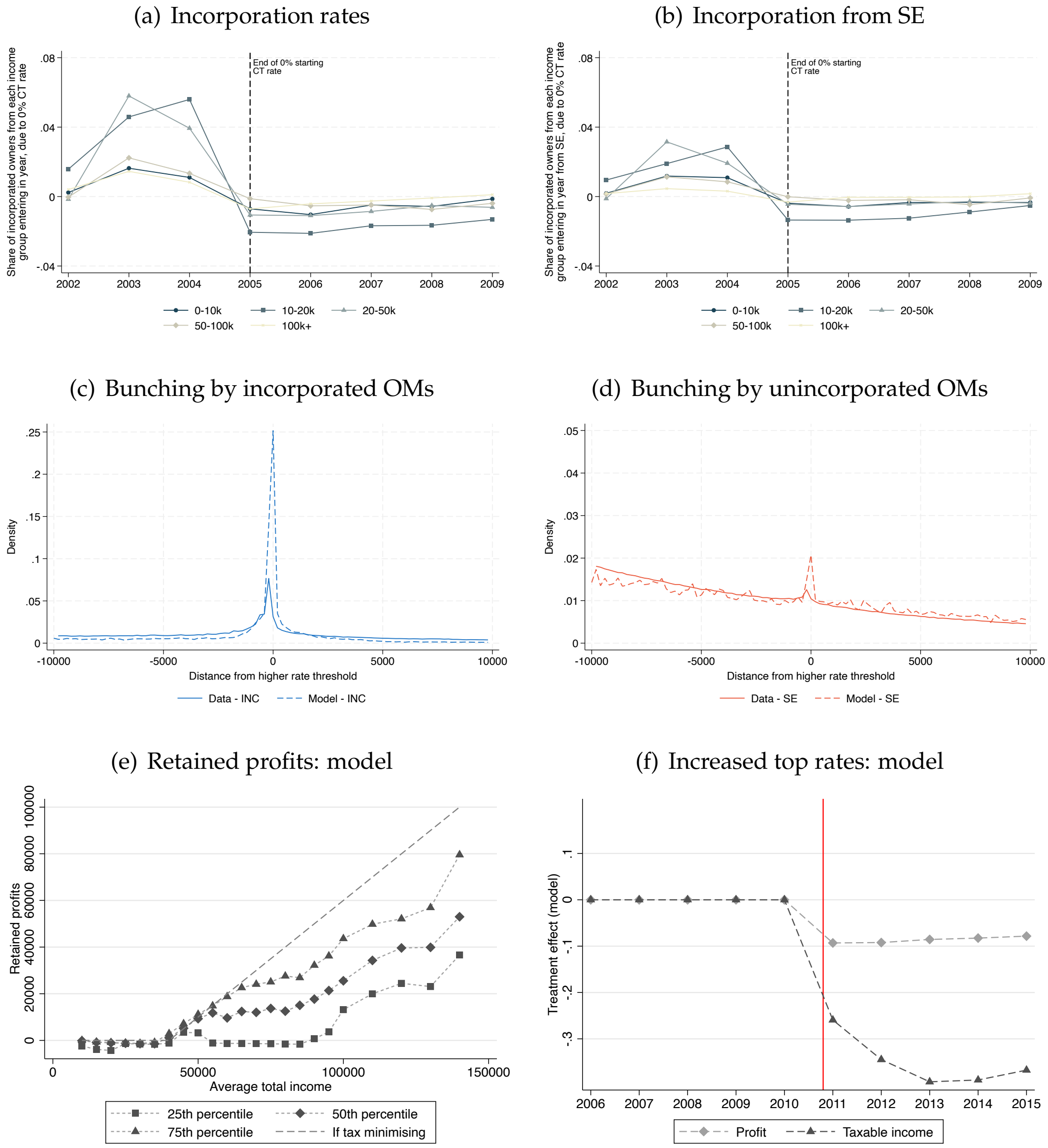
Panels (c) and (d) show the distributions of taxable income around the higher rate threshold for incorporated and unincorporated owner-managers in the data and simulated from model. The bunching in the model-generated data is more pronounced than in the data, but we nonetheless capture the much greater responsiveness of incorporated owner-managers to marginal tax rate changes than the self-employed. The magnitude of bunching is largely driven by the value of the optimization error threshold—we show sensitivity of our counterfactual results to this below. Calibrating a higher optimization error (which generates less bunching) actually widens the estimated efficiency differences across the reforms.

Table 5.3: *Targeted moments – entry and incorporation*

		Type				
		I	II	III	IV	V
Incorporation share - average	Data	0.03	0.08	0.15	0.23	0.67
	Model	0.03	0.11	0.20	0.24	0.72
Entry rate for SE - average	Data	0.14	0.06	0.05	0.05	0.02
	Model	0.19	0.09	0.08	0.07	0.02
Entry rate for SE - 2002	Data	0.15	0.09	0.08	0.09	0.05
	Model	0.18	0.06	0.07	0.07	0.03
Entry rate for SE - 2003	Data	0.15	0.09	0.08	0.08	0.04
	Model	0.18	0.08	0.07	0.08	0.03
Entry rate for SE - 2004	Data	0.14	0.08	0.07	0.07	0.03
	Model	0.20	0.08	0.08	0.08	0.03
Entry rate for SE - 2005	Data	0.16	0.08	0.07	0.07	0.03
	Model	0.18	0.08	0.07	0.06	0.02
Entry rate for INC - average	Data	0.00	0.00	0.01	0.02	0.05
	Model	0.00	0.00	0.01	0.01	0.04
Entry rate for INC - 2002	Data	0.00	0.00	0.01	0.01	0.05
	Model	0.00	0.00	0.01	0.01	0.07
Entry rate for INC - 2003	Data	0.00	0.01	0.02	0.02	0.08
	Model	0.00	0.01	0.01	0.02	0.08
Entry rate for INC - 2004	Data	0.00	0.01	0.01	0.02	0.07
	Model	0.00	0.01	0.01	0.02	0.06
Entry rate for INC - 2005	Data	0.00	0.01	0.01	0.01	0.06
	Model	0.00	0.00	0.01	0.01	0.04
Incorporation rate - average	Data	0.13	0.11	0.10	0.12	0.10
	Model	0.14	0.11	0.10	0.09	0.08
Incorporation rate - 2002	Data	0.16	0.17	0.16	0.16	0.15
	Model	0.10	0.13	0.12	0.14	0.15
Incorporation rate - 2003	Data	0.25	0.32	0.27	0.31	0.22
	Model	0.21	0.23	0.17	0.22	0.16
Incorporation rate - 2004	Data	0.22	0.26	0.21	0.24	0.17
	Model	0.21	0.20	0.13	0.16	0.13
Incorporation rate - 2005	Data	0.14	0.15	0.13	0.14	0.13
	Model	0.13	0.10	0.11	0.08	0.08
Incorporation rate (from SE only) - average	Data	0.06	0.06	0.05	0.05	0.02
	Model	0.07	0.07	0.06	0.05	0.02
Incorporation rate (from SE only) - 2002	Data	0.04	0.06	0.06	0.05	0.04
	Model	0.04	0.08	0.06	0.07	0.05
Incorporation rate (from SE only) - 2003	Data	0.12	0.18	0.12	0.16	0.07
	Model	0.11	0.17	0.11	0.12	0.05
Incorporation rate (from SE only) - 2004	Data	0.10	0.15	0.10	0.12	0.05
	Model	0.10	0.14	0.06	0.08	0.04
Incorporation rate (from SE only) - 2005	Data	0.05	0.07	0.05	0.06	0.04
	Model	0.05	0.07	0.06	0.04	0.02

Notes: The table shows the extensive margin moments targeted in estimation and their model counterparts. The entry rate for SE (INC) is defined as the ratio of newly entered self-employed (unincorporated) owner-managers to the existing stock of owner-managers. The incorporation rates are defined as the ratio of newly entering incorporated owner-managers to the existing stock of incorporated owner-managers. Details of the estimation process are provided in Appendix E.
Source: Authors' calculations using HMRC administrative datasets and model simulations.

Figure 5.1: *Model validation*



Notes: The top two panels show the difference in the incorporation rates due to the 0% starting rate of tax. We construct these by simulating a world in which the 0% starting rate had not been introduced and compare to our baseline simulations. The middle left (right) hand panel shows bunching around the higher rate threshold by incorporated (unincorporated) owner-managers in the data and simulated from the model. The bottom left hand panel shows the 25th, 50th and 75th percentiles of average annual retained profits for incorporated owner-managers, conditional on the average total income of their business (profit net of corporate tax), constructed using model-generated data. 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.

Panels (e) and (f) use data simulated from the model to replicate the two key figures from Miller, Pope, and Smith (2024) (shown in Figure 4.3(a)). Although not directly targeted, the model does a good job of capturing the joint distribution of retained profits and average business incomes. When we simulate the effects of the 2010-11 tax rises on high incomes (panel (f)), we get slightly larger effects 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.

Implied elasticities

In Table 5.4, we provide a set of elasticities to further validate our results and benchmark to the existing literature. The median compensated elasticity of labour supply is 0.62, with lower elasticities for the highest income type V. The implied uncompensated elasticities are substantially lower, with a mean of 0.07, indicating sizeable income effects. These are similar to the results obtained by Attanasio et al. (2018), who estimate a median Hicksian elasticity of 0.54. Our implied elasticities are at the upper end of the range estimated in the micro literature—the 95% confidence interval of bounds on the intensive margin Hicksian labour supply elasticities provided by Chetty (2012) is [0.23, 0.61]. As highlighted by Chetty (2012) though, the implied bounds on labour supply elasticities depend on the magnitude of optimization frictions—we therefore show sensitivity of our efficiency results both to the optimization error and the curvature of utility in leisure.

Table 5.4: *Implied elasticities*

	Value
Compensated elasticity of labour supply	0.621
Uncompensated elasticity of labour supply	0.056
Elasticity of user cost of capital	-2.045
Semi-elasticity of incorporation	0.033

Notes: For each individual, we compute the compensated (Hicksian) and uncompensated (Marshallian) elasticities of labour supply with respect to the wage rate. The values in the table show the median across individual-years, conditional on individuals working at least 1000 hours a year. The elasticity of the user cost of capital is constructed by simulating the removal of the disincentive to invest using new equity. For each individual-year, we then take the ratio of the percentage change in investment to the percentage change in the user cost of capital. The table shows the mean across individual-years affected by the reform i.e. for whom there was a decline in the user cost of capital. To construct the semi-elasticity of incorporation, we use the model to simulate a world in which the 0% starting rate of corporation tax had not been introduced. For each £1000 income bin, we calculate the change in log incorporation rate under the baseline and counterfactual world, and regress this on the change in tax savings as a percentage of business income.
Source: Model simulations.

An extensive literature estimates the elasticity of the user cost of capital, which describes the percentage change in investment given a 1 percent increase in the user cost of capital. In our model, the user cost of capital is given by ρ in equation (3.10). We consider a counterfactual that removes the disincentive to invest out of new equity, but otherwise leaves the tax rates unchanged. This implies that the user cost equals the depreciation rate ($\rho = \delta$) for all investments, irrespective of how they are financed. The implied user cost elasticity is -2, which is larger (in absolute terms) than the range found by Hassett and Hubbard (2002).

However, it is consistent with the estimates of Zwick and Mahon (2017), who highlight that the investment of smaller firms (more akin to the closely-held businesses we study) is much more responsive to the user cost than that of the more commonly studied large firms.

The final row of Table 5.4 presents the semi-elasticity of incorporation implied by the changes in behaviour over the 0% starting rate of corporation tax. This measures the percentage change in the rate of incorporation given a 1 percentage point increase in the tax savings from incorporation (measured as a share of business income). Tazhitdinova (2020) and Devereux and Liu (2015) use tax variation (including the 0% starting rate of corporation tax) and fixed effects models to estimate this elasticity. Our model-based elasticity estimate of 0.033 is very similar to these prior estimates.[31] An advantage of our structural approach is that we can quantify the impact of intertemporal switching on incorporation rates. For example, we find that 15% of the contemporaneous increase in incorporations in 2003-04 is offset by reduced incorporation rates in subsequent years.

6 The equity and efficiency effects of tax reforms

In this section, we use our model to study the effects of reforming the taxation of owner-managed businesses. 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 Overview of effects

We study the effects of three types of reform. First, an *average capital tax rate increase*, which we model as a one percentage point rise in the rates of tax on self-employment profits, dividend income and capital gains. This acts as a benchmark to compare our findings with those from models that assume there is a single capital tax rate. Second, a tax-revenue-equivalent increase in the *capital gains tax rate* alone—this is informative about the gains from reducing the differentials in rates across types of capital income. Third, a tax-revenue-equivalent increase in the *capital gains tax rate alongside base reform* that provides an upfront deduction for investments made out of new corporate equity. In each case, we simulate the counterfactual tax regime as if it had been in place over the entire period of study, and compare outcomes with those under the baseline tax system.

Table 6.1 summarises the effects of these three reforms. All three reforms raise just over £500m in revenue per year, which is equivalent to approximately 4% of the total revenue raised from business owner-managers in the baseline world. In all three cases this is achieved

[31] Tazhitdinova (2020) estimates a semi-elasticity of 0.039 over 2002-12, while Devereux and Liu (2015) estimate a semi-elasticity of 0.032.

in a progressive manner: 14% of the revenue raised from the average capital tax rate increase comes from the top 1%—this is even higher, at over 40%, for the revenue-equivalent increases in the capital gains tax rate. The Suits (1977) index (a measure of tax progressivity analagous to the Gini) rises by 0.002-0.003 across reforms.

Although all three reforms raise revenue progressively, they have very different implications for efficiency. We measure the efficiency cost by computing the marginal cost of funds (MCF) i.e. the ratio of the total amount required to lump-sum compensate owner-managers for the higher rates of tax to the total tax revenue raised.[32] The average capital tax rate increase reduces efficiency: the total amount required to compensate individuals is 12% larger than the total amount of revenue raised. This is the standard result in the literature that raising revenue progressively through increasing capital taxes comes at an efficiency cost. In stark contrast, revenue-equivalent increases in the CGT rate alone (both with and without base reform) actually improve efficiency, illustrated through MCFs below one i.e. compensating individuals uses only 53-59% of the revenue raised.[33]

Table 6.1: *The equity and efficiency effects of revenue-equivalent capital tax reforms*

		CGT rate increase	
	Average capital tax rate increase	+ base unchanged	+ base reform
Change in tax revenue (£m/year)	530	530	530
pp change in rate	1.0	6.2	6.6
Equity: share of revenue from top 1%	0.14	0.42	0.45
Equity: change in Suits Index (x100)	0.18	0.26	0.26
Efficiency: lump sum compensation/tax revenue	1.12	0.59	0.53

Notes: The first column shows the effect of a 1 percentage point increase in the 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, and the third column shows this increase in the CGT rate in addition to tax base reform that removes the disincentive to invest using new equity. The top 1% threshold is taken from Delestre et al. (2022) (adjusted for inflation to express in 2014 £). The Suits Index is a measure of tax progressivity (see Suits (1977)) between -1 and 1. The lump sum compensation is calculated as the sum of equivalent variation necessary to make individuals indifferent between the baseline regime and the tax reform package.
Source: Model simulations.

[32]The equivalent variation for each individual is the constant annual consumption transfer (in £ per year) that, applied over their remaining lifetime (including retirement), equates their discounted lifetime utility under the reform to the baseline. We then aggregate this annual compensation and the annual tax revenue raised across all simulated individuals and over the entire 13-year period of our study; the ratio of these two totals gives the MCF. This is the traditional notion of Hicks-Kaldor efficiency (Hicks, 1940; Kaldor, 1939) which captures Pareto improvements, but relies on lump-sum transfers.

[33]For these policy changes, the marginal cost of funds (MCF) is equivalent to the marginal value of public funds (MVPF). 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). An exception to this is found by 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 stepped-up basis creates big distortions to the timing of capital gains realizations.

6.2 Mechanisms

To unpack the mechanisms driving the differential impacts on efficiency, Table 6.2 summarises the changes in number of businesses, labour supply, investment and business incomes under each reform. Figure 6.1 provides further detail by plotting changes by average business income at baseline.

Average effects

Increasing capital tax rates lead to declines in investment, hours worked and the total number of businesses started. The average capital tax rate increase leads to a 0.9% reduction in the number of businesses;[34] annual investment declines by 2.2% and owner-managers' labour supply falls by 1.4%, such that average business income declines by 1.8%. These patterns are also evident for the revenue-equivalent increase in the CGT rate, although the effects across all businesses are smaller than for the average capital tax rate increase. These behavioural responses contribute to the efficiency cost of taxation.

However, the revenue-equivalent increase in the CGT rate leads to *improvements* in efficiency through lower rates of income shifting and tax-motivated incorporation. Figures 6.1(a) and (b) show significant declines in retained profits, along with reduced rates of incorporation under the higher CGT rate (shifting behaviour is effectively unchanged under the average capital tax rate increase). Both of these forms of shifting distort behaviour in ways that generate real utility costs: leading individuals to delay consumption, and to pay incorporation costs they would have preferred to avoid. Figure E.3 provides further detail on the magnitude of the consumption responses to the tax incentives faced by incorporated owner-managers. Consumption growth slows by approximately 0.5 percentage points when individuals' total income crosses the higher rate threshold—this indicates a distortion to behaviour, but not one that is implausibly large.[35] The increase in CGT rates leads to larger drops in consumption at older ages, as the incentive to retain profits to reduce tax liability has fallen. Reducing the magnitude of the distortions both to the intertemporal allocation of consumption and to the choice of legal form more than offsets the declines in investment and labour supply, such that overall efficiency rises when the CGT rate increases.

[34] The 1 percentage point increase in personal capital taxes leads to a 0.26 percentage point (0.9%) fall in the number of businesses in operation over the period. This is comparable to to Giroud and Rauh's 2019 estimate of 0.43 for the establishment elasticity of pass-through businesses.

[35] This is consistent with the findings of Chetty et al. (2014), who find that portfolio reallocation is the main way that individuals respond to changes in the incentives to save for retirement. In our setting, individuals reduce their personal saving to offset higher saving in their companies.

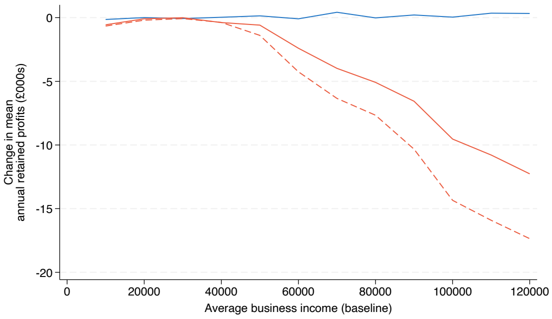
Table 6.2: *Effects of capital tax reforms on business outcomes*

	Average capital tax rate increase	CGT rate increase + base unchanged	CGT rate increase + base reform
All businesses			
% change in total businesses	-0.9	-0.1	-0.0
% change in incorporated businesses	-2.0	-1.6	-0.8
% change in unincorporated businesses	-0.9	0.0	0.0
% change in annual investment	-2.2	-0.8	2.3
% change in k-constrained businesses	45.1	17.9	-45.4
% change in business hours worked	-1.4	-0.0	0.1
% change in business income	-1.8	-0.1	0.1
High investment businesses			
% change in total businesses	-1.0	0.1	0.9
% change in incorporated businesses	-2.3	0.4	8.2
% change in unincorporated businesses	-0.9	0.0	-0.0
% change in annual investment	-1.9	-0.1	1.5
% change in k-constrained businesses	8.8	0.2	-1.5
% change in business hours worked	-1.6	-0.0	0.7
% change in business income	-1.7	-0.0	1.1
High profit businesses			
% change in total businesses	-3.8	-1.8	-1.8
% change in incorporated businesses	-3.7	-6.7	-6.4
% change in unincorporated businesses	-4.2	0.2	0.2
% change in annual investment	-1.9	-2.7	6.7
% change in k-constrained businesses	60.9	35.7	-89.7
% change in business hours worked	-1.9	-0.2	0.1
% change in business income	-1.8	-0.4	0.1
Transitioners from SE to INC			
% change in total businesses	-2.1	-0.7	-0.6
% change in incorporated businesses	-3.2	-2.3	-2.1
% change in unincorporated businesses	-3.8	-1.1	-1.5
% change in annual investment	-2.1	-0.5	5.9
% change in k-constrained businesses	73.2	6.5	-59.7
% change in business hours worked	-1.8	-0.1	0.4
% change in business income	-1.9	-0.1	0.6

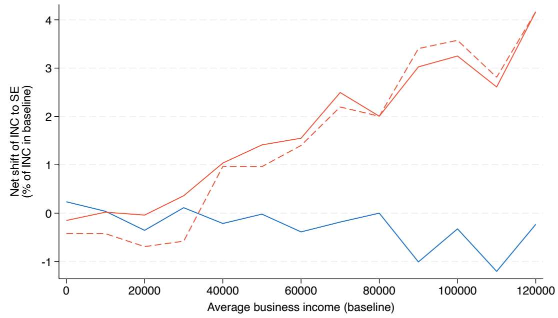
Notes: The first column shows the effect of a 1 percentage point increase in the rates of tax on self-employment profits, dividend income and capital gains. The second column shows the effect of a revenue-equivalent increase in the capital gains tax rate and the third column shows this increase in the CGT in addition to tax base reform that removes the disincentive to invest using new equity. k-constrained businesses are defined as those with a marginal product of capital greater than the depreciation rate. The changes in investment, capital-constrained businesses, business hours worked, and business income are computed for the businesses that operate both at baseline and in the reformed world. High investment businesses are business type III; high profit businesses are those with mean business income above £40,000 in the baseline world; transitioners are those owner-managers that move from self-employment into incorporation in the baseline world.
Source: Model simulations.

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

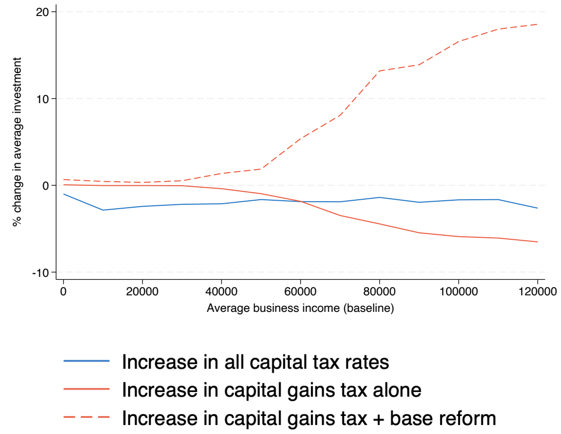
(a) Change in retained profits



(b) Switching in legal form



(c) Change in investment



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) for each reform. The top right panel shows reform-induced net change in the number of individuals choosing the unincorporated rather than incorporated form, scaled by the baseline incorporated population in that income bin. The bottom panel shows the percentage change in annual investment under each reform, across the distribution of average business income (in the baseline world). Source: Model simulations.

It is important to emphasise though, that increasing the CGT rate does lead to declines in investment and hours worked—and for some businesses these are substantial, as we describe below. Our third counterfactual reform illustrates how these can be avoided by combining an increase in the CGT rate with tax base reform that removes investment disincentives. The third column of Table 6.2 summarises these effects: this reform leads to a 2.3% *increase* in annual investment across all businesses, resulting in small increases in average business income. Consequently, this reform further increases efficiency, as shown in Table 6.1.

Heterogeneity across businesses

The effects of these reforms differ markedly across types of business, depending on: (i) importance of capital in production, (ii) average business income, and (iii) whether investment is financed from new or retained equity. The interaction of (ii) and (iii) determine whether businesses faced investment disincentives and the extent to which tax base reform reduces these. The bottom panels of Table 6.2 describe the effects of the reforms on different subgroups that may be of particular interest to policymakers. When calculating the overall efficiency effects, it is nonetheless important to aggregate over all businesses subject to the reforms (including those that have low incomes or do not invest). Otherwise we are likely to miss efficiency gains that arise from reducing income shifting and tax-motivated incorporation from firms that are not the intended target of government policy.

High-investment firms. The second panel of Table 6.2 describes the effects of the three reforms on high investment (type III) businesses. Under the average capital tax rate increase and CGT rate increase, the investment and business incomes of this group fall. However, when the CGT rate increase is combined with base reform, annual investment rises by 1.5%. There are also significant increases in business hours worked (0.7%) and business income (1.1%). The effects on labour supply are bigger than the average across all businesses because of the greater importance of capital in production for the high investment businesses. For a given additional £ of investment, the returns to working an extra hour are boosted by more than for the other types. Another important feature of the CGT rise plus base reform is that the number of high investment businesses increases by 1%, with this concentrated among incorporated businesses (a rise of 8%). Despite the rise in the CGT rate, the removal of the disincentive to invest using new equity draws in marginal businesses that were previously unviable. If the share of firms with a high θ is higher in the broader population, this would amplify the efficiency improvements of the CGT rate rise plus base reform.

High-profit firms. The third panel of Table 6.2 describes the effects on high profit businesses (predominantly type V)—owner-managers of these businesses are the most affected by the rise in the CGT rate. Increasing the CGT rate (column (2)) leads to large declines in the the number of these businesses and their annual investment. On average, investment falls by 3%, but for those with more than £90,000 of business income at baseline the declines are much larger—around 8% (Figure 6.1(c)). This highlights how raising capital tax *rates* can cause significant declines in investment for some businesses. However, our third counterfactual shows how these drops in investment from raising rates can be more than offset by base reform: annual investment for high profit businesses rises by 7% on average, with increases of more than 15% for businesses with the highest baseline profits (Figure 6.1(c)). The share of capital-constrained firms falls by 90%.[36] The total number of high profit businesses

[36]Firms can invest inefficiently low amounts (i.e. have marginal products of capital below δ) both because they have insufficient total assets or because they have insufficient company assets. The latter leads to inefficiently low investment because of the tax disincentive to invest out of new equity (see equation (3.10)). Table E.1 shows that, at baseline, type V contains the greatest fraction of capital-constrained businesses, with almost all of this driven by insufficient company assets.

still declines (by 1.8%) under this third reform, because, unlike for the high investment businesses, a much greater fraction of the business profits of this group reflect returns to the owner-managers' labour rather than capital investments. These disguised returns to labour are precisely what is targeted through higher rates of CGT, but base reform ensures the removal of investment disincentives for those businesses remaining active.

Transitioners from self-employment to incorporation. The final panel of Table 6.2 describes the effects for those owner-managers that transition from self-employment to incorporation in the baseline world. These are another subset of businesses that might be of particular interest to policymakers—Table 4.1 shows that these businesses have higher growth rates than solely self-employed or incorporated ones. Under the CGT rise plus base reform, these businesses increase investment by 6% on average, accompanied by rises in both hours worked and business incomes.

6.3 Sensitivity

In this section, we describe the sensitivity of our main results to the calibrated parameters. For three parameters—the curvatures of utility in leisure and consumption and the optimization threshold—we re-solve and simulate the model with higher and lower values of the parameters compared with our baseline estimation.[37] Tables F.1–F.3 summarise the differences in the model moments and Figure F.1 shows the MCFs for the three main tax reforms under the different parameter values.

Curvature of utility in consumption. We set $\nu_c = 0.8$ in the baseline estimation, and show sensitivity to raising this to 0.9 and lowering it to 0.7. This leads to small changes in some of the model parameters, with both the mean and variance of incomes falling as we increase ν_c (see Table F.1). Figure F.1 shows the implied marginal costs of funds for all three reforms are slightly higher when ν_c is equal to 0.9 compared with baseline. This is driven by the fact that increasing ν_c increases the consumption-equivalent cost of any given behavioural distortion. Despite this, the efficiency ranking of the three different tax reforms is not sensitive to the recalibration of ν_c: the average capital tax rate reduces efficiency, whereas the CGT rate rise boosts it, and more so if combined with base reform.

Curvature of utility in leisure. In our baseline estimation, we set $\nu_l = 1.5$. We show sensitivity to raising this to 1.75 and lowering it to 1.25—higher values of ν_l correspond to less elastic

[37] For the ν_l sensitivity we recalculate the implied χ parameter to ensure that the average number of hours worked is consistent with the baseline. For the ν_C sensitivity, we rescale utility so that the average level aligns with the baseline to avoid having to readjust the switching cost variables.

labour supply. Table F.2 shows that there are small changes in the model moments through varying ν_l; for example, the standard deviation of business incomes falls as we raise ν_l. Figure F.1 shows that the MCFs of each tax reform are broadly similar as under the baseline: the average capital tax rate increase reduces efficiency, while efficiency increases under the CGT rate rise, and more so if combined with base reform. The efficiency costs of the average capital tax rate rise are somewhat lower (but still positive) under the higher value of ν_l, which is what we would expect for a calibration in which individuals' labour supply is less elastic.

Optimization errors. We set an optimization error threshold equal to 2% in the baseline estimation—without this, the model leads to much more pronounced bunching at tax thresholds than is present in the data. Increasing (or decreasing) the optimization error leads to less (or more) bunching at the tax thresholds (see Figure F.2), but with little effect on the other model parameters (see Table F.3). The exception is for retained profits—these are lower for higher values of the optimization error. Increasing the optimization error (which still creates "too much" bunching relative to the data) leads to a small amplification of the differences in the MCFs across the three reforms. Even at the lower value of the optimization error, the average capital tax rate increase reduces efficiency, while the CGT rate rises boost it, with magnitudes similar to the central calibration.

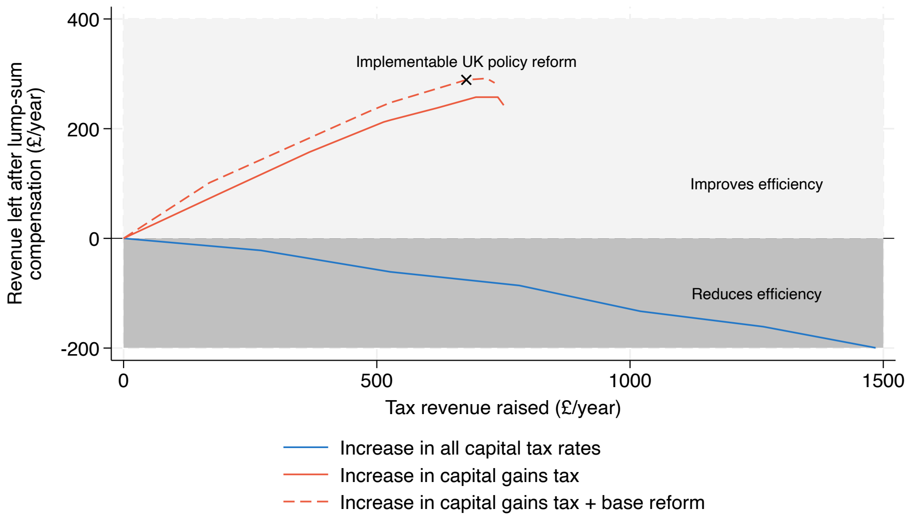
Influence of different sets of moments

In Appendix E, we use the tests developed by Honoré et al. (2020) to show sensitivity of the estimated model parameters to removing different sets of moments from the objective function. We extend these methods to show how the included moments affect the precision of the efficiency results. We remove (i) the moments relating to retained profits, and (ii) the moments related to changes in the incorporation rates, and compute the adjusted variance-covariance matrix of the model parameters. We then take 100 bootstrap draws from these two perturbed matrices, re-solve and simulate the model under the different tax reforms and recalculate the marginal cost of funds. We use these to construct 95% confidence intervals for the MCFs, reported in Table F.4, along with the 95% confidence interval constructed using the unperturbed matrix. Removing the retained profits and the incorporation moments slightly *tighten* the precision of the estimated MCF of the average capital tax rate increase, but *reduces* it for the CGT rate rises. Nonetheless, the effects are small.

6.4 The equity-efficiency frontier

Figure 6.2 shows that the differential impact on efficiency across the three types of reform is not limited to incremental increases. It traces out the revenue net of lump-sum compensation against the overall revenue raised from each type of reform—moving right along each line corresponds to a larger increase in each set of tax rates. The point denoted 'X' on the figure corresponds to a specific, feasible counterfactual UK policy. It combines the removal of the preferential 10% capital gains tax rate for business owners ("Entrepreneurs Relief"), such that gains on business assets are taxed at the same rate as other capital gains (20%), alongside base reform that removes the disincentive to invest out of new equity. [38] Together, these reforms would raise approximately £700 million per year in revenue, which is approximately 18% of the annual revenue raised from capital gains tax over the period we study.[39]

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



Notes: The figure shows the revenue net of lump-sum compensation 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.

There are, though, 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

[38]This could be implemented by a cash-flow tax 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; see Adam and Miller (2021).

[39]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.

cannot be avoided. Nonetheless, our results highlight that in 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.

6.5 Robustness and discussion

To focus on the key margins of behavioural response for our counterfactuals of interest in a computationally tractable model, we abstract from other features of firm dynamics. In this section, we provide additional model simulations and further discussion to shed light on how these other factors are likely to affect our results.

Lower investment financing costs for incorporated businesses

In our main specification, we model non-tax differences between the legal forms through the fixed incorporation cost, F^{inc}. This rules out differences between the legal forms that may interact with other margins of choice in the model. For example, if incorporated businesses have a lower cost of capital due to better access to external finance (Devereux and Liu (2015)). We consider an extension that approximates this by analysing a counterfactual in which incorporated owner-managers have a 20% lower cost of capital (δ); we then adjust the means of the incorporation costs, $F^{inc}_{j,m}$ so that the average incorporation share remains as in the baseline scenario. Table F.5 shows that the majority of the moments are very similar to baseline, although investment as a share of mean profit is a slightly higher under the robustness exercise. Under this scenario, it is more efficient for investment-focused owner-managers to incorporate (because they face lower financing costs), but the current disincentive to invest using new equity pushes against this. This means that the efficiency costs of average capital tax rate increase are higher than baseline, but the CGT rate rise plus base reform leads to slightly larger efficiency gains than the baseline model (see Table F.7).

Differential tax treatment of losses across legal forms

Another difference between the legal forms that we do not model in the baseline is the asymmetric tax treatment of losses. The rules on how losses can be offset are complicated, with restrictions on the extent to which they can be set against income from other sources and carried forwards and back (see Adam and Miller (2021) for further details). There are various scenarios in which a self-employed individual may receive a bigger tax benefit from a given loss than someone running an incorporated business. In our baseline model, the log-normal distribution of productivity means that individuals do not make losses. We consider a computationally tractable extension in which individuals face stochastic, non-zero fixed costs that can lead to negative realized profits.[40] If an individual is self-employed, they receive a tax refund equal to the loss times the basic rate of income tax; incorporated owner-managers receive no refund—a particularly extreme case of asymmetric treatment. Under this specification, the variance of incorporated owner-managers is slightly higher, and investment as a share of mean profit slightly lower (see Table F.6). The MCFs associated with the three different tax reforms are all slightly lower than in the baseline model, although the differences are small (see Table F.7).

Sweat equity

Like us, Bhandari and McGrattan (2021) emphasise the important role of owner effort in creating business value. They also model owner hours as a key input into generating profit, but additionally allow owners to allocate time to building a stock of intangible capital that enters the production function directly. They find the intensive-margin labour supply response is much larger in their sweat model than in a standard Lucas model because the intangible investment channel amplifies the effect of taxation on total owner effort.

Our results complement theirs: we also find that a key margin of owner-managers' response to tax changes is through their labour supply, but this depends crucially on the nature of the tax reforms considered. For example, the CGT rate rise plus base reform actually *increases* owner-managers' labour supply, because of its complementarity with tangible investments. For many owner-managed businesses there is no clear distinction between time spent producing current output and time spent building intangible capital. If owner hours serve this dual role, then the increase in labour supply induced by the base reform would also boost the accumulation of sweat equity, further amplifying the response. However, to the extent that capital gains taxes are (in part) a tax on the labour supply of owner-managers (with no associated deduction for this cost), this will discourage the accumulation of assets created by owner effort. This echoes the human capital taxation literature (Bovenberg and Jacobs, 2005; Stantcheva, 2017) and connects to the broad principal underpinning our results—allowing the costs of investment to be fully deductible from all layers of tax ensures productive efficiency (Diamond and Mirrlees, 1971).

Spillovers from entrepreneurial activity

A reasonable rationale for using policy to boost entrepreneurship is if it generates positive spillovers. Importantly though, not all businesses create spillovers and neither governments

[40]We assume that owner-managers face an 25% probability of facing a fixed cost equivalent to the 25th percentile of the type-specific investment distribution, with a 75% chance of facing a negative fixed cost, such that the expected value is zero. This results in 2% of businesses making a loss, rising to 6% for type III businesses.

nor researchers can observe which ones do. Increasing the capital gains tax rate in combination with base reform increases investment and entry of high-investment businesses. So, to the extent that spillovers are linked to tangible investments, then this would reinforce our efficiency results. If though, spillovers are created by the labour supply of some business owner-managers, then this could weaken our results (there is a 1.8% fall in high-profit businesses). We do a back-of-the envelope calculation to show that overturning our estimated efficiency improvements would require positive spillovers from innovation that vastly exceed existing estimates.[41] Measuring positive spillovers is hard, with considerable uncertainty surrounding the estimates, and it is also possible that our results understate the entry responses to tax changes for innovative firms. Even so, it is likely that lower capital tax rates are not the best policy tool to address spillovers, with alternatives, such as R&D tax credits or subsidies for specific activities, likely better targeted, a conclusion also drawn by Gordon and Sarada (2018).

Generalizability of results to a wider set of firms

Our focus on owner-managed businesses is motivated by their centrality to policy debates, but it is also useful to highlight how the reforms that we consider might affect a broader set of businesses. Some privately-held companies are characterised by extremely rapid growth, such that their behaviour may not be well-captured by the parametrization of our model. For example, their owners may face more uncertainty about their potential returns or have to enter in order to learn their true productivity (Catherine, 2022), which could affect the estimated entry elasticity. To the extent though, that these firms rely on new corporate equity at some point, we would expect tax base reform to have even larger efficiency gains than described here.[42] For widely-held firms, we expect that personal capital taxes will be (mostly) irrelevant because they primarily finance investment through retained equity or debt—in this case it is the design of the *corporate* tax base that is key.

[41] We calculate the change in the private returns from business ownership as the difference between business profit and what the owner-manager could have made as a full-time employee. The aggregate change in these returns is approximately 75% of the efficiency gain (revenue raised net of required lump-sum compensation) i.e. we would need a spillover multiplier of 1.3 on each £ of private business returns. Estimates of the social-to-private return gap on R&D expenditure range from 0.5 to 1.0 net of business-stealing effects (Bloom et al., 2013) to approximately 3.0 when gross technology spillovers are included (Jones and Williams, 1998). However, these estimates apply to R&D expenditure, not to total business profits, and are generated only by the fraction of businesses that engage in innovation. If only 20% of owner-managed businesses engage in innovation, and *even if half* the returns of these businesses constitute returns to innovation, then our required spillover multiplier is more than 13.

[42] This provides a further advantage of base reform relative to alternative approaches that, for example, base tax treatment on legal form or firm size, which introduce additional distortions (Garicano et al., 2016). Reforming the tax base directly removes marginal investments from tax, without the need for line drawing.

Interaction with other capital taxes

In this paper, we focus on capital taxes as they apply to business owner-managers. It is common for tax systems to levy different capital gains tax rates on business owners, such that we can abstract from other capital gains tax rates (such as those on property). Nonetheless, the reforms that we consider interact with other parts of the capital tax system in important ways. Much of our analysis focuses on the effects of raising capital gains taxes, which tend to be taxed at the lowest rate and create significant timing effects. But our results also speak to the potential effects of increasing dividend tax rates. This would exacerbate shifting into capital gains (but reduce it from labour income), as well as deterring investment out of new equity, unless there is a neutral tax base.[43]

We assume that when owner-managers retire, they pay out any remaining company assets as capital gains. In practice, individuals can defer this, either by paying themselves dividend income into retirement or by passing the business on to their heirs—in this case, CGT is avoided entirely under "step-up" at death (although estate or inheritance tax may be due).[44] "Step-up" introduces an additional timing distortion—if reforms that increase capital gains tax rates also remove the ability to step-up at death, then the efficiency gains are likely to be even bigger. Another dimension from which we abstract is international mobility. It is possible that particularly successful entrepreneurs are more mobile in response to tax changes, with the migration decision negatively impacting their companies (Jakobsen et al., 2026). How capital gains are taxed when individuals leave and enter a country will be an important determinant of this decision. More broadly, these "leakages", *if they are left in place*, could reduce the efficiency gains to increasing capital gains taxes. This provides a rationale for policymakers to remove other avoidance opportunities alongside the reforms that we consider here.

7 Summary and conclusions

In this paper, we develop a framework that reveals the existence of capital tax reforms that boost equity and efficiency. It explicitly accounts for the distortions created by tax rate differentials, and illustrates how tax base reforms can allow policymakers to raise revenue without deterring investment. Our results speak to debates about the taxation of private business wealth. Calls for an annual wealth tax are often motivated by the large stock of

[43]Any change to dividend taxes would also apply more broadly because most countries have a single rate, including to arms-length investments. However, for larger firms, the literature tends to find that changes in dividend taxes primarily affect firm payout policy rather than investment decisions, likely driven by the fact that these firms primarily use retained equity to finance investments (e.g. Yagan (2015), Chetty and Saez (2005)).

[44]Under "step-up" (or "uplift") at death, the base cost of an asset is reset to its market value at the date of death, such that any capital gains accrued during the deceased's lifetime are never subject to CGT.

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.

Nonetheless, there remain important avenues for future research, some of which we touch on above. Extending the framework to allow for positive spillovers from innovation, learning and experimentation, in addition to investment in intangible assets, would be valuable. This would offer the opportunities for more extensive study of the nature of market failures that can affect entrepreneurial activity. Analysing a wider set of tax and policy instruments, such as the tax treatment of losses, R&D tax credits, and start-up loans, could be a fruitful way to explore how better to target such market failures. 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. Our paper provides a starting point for evaluating this trade-off, as well as demonstrating that there is significant scope for policymakers to improve welfare before they have to face it.

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Appendix

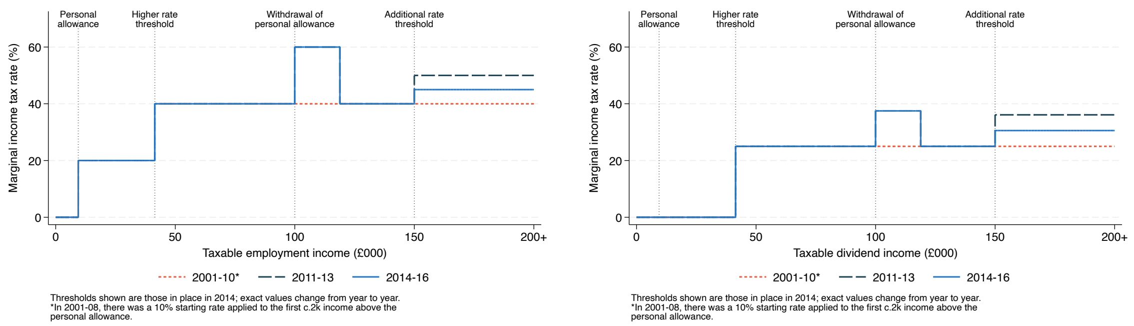
A Tax system

A.1 Rates and thresholds

Tables A.1, A.2 and A.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 A.1 illustrates the marginal tax rates schedules for employment and dividend income over the period we study.

Figure A.1: *Marginal personal income tax rate schedules*

(a) Employment income (b) Dividend income



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 A.3.

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

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

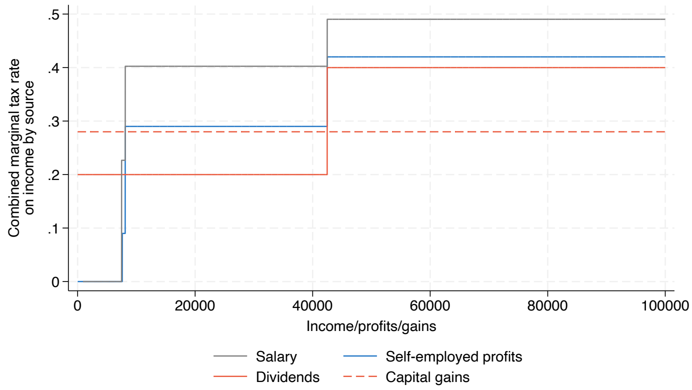
Note: This table shows the statutory capital gains threshold (column 2) and rates (columns 3 and 4) in each year, assuming that the asset is a business asset that qualifies for taper relief (before 2008-09) and Entrepreneurs' Relief (2008-09 onwards) respectively. An amount equal to the allowance can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

Table A.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.*

Figure A.2: *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 A.

Table A.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).

A.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 the introduction of the Annual Investment Allowance in 2008, capital allowances featured a 50% first-year allowance and 25% writing-down allowance, implying a present value of deductions of approximately 96% of the investment cost at the corporate risk-free rate. We approximate this as full deductibility ($\lambda = 1$) at the business level. Post-2008, the AIA provides full first-year deductions for qualifying expenditure below the allowance threshold, which covers the vast majority of firms in our sample.

B Data

This paper uses administrative data from corporate and personal tax records, supplemented by data from company accounts. 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). We also use information from the Longitudinal Small Business Survey. This appendix describes the data.

B.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.[45] 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.[46] These data are from Companies House, the UK company registrar, to which all companies must submit accounts. The accounts data are in two parts. First, the number of directors and number of shareholders are observed at a single point in time – in the most recent year that the company is in the data. This information is matched to the corporate tax record in 98% of cases. Second, information on the company balance sheet is recorded (mostly annually) in company accounts. In 87% of company-years, the corporate

[45] 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.

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

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. 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.

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. We therefore uniformly scale up the weights on matched firms to align with the aggregate population shares of incorporated businesses, treating the matched sample as representative of the active population above these lowest income levels.

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.

B.2 Additional tables and figures

Table B.1: *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.

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:

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

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. We convert both variables to a z-score so they are on the same scale.

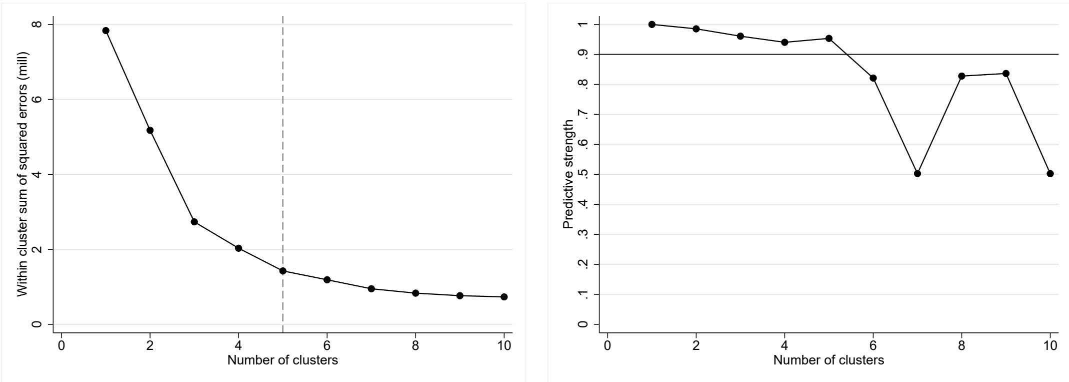
C.2 Number of clusters

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.

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.

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 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.

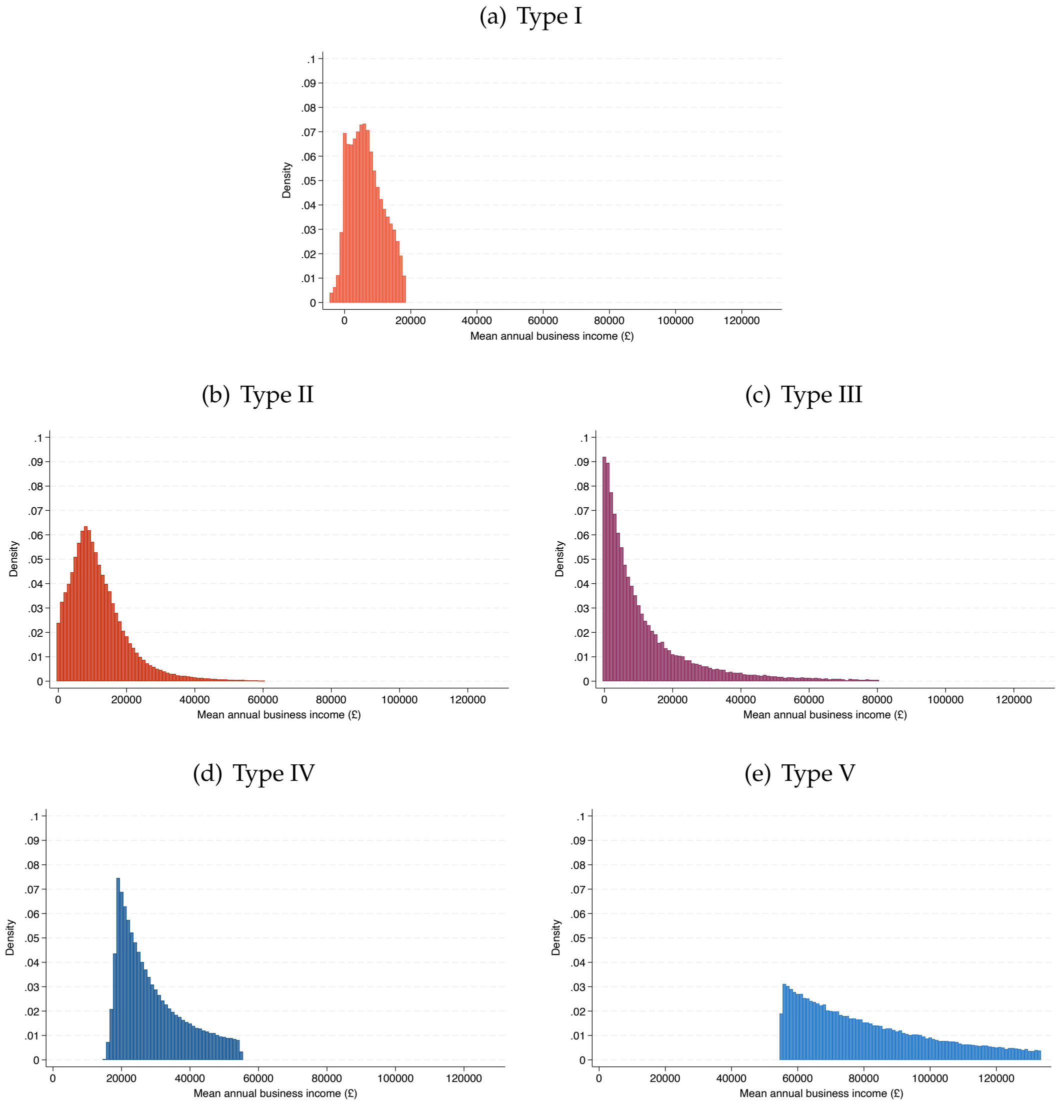
Table C.1 shows that these differences are also reflected in variation in industry composition across types. More than 40% of type V business owners work in business services, while type III (the highest investment type) are more likely to work in agriculture, mining or utilities.

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.

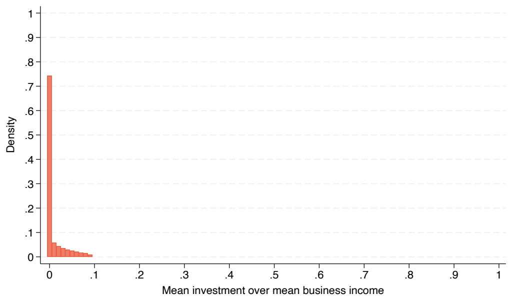
Figure C.2: *Distributions of mean business income by type*



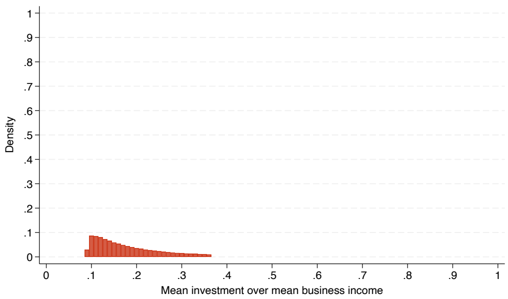
Notes: Each panel shows the distribution of mean business income by the different latent types.
Source: Authors calculations using HMRC administrative datasets.

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

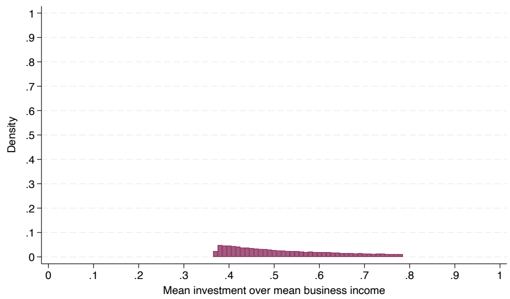
(a) Type I



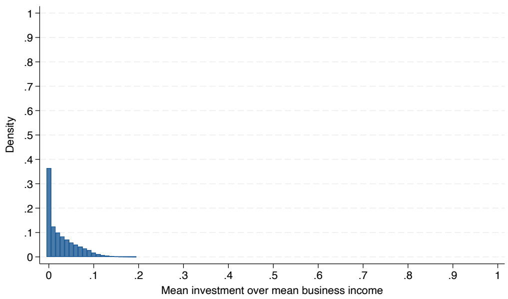
(b) Type II



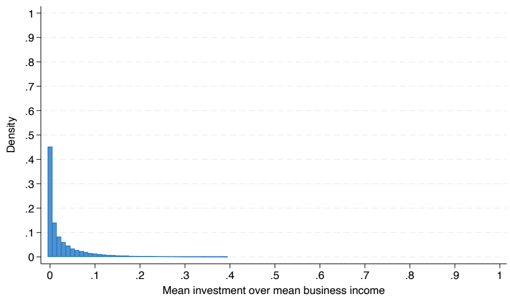
(c) Type III



(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, $\tilde{y}_{it}$,[47] 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:

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

$\lambda^{INC,p}$ governs the deductibility of new equity injections from personal tax.[48] In our setting, $\lambda^{INC,p} = 0$: new equity injections are *not* deductible from personal tax, such that marginal

[47] 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.

[48] 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

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 therefore effectively four legal forms: employee, self-employed, incorporated (one shareholder) and incorporated (two shareholders). Individuals do not choose whether to be a one or two shareholder company, this is instead allocated at random when they incorporate.

There are six 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).[49] 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.

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).

[49] 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 (3.10). Employees (and business owners in type I, for which we set θ = 0) simply set $k = 0$.

Since total assets, a, and the share of assets held in the company, $\tilde{a}^c$, are both state variables on exogenous grids, company assets $a^c = a \times \tilde{a}^c$ are known when the capital choice is evaluated. For incorporated owner-managers, we compute the optimal capital under both the retained-equity user cost ($\rho = \delta$) and the new-equity user cost, and select the regime-consistent candidate.

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 $\frac{\partial z}{\partial l} = -\omega(1-\theta)h^{-\theta}k^{\theta}$. 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. $c(\Omega|d', \tilde{a}^{c'})$.

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} (captured in $F_{dd'}$) and the logit shock associated with switching legal form, $\zeta_{d'}$.[50] The choice of legal form next period is then:

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

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

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 A, 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.

The simulation covers tax years 2000-01 to 2015-16. Our estimation sample consists of business owners active in 2013-14, with simulated moments computed over the period 2002-03 to 2013-14. The three tax regimes correspond to: (i) 2000-01—2002-03 and 2005-06—2010/11; (ii) 2003-04-–2004/05 (the 0% starting rate of corporation tax); and (iii) 2011-12-–2013/14 (higher rates on top incomes). 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 (£41,450), 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,

[50] In our numerical implementation, we normalize all value functions by σ_{ζ}, such that the inclusive value takes the standard log-sum-exp form without an explicit scale parameter. The Euler equation and switching costs are adjusted accordingly.

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%.[51]

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. The share of individuals that are business owners in the first year (i.e. 2000) is estimated in the MSM stage—this is pinned down by the information on the entry rates over time. We set the share of owner-managers that are incorporated in this first year using the estimated shares from the 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 recover the choices of leisure and capital by interpolating over the pre-solved intratemporal conditions and select the share of assets held in the company

[51] Although, satutory capital gains are calculated net of contributed principal, tracking lifetime shareholder basis would require an additional state variable. We therefore abstract from the exemption of the initial principal and treat terminal corporate assets as fully taxable gains, an approximation justified by the assumption that retained earnings and gains represent the vast majority of the accrued value at exit.

from the grid search described above. Because leisure and capital are not restricted to a grid, agents can locate 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 type-specific parameter vectors, $\hat{\theta}_j$, and the common discount factor, $\hat{\beta}$. The discount factor is common across types and is identified primarily from the retained profit moments for type V (the vast majority of high-income incorporated owner-managers belong to this type). We estimate β jointly with the type V parameters by minimising the type V objective function:

$$(\hat{\beta}, \hat{\theta}_j) = \arg\min G_j(\theta_j, \beta)' W_j G_j(\theta_j, \beta) \quad \text{for} \quad j = 5 \tag{E.2}$$

Conditional on $\hat{\beta}$, we estimate the remaining type-specific parameters independently for each type $j \neq 5$:

$$\hat{\theta}_j = \arg\min G_j(\theta_j; \hat{\beta})' W_j G_j(\theta_j; \hat{\beta}). \tag{E.3}$$

The type-specific parameter vector is:

$$\theta_j = (\sigma_\zeta, F_m^{start}, F_{d=OM}^{start}, F_{sd}^{start}, F_m^{inc}, F_{sd}^{inc}, \mu_\psi, \sigma_\psi, \sigma_\epsilon, \phi, \theta, \varsigma_{OM})_j \tag{E.4}$$

where ς_{OM} governs the share of individuals that are business owners 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 reported standard errors for the type-specific parameters are computed conditional on $\hat{\beta}$.

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 all parameters apart from β are type-specific, and therefore only affect the model fit for that type. The primary moments used to identify β are the 50th, 75th and 90th percentiles of retained profits, which are only relevant for incorporated owner-managers with sufficiently high incomes (the vast majority of whom are in type V).

In the first step, we fix the value of β, and draw 1000 candidate vectors for the type-specific parameters, $(\sigma_\zeta, F_m^{start}, F_{d=OM}^{start}, F_{sd}^{start}, F_m^{inc}, F_{sd}^{inc}, \mu_\psi, \sigma_\psi, \sigma_\epsilon, \phi, \theta, \varsigma_{OM})$, 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 take the parameter vector that corresponds to the smallest value of the objective function and use these as starting values for the next step.

In the second step, we use 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 function 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

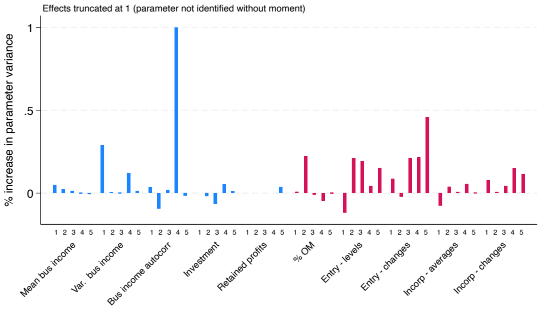
We calculate measures of sensitivity of the parameters to the included moments using the methods developed by Honoré et al. (2020).[52] We consider the change in the asymptotic variance from completely excluding the kth set of moments, relative to the baseline when all moments are included (this is measure 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 moments: (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) investment as a share of mean business income; (v) retained business income; (vi) share of business owners who are OM; (vii) average entry rates; (ix) changes in entry rates over time; (x) average incorporation rates; (xi) changes in incorporation rates over time.

Figure E.1 and E.2 shows the sensitivity of each parameter (each panel corresponds to a different parameter) to the groups of moments shown on the horizontal axis. The labels $1, \ldots, 5$ within each moment grouping correspond to the different business types. Larger values indicate that tthe set of moments is more informative for that parameter. Extremely large values indicate that the parameter is not identified when we remove that moment set (we truncate these at 1 to ensure the other patterns are still visible)—this is the case for θ and the investment share of business profit, as well as for the σ_ϵs and the variance and autocorrelation of business incomes. 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. Retained profits are informative about the discount factor. It is notable that the autocorrelation in business incomes plays a significant role in pinning down a number of parameters, highlighting the dynamic aspects of the model.

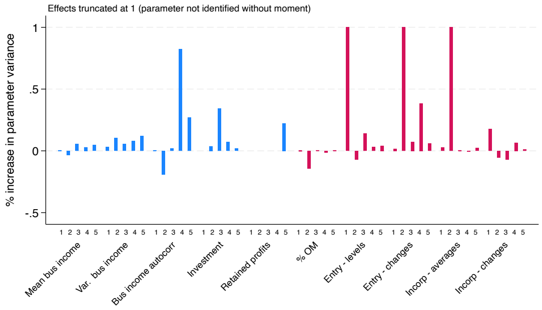
[52] These are similar to, and designed to complement, the measures proposed by Andrews et al. (2017)).

Figure E.1: *Moment informativeness*

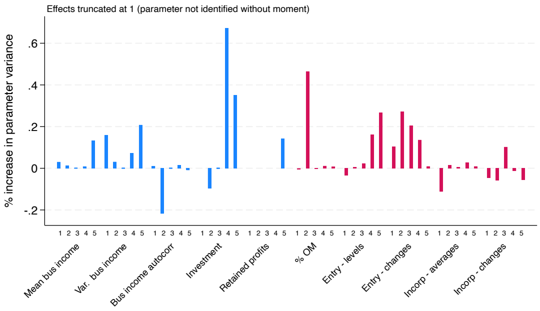
(a) Mean of start-up costs, F_m^{start}



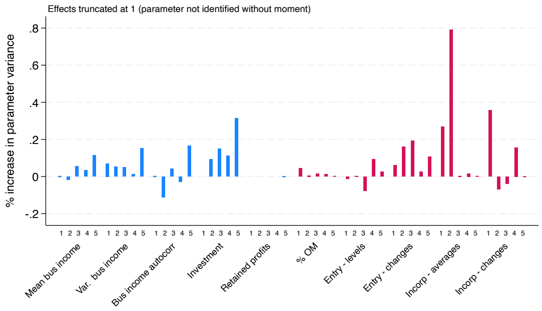
(b) Additional start-up costs for INC, $F^{start} \times d' = INC$



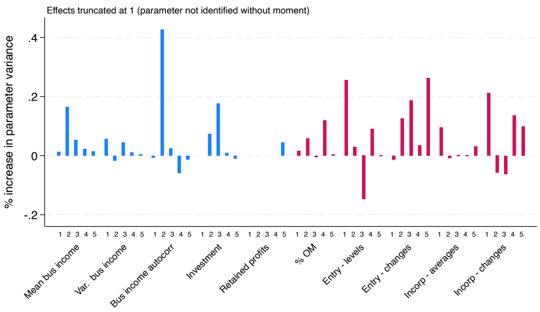
(c) Std. dev. of start-up costs, F_{sd}^{start}



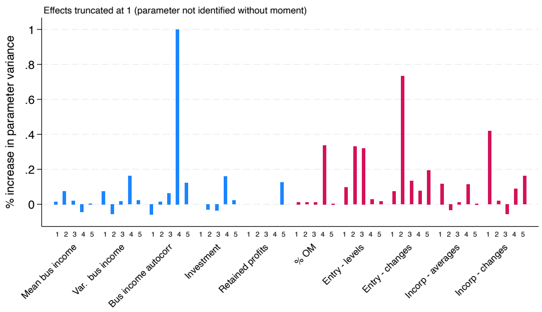
(d) Mean of incorporation costs, F_m^{inc}



(e) Std. dev. of incorporation costs, F_{sd}^{inc}



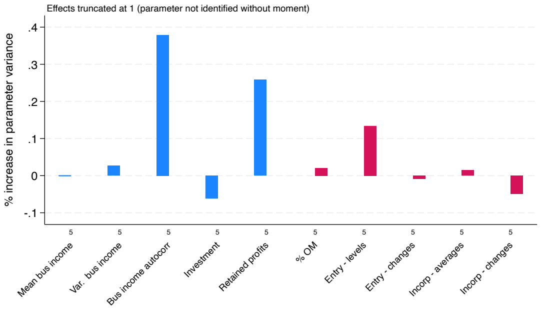
(f) Inverse of dispersion in logit shocks, $1/\sigma_\zeta$



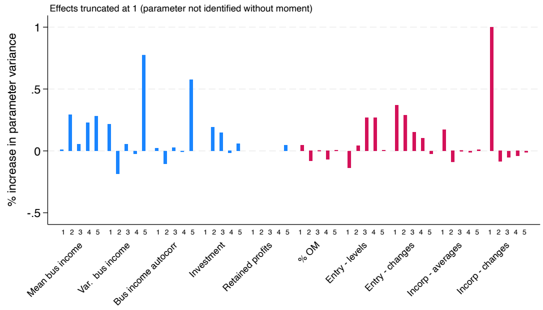
Notes: Each bar shows the change in the asympotic variance of parameter described at the top of each panel when the set of moments k are removed (shown on the horizontal axis), relative to the baseline asympotic variance when all moments are included. The effects are divided through by the number of moments in each set k, so they can be interpreted as a per-moment average. The blue bars correspond to moments that are predominantly related to incomes and profits, and the red bars to those that describe shifting between legal forms.

Figure E.2: *Moment informativeness*

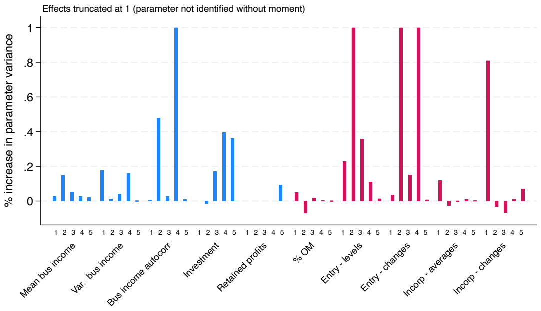
(a) Discount factor, β



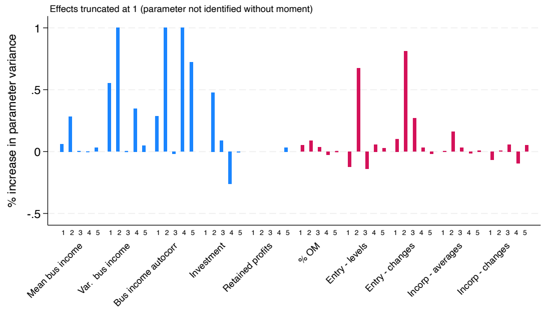
(b) Mean of latent productivity, μ_ψ



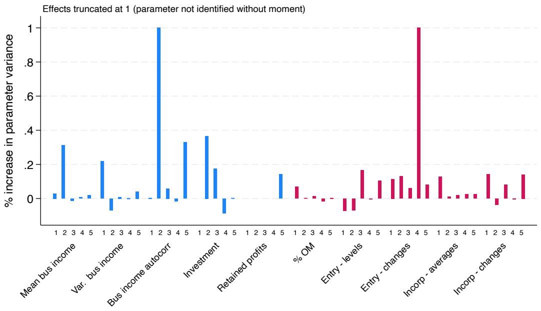
(c) Std. dev. of latent productivity, σ_ψ



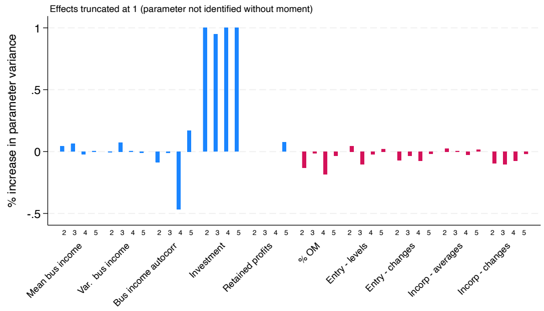
(d) Std. dev. of productivity shocks, σ_ϵ



(e) Persistence of productivity, ϕ



(f) Importance of capital in production, θ



Notes: Each bar shows the change in the asympotic variance of parameter described at the top of each panel (for the business owner type indicated on the horizontal axis) when the set of moments k are removed (also shown on the horizontal axis), relative to the baseline asympotic variance when all moments are included. The effects are divided through by the number of moments in each set k, so they can be interpreted as a per-moment average. The blue bars correspond to moments that are predominantly related to incomes and profits, and the red bars to those that describe shifting between legal forms.

E.4 Model properties

Table E.1: *Capital constraints by type*

	% businesses that are capital constrained	% businesses that are likely constrained due to insufficient company assets
I	0.0	0.0
II	1.6	0.2
III	7.8	2.0
IV	1.4	0.2
V	13.3	12.6

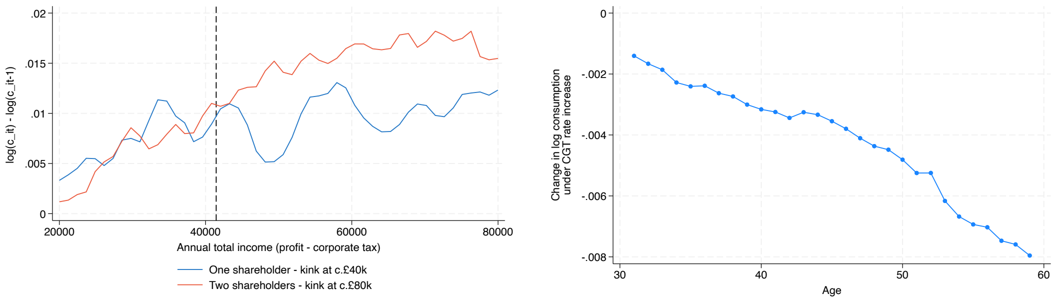
Notes: Business owners are defined to be capital constrained if their marginal product of capital exceeds the depreciation cost – the shares of business owner-years that suffer from this within each type are shown in the first column. The second column shows the share of business owner-years that are 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.

Figure E.3 provides further breakdown of the consumption responses to tax incentives implied by the model. The left hand panel shows consumption growth across the distribution of annual total income (measured as business profit minus corporate tax paid). It compare the growth rates for one shareholder companies (in blue, who face a kink in the incentive to retain at £41,500) and two shareholder companies (in red, who face a kink at £83,000). The difference in growth rates opens up just as total incomes cross the kink faced by the one-shareholder companies, with these owner-managers experiencing lower consumption growth of approximately 0.5 percentage point. These changes are meaningful, but also not huge, given the large differences in the post-tax rate of return. This suggests that the individuals are able to use personal savings to smooth consumption when retained more profits, but the fact that they do not retain all profits in excess of £40,000 indicates that there costs to doing so. The right hand panel shows the change in log consumption under the CGT rate rise (relative to baseline) across the age distribution for those who ran incorporated businesses at baseline. Consumption falls at all ages, as expected (their tax burden has increased), but with larger falls at older ages, since the tax advantage to deferring consumption has fallen.

Figure E.3: *Consumption responses to tax incentives*

(a) Consumption growth

(b) Change in lifecycle consumption



Notes: The left hand panel shows consumption growth as across the distribution of annual total income (measured as business profit minus corporate tax paid). The lines show the conditional mean of the annual difference in log consumption for one shareholder companies (in blue, who face a kink in the incentive to retain at £41,500) and two shareholder companies (in red, who face a kink at £83,000). The right panel shows the difference in log consumption under the increased rate of CGT compared with baseline across the lifecycle, for individuals that ran an incorporated business in the baseline world. Source: Model simulations.

F Sensitivity and robustness

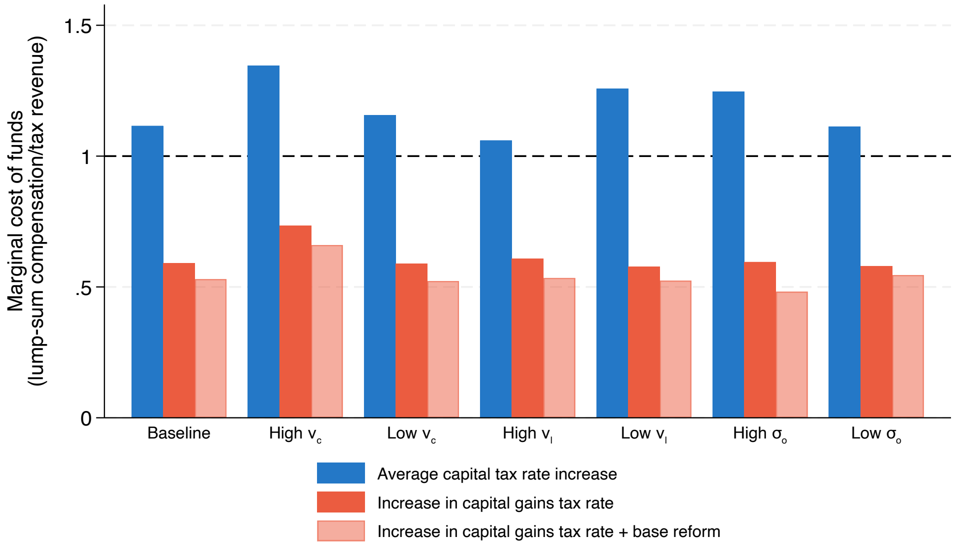
F.1 Sensitivity to model parameters

We show sensitivity of our results to three of the parameters that we calibrate that govern individuals' utilities.

First, we set the coefficient of relative risk aversion, ν_c, to a lower value, 0.7, and a higher value, 0.9, compared with our baseline value of 0.8. We adjust the scaling of utility so that it matches the average at baseline to avoid having to re-estimate the parameters governing the fixed costs of incorporation, start-up, and dispersion of the logit shocks. Second, we set the coefficient of relative risk aversion, ν_l, to a lower value, 1.25, and a higher value, 1.75, compared with our baseline value of 1.5. Third, we set the optimization error, ς_o, to a lower value, 0.015, and a higher value, 0.025, compared with our baseline value of 0.02. Tables F.1–F.3 compare the model moments (targeted in estimation) across these different parameter values. In general, varying the parameters in this way does not lead to large differences in the simulated model moments—further discussion is provided in the main text.

For each parameter value, we then re-solve and simulate under the three counterfactual tax reforms (and the baseline world). We compute the estimated efficiency cost, measured as the marginal cost of funds in each case. This is shown in Figure F.1. The main findings that the average capital tax rate reduces efficiency, and the CGT rises increase it (and by more if accompanied by base reform) are robust to varying the parameter values in this way.

Figure F.1: *Sensitivity of efficiency results to parameter estimates*



Notes: For each parameter value, we then re-solve and simulate under the three counterfactual tax reforms and the baseline world. The bars show the estimated efficiency cost, measured as the marginal cost of funds for each tax reform, under the parameter value shown on the horizontal axis.
Source: Model simulations.

Table F.1: *Sensitivity to ν_c*

		Type				
		I	II	III	IV	V
Mean bus income - INC	Baseline: $\nu_c = 0.8$	10412	21587	19391	34572	80062
	Sensitivity: $\nu_c = 0.9$	9860	20278	17314	34300	78876
	Sensitivity: $\nu_c = 0.7$	11511	23303	21695	34973	81257
Mean bus income - SE	Baseline: $\nu_c = 0.8$	7513	16764	15717	31550	77786
	Sensitivity: $\nu_c = 0.9$	7141	16233	14466	31515	78886
	Sensitivity: $\nu_c = 0.7$	7975	17318	17028	31647	76786
Std. dev. bus income - INC	Baseline: $\nu_c = 0.8$	7451	15746	23487	17040	46881
	Sensitivity: $\nu_c = 0.9$	7310	15148	21703	16734	45157
	Sensitivity: $\nu_c = 0.7$	8147	16523	25391	17443	48580
Std. dev. bus income - SE	Baseline: $\nu_c = 0.8$	5929	14116	21047	17306	47827
	Sensitivity: $\nu_c = 0.9$	5565	13639	19762	16977	47339
	Sensitivity: $\nu_c = 0.7$	6460	14602	22283	17701	48716
Coeff. on AR(1) of log bus income	Baseline: $\nu_c = 0.8$	0.16	0.24	0.14	0.30	0.35
	Sensitivity: $\nu_c = 0.9$	0.15	0.23	0.14	0.29	0.36
	Sensitivity: $\nu_c = 0.7$	0.16	0.24	0.14	0.30	0.35
Mean investment/mean bus income	Baseline: $\nu_c = 0.8$	–	0.20	0.51	0.04	0.04
	Sensitivity: $\nu_c = 0.9$	–	0.20	0.51	0.04	0.04
	Sensitivity: $\nu_c = 0.7$	–	0.20	0.51	0.04	0.04
Incorporation share - average	Baseline: $\nu_c = 0.8$	0.03	0.11	0.20	0.24	0.72
	Sensitivity: $\nu_c = 0.9$	0.03	0.10	0.19	0.24	0.73
	Sensitivity: $\nu_c = 0.7$	0.04	0.13	0.22	0.24	0.70
Entry rate for SE - 2002	Baseline: $\nu_c = 0.8$	0.18	0.06	0.07	0.07	0.03
	Sensitivity: $\nu_c = 0.9$	0.19	0.06	0.07	0.07	0.03
	Sensitivity: $\nu_c = 0.7$	0.19	0.06	0.08	0.07	0.03
Entry rate for SE - 2003	Baseline: $\nu_c = 0.8$	0.18	0.08	0.07	0.08	0.03
	Sensitivity: $\nu_c = 0.9$	0.18	0.07	0.07	0.08	0.03
	Sensitivity: $\nu_c = 0.7$	0.18	0.08	0.08	0.08	0.03
Entry rate for SE - 2004	Baseline: $\nu_c = 0.8$	0.20	0.08	0.08	0.08	0.03
	Sensitivity: $\nu_c = 0.9$	0.20	0.08	0.07	0.08	0.03
	Sensitivity: $\nu_c = 0.7$	0.21	0.07	0.08	0.08	0.03
Entry rate for SE - 2005	Baseline: $\nu_c = 0.8$	0.18	0.08	0.07	0.06	0.02
	Sensitivity: $\nu_c = 0.9$	0.19	0.08	0.07	0.07	0.02
	Sensitivity: $\nu_c = 0.7$	0.18	0.08	0.07	0.06	0.02
Entry rate for SE - average	Baseline: $\nu_c = 0.8$	0.19	0.09	0.08	0.07	0.02
	Sensitivity: $\nu_c = 0.9$	0.20	0.09	0.08	0.07	0.02
	Sensitivity: $\nu_c = 0.7$	0.19	0.09	0.08	0.07	0.02
Entry rate for INC - 2002	Baseline: $\nu_c = 0.8$	0.00	0.00	0.01	0.01	0.07
	Sensitivity: $\nu_c = 0.9$	0.00	0.00	0.01	0.01	0.07
	Sensitivity: $\nu_c = 0.7$	0.00	0.01	0.01	0.01	0.07
Entry rate for INC - 2003	Baseline: $\nu_c = 0.8$	0.00	0.01	0.01	0.02	0.08
	Sensitivity: $\nu_c = 0.9$	0.00	0.01	0.01	0.02	0.08
	Sensitivity: $\nu_c = 0.7$	0.00	0.01	0.02	0.02	0.08
Entry rate for INC - 2004	Baseline: $\nu_c = 0.8$	0.00	0.01	0.01	0.02	0.06
	Sensitivity: $\nu_c = 0.9$	0.01	0.01	0.01	0.02	0.07
	Sensitivity: $\nu_c = 0.7$	0.01	0.01	0.02	0.02	0.06
Entry rate for INC - 2005	Baseline: $\nu_c = 0.8$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\nu_c = 0.9$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\nu_c = 0.7$	0.00	0.00	0.01	0.01	0.04
Entry rate for INC - average	Baseline: $\nu_c = 0.8$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\nu_c = 0.9$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\nu_c = 0.7$	0.00	0.00	0.01	0.01	0.04
Incorporation rate - 2002	Baseline: $\nu_c = 0.8$	0.10	0.13	0.12	0.14	0.15
	Sensitivity: $\nu_c = 0.9$	0.07	0.12	0.10	0.14	0.16
	Sensitivity: $\nu_c = 0.7$	0.09	0.16	0.13	0.14	0.14
Incorporation rate - 2003	Baseline: $\nu_c = 0.8$	0.21	0.23	0.17	0.22	0.16
	Sensitivity: $\nu_c = 0.9$	0.19	0.24	0.15	0.23	0.16
	Sensitivity: $\nu_c = 0.7$	0.24	0.23	0.18	0.21	0.16
Incorporation rate - 2004	Baseline: $\nu_c = 0.8$	0.21	0.20	0.13	0.16	0.13
	Sensitivity: $\nu_c = 0.9$	0.22	0.20	0.11	0.16	0.13
	Sensitivity: $\nu_c = 0.7$	0.26	0.20	0.13	0.16	0.12
Incorporation rate - 2005	Baseline: $\nu_c = 0.8$	0.13	0.10	0.11	0.08	0.08
	Sensitivity: $\nu_c = 0.9$	0.17	0.07	0.09	0.08	0.08
	Sensitivity: $\nu_c = 0.7$	0.13	0.08	0.10	0.08	0.08
Incorporation rate - average	Baseline: $\nu_c = 0.8$	0.14	0.11	0.10	0.09	0.08
	Sensitivity: $\nu_c = 0.9$	0.15	0.11	0.10	0.09	0.08
	Sensitivity: $\nu_c = 0.7$	0.14	0.10	0.10	0.09	0.08
Incorporation rate (from SE only) - 2002	Baseline: $\nu_c = 0.8$	0.04	0.08	0.06	0.07	0.05
	Sensitivity: $\nu_c = 0.9$	0.02	0.08	0.05	0.08	0.05
	Sensitivity: $\nu_c = 0.7$	0.04	0.11	0.06	0.07	0.04
Incorporation rate (from SE only) - 2003	Baseline: $\nu_c = 0.8$	0.11	0.17	0.11	0.12	0.05
	Sensitivity: $\nu_c = 0.9$	0.08	0.18	0.08	0.13	0.05
	Sensitivity: $\nu_c = 0.7$	0.15	0.15	0.09	0.12	0.05
Incorporation rate (from SE only) - 2004	Baseline: $\nu_c = 0.8$	0.10	0.14	0.06	0.08	0.04
	Sensitivity: $\nu_c = 0.9$	0.09	0.14	0.05	0.08	0.04
	Sensitivity: $\nu_c = 0.7$	0.10	0.12	0.06	0.08	0.04
Incorporation rate (from SE only) - 2005	Baseline: $\nu_c = 0.8$	0.05	0.07	0.06	0.04	0.02
	Sensitivity: $\nu_c = 0.9$	0.06	0.05	0.05	0.04	0.02
	Sensitivity: $\nu_c = 0.7$	0.03	0.05	0.05	0.04	0.02
Incorporation rate (from SE only) - average	Baseline: $\nu_c = 0.8$	0.07	0.07	0.06	0.05	0.02
	Sensitivity: $\nu_c = 0.9$	0.07	0.07	0.05	0.05	0.03
	Sensitivity: $\nu_c = 0.7$	0.07	0.07	0.05	0.05	0.02
p.50 retained profits for high-income businesses	Baseline: $\nu_c = 0.8$			2287		
	Sensitivity: $\nu_c = 0.9$			2394		
	Sensitivity: $\nu_c = 0.7$			2035		
p.75 retained profits for high-income businesses	Baseline: $\nu_c = 0.8$			16385		
	Sensitivity: $\nu_c = 0.9$			16113		
	Sensitivity: $\nu_c = 0.7$			16453		
p.90 retained profits for high-income businesses	Baseline: $\nu_c = 0.8$			34586		
	Sensitivity: $\nu_c = 0.9$			33768		
	Sensitivity: $\nu_c = 0.7$			35079		

Notes: The table shows sensitivity of the model moments to higher and lower values of ν_c.

Table F.2: *Sensitivity to ν_l*

		Type				
		I	II	III	IV	V
Mean bus income - INC	Baseline: $\nu_l = 1.50$	10412	21587	19391	34572	80062
	Sensitivity: $\nu_l = 1.75$	10481	21323	19059	34495	79733
	Sensitivity: $\nu_l = 1.25$	10718	21612	19608	34821	80448
Mean bus income - SE	Baseline: $\nu_l = 1.50$	7513	16764	15717	31550	77786
	Sensitivity: $\nu_l = 1.75$	7431	16671	15555	31232	77372
	Sensitivity: $\nu_l = 1.25$	7562	16915	15938	31942	77745
Std. dev. bus income - INC	Baseline: $\nu_l = 1.50$	7451	15746	23487	17040	46881
	Sensitivity: $\nu_l = 1.75$	7320	14967	22416	16330	45052
	Sensitivity: $\nu_l = 1.25$	7997	16490	24626	17960	49129
Std. dev. bus income - SE	Baseline: $\nu_l = 1.50$	5929	14116	21047	17306	47827
	Sensitivity: $\nu_l = 1.75$	5685	13445	20198	16401	45516
	Sensitivity: $\nu_l = 1.25$	6293	14937	22105	18430	50899
Coeff. on AR(1) of log bus income	Baseline: $\nu_l = 1.50$	0.16	0.24	0.14	0.30	0.35
	Sensitivity: $\nu_l = 1.75$	0.18	0.26	0.14	0.30	0.37
	Sensitivity: $\nu_l = 1.25$	0.14	0.22	0.14	0.25	0.34
Mean investment/mean bus income	Baseline: $\nu_l = 1.50$	–	0.20	0.51	0.04	0.04
	Sensitivity: $\nu_l = 1.75$	–	0.20	0.51	0.04	0.04
	Sensitivity: $\nu_l = 1.25$	–	0.20	0.51	0.04	0.04
Incorporation share - average	Baseline: $\nu_l = 1.50$	0.03	0.11	0.20	0.24	0.72
	Sensitivity: $\nu_l = 1.75$	0.03	0.11	0.20	0.24	0.71
	Sensitivity: $\nu_l = 1.25$	0.03	0.12	0.20	0.24	0.72
Entry rate for SE - 2002	Baseline: $\nu_l = 1.50$	0.18	0.06	0.07	0.07	0.03
	Sensitivity: $\nu_l = 1.75$	0.19	0.06	0.07	0.07	0.03
	Sensitivity: $\nu_l = 1.25$	0.19	0.06	0.07	0.07	0.03
Entry rate for SE - 2003	Baseline: $\nu_l = 1.50$	0.18	0.08	0.07	0.08	0.03
	Sensitivity: $\nu_l = 1.75$	0.18	0.08	0.07	0.08	0.03
	Sensitivity: $\nu_l = 1.25$	0.18	0.08	0.07	0.08	0.03
Entry rate for SE - 2004	Baseline: $\nu_l = 1.50$	0.20	0.08	0.08	0.08	0.03
	Sensitivity: $\nu_l = 1.75$	0.21	0.08	0.08	0.08	0.03
	Sensitivity: $\nu_l = 1.25$	0.21	0.08	0.08	0.08	0.03
Entry rate for SE - 2005	Baseline: $\nu_l = 1.50$	0.18	0.08	0.07	0.06	0.02
	Sensitivity: $\nu_l = 1.75$	0.19	0.08	0.06	0.07	0.02
	Sensitivity: $\nu_l = 1.25$	0.18	0.08	0.07	0.06	0.02
Entry rate for SE - average	Baseline: $\nu_l = 1.50$	0.19	0.09	0.08	0.07	0.02
	Sensitivity: $\nu_l = 1.75$	0.20	0.09	0.08	0.07	0.02
	Sensitivity: $\nu_l = 1.25$	0.19	0.09	0.08	0.07	0.02
Entry rate for INC - 2002	Baseline: $\nu_l = 1.50$	0.00	0.00	0.01	0.01	0.07
	Sensitivity: $\nu_l = 1.75$	0.00	0.00	0.01	0.01	0.07
	Sensitivity: $\nu_l = 1.25$	0.00	0.00	0.01	0.01	0.07
Entry rate for INC - 2003	Baseline: $\nu_l = 1.50$	0.00	0.01	0.01	0.02	0.08
	Sensitivity: $\nu_l = 1.75$	0.00	0.01	0.01	0.02	0.08
	Sensitivity: $\nu_l = 1.25$	0.00	0.01	0.01	0.02	0.08
Entry rate for INC - 2004	Baseline: $\nu_l = 1.50$	0.00	0.01	0.01	0.02	0.06
	Sensitivity: $\nu_l = 1.75$	0.01	0.01	0.01	0.02	0.06
	Sensitivity: $\nu_l = 1.25$	0.01	0.01	0.01	0.02	0.07
Entry rate for INC - 2005	Baseline: $\nu_l = 1.50$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\nu_l = 1.75$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\nu_l = 1.25$	0.00	0.00	0.01	0.01	0.04
Entry rate for INC - average	Baseline: $\nu_l = 1.50$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\nu_l = 1.75$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\nu_l = 1.25$	0.00	0.00	0.01	0.01	0.04
Incorporation rate - 2002	Baseline: $\nu_l = 1.50$	0.10	0.13	0.12	0.14	0.15
	Sensitivity: $\nu_l = 1.75$	0.10	0.13	0.12	0.14	0.14
	Sensitivity: $\nu_l = 1.25$	0.10	0.15	0.12	0.13	0.15
Incorporation rate - 2003	Baseline: $\nu_l = 1.50$	0.21	0.23	0.17	0.22	0.16
	Sensitivity: $\nu_l = 1.75$	0.22	0.24	0.16	0.22	0.16
	Sensitivity: $\nu_l = 1.25$	0.21	0.22	0.17	0.22	0.16
Incorporation rate - 2004	Baseline: $\nu_l = 1.50$	0.21	0.20	0.13	0.16	0.13
	Sensitivity: $\nu_l = 1.75$	0.23	0.21	0.12	0.16	0.12
	Sensitivity: $\nu_l = 1.25$	0.22	0.21	0.12	0.16	0.13
Incorporation rate - 2005	Baseline: $\nu_l = 1.50$	0.13	0.10	0.11	0.08	0.08
	Sensitivity: $\nu_l = 1.75$	0.13	0.10	0.10	0.08	0.08
	Sensitivity: $\nu_l = 1.25$	0.14	0.08	0.11	0.08	0.08
Incorporation rate - average	Baseline: $\nu_l = 1.50$	0.14	0.11	0.10	0.09	0.08
	Sensitivity: $\nu_l = 1.75$	0.15	0.11	0.10	0.09	0.08
	Sensitivity: $\nu_l = 1.25$	0.14	0.10	0.10	0.09	0.08
Incorporation rate (from SE only) - 2002	Baseline: $\nu_l = 1.50$	0.04	0.08	0.06	0.07	0.05
	Sensitivity: $\nu_l = 1.75$	0.04	0.08	0.06	0.07	0.05
	Sensitivity: $\nu_l = 1.25$	0.04	0.10	0.06	0.07	0.05
Incorporation rate (from SE only) - 2003	Baseline: $\nu_l = 1.50$	0.11	0.17	0.11	0.12	0.05
	Sensitivity: $\nu_l = 1.75$	0.12	0.18	0.10	0.13	0.05
	Sensitivity: $\nu_l = 1.25$	0.11	0.14	0.11	0.13	0.05
Incorporation rate (from SE only) - 2004	Baseline: $\nu_l = 1.50$	0.10	0.14	0.06	0.08	0.04
	Sensitivity: $\nu_l = 1.75$	0.10	0.15	0.06	0.09	0.04
	Sensitivity: $\nu_l = 1.25$	0.08	0.14	0.05	0.08	0.04
Incorporation rate (from SE only) - 2005	Baseline: $\nu_l = 1.50$	0.05	0.07	0.06	0.04	0.02
	Sensitivity: $\nu_l = 1.75$	0.05	0.07	0.06	0.04	0.02
	Sensitivity: $\nu_l = 1.25$	0.05	0.06	0.06	0.04	0.02
Incorporation rate (from SE only) - average	Baseline: $\nu_l = 1.50$	0.07	0.07	0.06	0.05	0.02
	Sensitivity: $\nu_l = 1.75$	0.07	0.07	0.06	0.05	0.02
	Sensitivity: $\nu_l = 1.25$	0.07	0.07	0.06	0.05	0.03
p.50 retained profits for high-income businesses	Baseline: $\nu_l = 1.50$			2287		
	Sensitivity: $\nu_l = 1.75$			1700		
	Sensitivity: $\nu_l = 1.25$			3197		
p.75 retained profits for high-income businesses	Baseline: $\nu_l = 1.50$			16385		
	Sensitivity: $\nu_l = 1.75$			15430		
	Sensitivity: $\nu_l = 1.25$			18411		
p.90 retained profits for high-income businesses	Baseline: $\nu_l = 1.50$			34586		
	Sensitivity: $\nu_l = 1.75$			33514		
	Sensitivity: $\nu_l = 1.25$			36930		

Notes: The table shows sensitivity of the model moments to higher and lower values of ν_l.

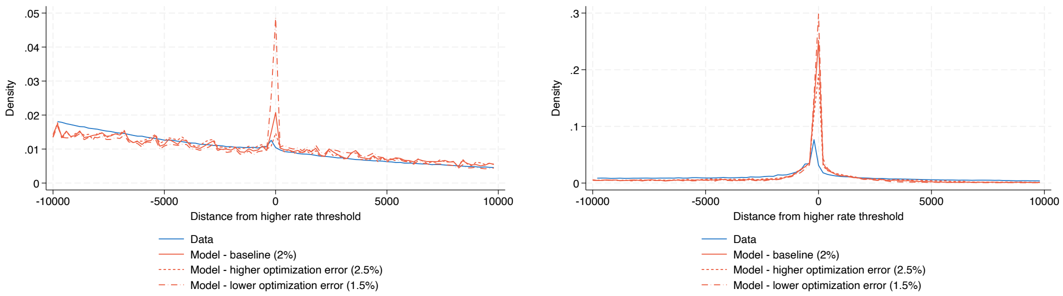
Table F.3: *Sensitivity to ς_o*

		Type				
		I	II	III	IV	V
Mean bus income - INC	Baseline: $\varsigma_o = 0.020$	10412	21587	19391	34572	80062
	Sensitivity: $\varsigma_o = 0.025$	10665	21933	19573	35583	80918
	Sensitivity: $\varsigma_o = 0.015$	10205	21263	19148	33961	79631
Mean bus income - SE	Baseline: $\varsigma_o = 0.020$	7513	16764	15717	31550	77786
	Sensitivity: $\varsigma_o = 0.025$	7622	16857	15865	31656	79926
	Sensitivity: $\varsigma_o = 0.015$	7490	16684	15583	31213	74553
Std. dev. bus income - INC	Baseline: $\varsigma_o = 0.020$	7451	15746	23487	17040	46881
	Sensitivity: $\varsigma_o = 0.025$	7785	15859	23743	17299	47525
	Sensitivity: $\varsigma_o = 0.015$	7182	15442	23087	16613	46236
Std. dev. bus income - SE	Baseline: $\varsigma_o = 0.020$	5929	14116	21047	17306	47827
	Sensitivity: $\varsigma_o = 0.025$	6159	14226	21309	17419	49036
	Sensitivity: $\varsigma_o = 0.015$	5885	13934	20749	16811	46957
Coeff. on AR(1) of log bus income	Baseline: $\varsigma_o = 0.020$	0.16	0.24	0.14	0.30	0.35
	Sensitivity: $\varsigma_o = 0.025$	0.17	0.24	0.14	0.30	0.35
	Sensitivity: $\varsigma_o = 0.015$	0.16	0.24	0.14	0.30	0.34
Mean investment/mean bus income	Baseline: $\varsigma_o = 0.020$	–	0.20	0.51	0.04	0.04
	Sensitivity: $\varsigma_o = 0.025$	–	0.20	0.51	0.04	0.04
	Sensitivity: $\varsigma_o = 0.015$	–	0.20	0.51	0.04	0.04
Incorporation share - average	Baseline: $\varsigma_o = 0.020$	0.03	0.11	0.20	0.24	0.72
	Sensitivity: $\varsigma_o = 0.025$	0.03	0.11	0.20	0.24	0.71
	Sensitivity: $\varsigma_o = 0.015$	0.03	0.11	0.20	0.24	0.72
Entry rate for SE - 2002	Baseline: $\varsigma_o = 0.020$	0.18	0.06	0.07	0.07	0.03
	Sensitivity: $\varsigma_o = 0.025$	0.18	0.06	0.07	0.07	0.03
	Sensitivity: $\varsigma_o = 0.015$	0.18	0.06	0.07	0.07	0.03
Entry rate for SE - 2003	Baseline: $\varsigma_o = 0.020$	0.18	0.08	0.07	0.08	0.03
	Sensitivity: $\varsigma_o = 0.025$	0.18	0.08	0.07	0.08	0.03
	Sensitivity: $\varsigma_o = 0.015$	0.18	0.08	0.07	0.08	0.03
Entry rate for SE - 2004	Baseline: $\varsigma_o = 0.020$	0.20	0.08	0.08	0.08	0.03
	Sensitivity: $\varsigma_o = 0.025$	0.20	0.08	0.08	0.08	0.03
	Sensitivity: $\varsigma_o = 0.015$	0.20	0.08	0.08	0.08	0.03
Entry rate for SE - 2005	Baseline: $\varsigma_o = 0.020$	0.18	0.08	0.07	0.06	0.02
	Sensitivity: $\varsigma_o = 0.025$	0.18	0.08	0.06	0.06	0.02
	Sensitivity: $\varsigma_o = 0.015$	0.18	0.08	0.06	0.06	0.02
Entry rate for SE - average	Baseline: $\varsigma_o = 0.020$	0.19	0.09	0.08	0.07	0.02
	Sensitivity: $\varsigma_o = 0.025$	0.19	0.09	0.08	0.07	0.02
	Sensitivity: $\varsigma_o = 0.015$	0.19	0.09	0.08	0.07	0.02
Entry rate for INC - 2002	Baseline: $\varsigma_o = 0.020$	0.00	0.00	0.01	0.01	0.07
	Sensitivity: $\varsigma_o = 0.025$	0.00	0.00	0.01	0.01	0.07
	Sensitivity: $\varsigma_o = 0.015$	0.00	0.00	0.01	0.01	0.07
Entry rate for INC - 2003	Baseline: $\varsigma_o = 0.020$	0.00	0.01	0.01	0.02	0.08
	Sensitivity: $\varsigma_o = 0.025$	0.00	0.01	0.01	0.02	0.08
	Sensitivity: $\varsigma_o = 0.015$	0.00	0.01	0.01	0.02	0.08
Entry rate for INC - 2004	Baseline: $\varsigma_o = 0.020$	0.00	0.01	0.01	0.02	0.06
	Sensitivity: $\varsigma_o = 0.025$	0.00	0.01	0.01	0.02	0.06
	Sensitivity: $\varsigma_o = 0.015$	0.00	0.01	0.01	0.02	0.07
Entry rate for INC - 2005	Baseline: $\varsigma_o = 0.020$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\varsigma_o = 0.025$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\varsigma_o = 0.015$	0.00	0.00	0.01	0.01	0.04
Entry rate for INC - average	Baseline: $\varsigma_o = 0.020$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\varsigma_o = 0.025$	0.00	0.00	0.01	0.01	0.04
	Sensitivity: $\varsigma_o = 0.015$	0.00	0.00	0.01	0.01	0.04
Incorporation rate - 2002	Baseline: $\varsigma_o = 0.020$	0.10	0.13	0.12	0.14	0.15
	Sensitivity: $\varsigma_o = 0.025$	0.10	0.13	0.11	0.14	0.15
	Sensitivity: $\varsigma_o = 0.015$	0.10	0.13	0.11	0.13	0.15
Incorporation rate - 2003	Baseline: $\varsigma_o = 0.020$	0.21	0.23	0.17	0.22	0.16
	Sensitivity: $\varsigma_o = 0.025$	0.21	0.23	0.17	0.22	0.16
	Sensitivity: $\varsigma_o = 0.015$	0.21	0.23	0.17	0.22	0.16
Incorporation rate - 2004	Baseline: $\varsigma_o = 0.020$	0.21	0.20	0.13	0.16	0.13
	Sensitivity: $\varsigma_o = 0.025$	0.21	0.20	0.12	0.16	0.13
	Sensitivity: $\varsigma_o = 0.015$	0.21	0.21	0.12	0.16	0.13
Incorporation rate - 2005	Baseline: $\varsigma_o = 0.020$	0.13	0.10	0.11	0.08	0.08
	Sensitivity: $\varsigma_o = 0.025$	0.12	0.10	0.11	0.08	0.08
	Sensitivity: $\varsigma_o = 0.015$	0.13	0.10	0.11	0.08	0.08
Incorporation rate - average	Baseline: $\varsigma_o = 0.020$	0.14	0.11	0.10	0.09	0.08
	Sensitivity: $\varsigma_o = 0.025$	0.14	0.11	0.10	0.09	0.08
	Sensitivity: $\varsigma_o = 0.015$	0.14	0.11	0.10	0.09	0.08
Incorporation rate (from SE only) - 2002	Baseline: $\varsigma_o = 0.020$	0.04	0.08	0.06	0.07	0.05
	Sensitivity: $\varsigma_o = 0.025$	0.04	0.08	0.06	0.07	0.05
	Sensitivity: $\varsigma_o = 0.015$	0.04	0.08	0.06	0.07	0.05
Incorporation rate (from SE only) - 2003	Baseline: $\varsigma_o = 0.020$	0.11	0.17	0.11	0.12	0.05
	Sensitivity: $\varsigma_o = 0.025$	0.11	0.17	0.11	0.12	0.05
	Sensitivity: $\varsigma_o = 0.015$	0.11	0.17	0.11	0.13	0.05
Incorporation rate (from SE only) - 2004	Baseline: $\varsigma_o = 0.020$	0.10	0.14	0.06	0.08	0.04
	Sensitivity: $\varsigma_o = 0.025$	0.10	0.14	0.06	0.09	0.04
	Sensitivity: $\varsigma_o = 0.015$	0.10	0.15	0.06	0.09	0.04
Incorporation rate (from SE only) - 2005	Baseline: $\varsigma_o = 0.020$	0.05	0.07	0.06	0.04	0.02
	Sensitivity: $\varsigma_o = 0.025$	0.05	0.07	0.06	0.04	0.02
	Sensitivity: $\varsigma_o = 0.015$	0.05	0.07	0.06	0.04	0.02
Incorporation rate (from SE only) - average	Baseline: $\varsigma_o = 0.020$	0.07	0.07	0.06	0.05	0.02
	Sensitivity: $\varsigma_o = 0.025$	0.07	0.07	0.06	0.05	0.03
	Sensitivity: $\varsigma_o = 0.015$	0.07	0.07	0.06	0.05	0.02
p.50 retained profits for high-income businesses	Baseline: $\varsigma_o = 0.020$			2287		
	Sensitivity: $\varsigma_o = 0.025$			-817		
	Sensitivity: $\varsigma_o = 0.015$			5881		
p.75 retained profits for high-income businesses	Baseline: $\varsigma_o = 0.020$			16385		
	Sensitivity: $\varsigma_o = 0.025$			12936		
	Sensitivity: $\varsigma_o = 0.015$			20369		
p.90 retained profits for high-income businesses	Baseline: $\varsigma_o = 0.020$			34586		
	Sensitivity: $\varsigma_o = 0.025$			31122		
	Sensitivity: $\varsigma_o = 0.015$			38804		

Notes: The table shows sensitivity of the model moments to higher and lower values of ς_o.

Figure F.2: *Bunching sensitivity to optimization error*

(a) Bunching by self-employed OMs (b) Bunching by incorporated OMs



Notes: The figure shows the distributions of taxable income around the higher rate threshold in the data (blue lines) and simulated from the model under the baseline value of the optimation error (2%), and higher (2.5%) and lower (1.5%) values. The top panel shows bunching for the self-employed and the bottom panel for incorporated owner-managers.
Source: Data and model simulations.

F.2 Sensitivity to included moments

We extend the methods developed by Honoré et al. (2020) and used in Appendix E.3 to show how our estimated efficiency costs depend on moments included. The idea behind the approach is to remove the kth set of moments, and then compute the perturbed variance-covariance matrix associated with the model parameters. Using this perturbed matrix, we take 100 bootstrap draws—for each, we re-solve and simulate the model under both the baseline world and the three counterfactual tax reforms, and compute the marginal cost of funds. Taking the 2.5th and 97.5th percentiles across the 100 draws gives us 95% confidence intervals for the MCFs, reported in Table F.4. We use a similar approach to construct 95% confidence intervals using the unperturbed variance-covariance matrix of the parameters.

This is computationally intensive, as, for each moment set, we need to re-solve and simulate the model 400 times (100 $\times$ the four policy environments). We therefore perform this exercise for the two moment sets that correspond most closely to the variation driven by tax incentives in the model: changes in incorporation rates and the distribution of retained profits. The changes in the confidence intervals show how removing these moments affects the precision of the estimated efficiency costs. Removing the retained profits and the incorporation moments slightly *tighten* the precision of the estimated MCF of the average capital tax rate increase, but *reduces* it for the CGT rate rises. Nonetheless, the effects are small.

Table F.4: *Efficiency effects of tax reforms, confidence intervals and moment sensitivity*

		CGT rate increase	
	Average capital tax rate increase	+ base unchanged	+ base reform
Marginal cost of funds	1.116	0.591	0.530
95% confidence intervals:			
Baseline	[1.067, 1.149]	[0.582, 0.603]	[0.522, 0.540]
Moments on retained profits removed	[1.070, 1.137]	[0.582, 0.605]	[0.521, 0.542]
Moments on incorporation rate changes removed	[1.075, 1.135]	[0.580, 0.602]	[0.518, 0.541]

Notes: The first column shows the effect of a 1 percentage point increase in the 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, 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. Cost of funds is defined as lump sum compensation (calculated as the sum of equivalent variation necessary to make individuals indifferent between the baseline regime and the tax reform package) over revenue raised.
Source: Model simulations.

F.3 Robustness to model extensions

Table F.5: *Robustness to asymmetric financing cost*

		Type				
		I	II	III	IV	V
Mean bus income - INC	Baseline: equal financing cost	10412	21587	19391	34572	80062
	Robustness: lower financing cost for INC	10412	22002	19823	34569	80140
Mean bus income - SE	Baseline: equal financing cost	7513	16764	15717	31550	77786
	Robustness: lower financing cost for INC	7513	16830	15717	31543	77697
Std. dev. bus income - INC	Baseline: equal financing cost	7451	15746	23487	17040	46881
	Robustness: lower financing cost for INC	7451	15856	24104	17021	47021
Std. dev. bus income - SE	Baseline: equal financing cost	5929	14116	21047	17306	47827
	Robustness: lower financing cost for INC	5929	14148	21086	17307	47811
Coeff. on AR(1) of log bus income	Baseline: equal financing cost	0.16	0.24	0.14	0.30	0.35
	Robustness: lower financing cost for INC	0.16	0.25	0.14	0.30	0.34
Mean investment/mean bus income	Baseline: equal financing cost	–	0.20	0.51	0.04	0.04
	Robustness: lower financing cost for INC	–	0.20	0.53	0.04	0.04
Incorporation share - average	Baseline: equal financing cost	0.03	0.11	0.20	0.24	0.72
	Robustness: lower financing cost for INC	0.03	0.11	0.20	0.24	0.72
Entry rate for SE - 2002	Baseline: equal financing cost	0.18	0.06	0.07	0.07	0.03
	Robustness: lower financing cost for INC	0.18	0.06	0.07	0.07	0.03
Entry rate for SE - 2003	Baseline: equal financing cost	0.18	0.08	0.07	0.08	0.03
	Robustness: lower financing cost for INC	0.18	0.08	0.07	0.08	0.03
Entry rate for SE - 2004	Baseline: equal financing cost	0.20	0.08	0.08	0.08	0.03
	Robustness: lower financing cost for INC	0.20	0.08	0.08	0.08	0.03
Entry rate for SE - 2005	Baseline: equal financing cost	0.18	0.08	0.07	0.06	0.02
	Robustness: lower financing cost for INC	0.18	0.08	0.06	0.06	0.02
Entry rate for SE - average	Baseline: equal financing cost	0.19	0.09	0.08	0.07	0.02
	Robustness: lower financing cost for INC	0.19	0.09	0.08	0.07	0.02
Entry rate for INC - 2002	Baseline: equal financing cost	0.00	0.00	0.01	0.01	0.07
	Robustness: lower financing cost for INC	0.00	0.00	0.01	0.01	0.07
Entry rate for INC - 2003	Baseline: equal financing cost	0.00	0.01	0.01	0.02	0.08
	Robustness: lower financing cost for INC	0.00	0.01	0.01	0.02	0.08
Entry rate for INC - 2004	Baseline: equal financing cost	0.00	0.01	0.01	0.02	0.06
	Robustness: lower financing cost for INC	0.00	0.01	0.01	0.02	0.06
Entry rate for INC - 2005	Baseline: equal financing cost	0.00	0.00	0.01	0.01	0.04
	Robustness: lower financing cost for INC	0.00	0.00	0.01	0.01	0.04
Entry rate for INC - average	Baseline: equal financing cost	0.00	0.00	0.01	0.01	0.04
	Robustness: lower financing cost for INC	0.00	0.00	0.01	0.01	0.04
Incorporation rate - 2002	Baseline: equal financing cost	0.10	0.13	0.12	0.14	0.15
	Robustness: lower financing cost for INC	0.10	0.12	0.11	0.13	0.15
Incorporation rate - 2003	Baseline: equal financing cost	0.21	0.23	0.17	0.22	0.16
	Robustness: lower financing cost for INC	0.21	0.23	0.14	0.22	0.16
Incorporation rate - 2004	Baseline: equal financing cost	0.21	0.20	0.13	0.16	0.13
	Robustness: lower financing cost for INC	0.21	0.22	0.10	0.16	0.12
Incorporation rate - 2005	Baseline: equal financing cost	0.13	0.10	0.11	0.08	0.08
	Robustness: lower financing cost for INC	0.13	0.08	0.08	0.08	0.08
Incorporation rate - average	Baseline: equal financing cost	0.14	0.11	0.10	0.09	0.08
	Robustness: lower financing cost for INC	0.14	0.10	0.08	0.09	0.08
Incorporation rate (from SE only) - 2002	Baseline: equal financing cost	0.04	0.08	0.06	0.07	0.05
	Robustness: lower financing cost for INC	0.04	0.08	0.05	0.07	0.05
Incorporation rate (from SE only) - 2003	Baseline: equal financing cost	0.11	0.17	0.11	0.12	0.05
	Robustness: lower financing cost for INC	0.11	0.17	0.09	0.13	0.05
Incorporation rate (from SE only) - 2004	Baseline: equal financing cost	0.10	0.14	0.06	0.08	0.04
	Robustness: lower financing cost for INC	0.10	0.16	0.04	0.08	0.04
Incorporation rate (from SE only) - 2005	Baseline: equal financing cost	0.05	0.07	0.06	0.04	0.02
	Robustness: lower financing cost for INC	0.05	0.06	0.04	0.04	0.02
Incorporation rate (from SE only) - average	Baseline: equal financing cost	0.07	0.07	0.06	0.05	0.02
	Robustness: lower financing cost for INC	0.07	0.07	0.04	0.05	0.02
p.50 retained profits for high-income businesses	Baseline: equal financing cost			2287		
	Robustness: lower financing cost for INC			2800		
p.75 retained profits for high-income businesses	Baseline: equal financing cost			16385		
	Robustness: lower financing cost for INC			17420		
p.90 retained profits for high-income businesses	Baseline: equal financing cost			34586		
	Robustness: lower financing cost for INC			35284		

Notes: The table shows sensitivity of the model moments to introducing lower cost of financing for incorporated owner-managers, with an adjustment in the fixed cost of incorporation to preserve the average share of incorporated businesses in each type.

Table F.6: *Robustness to asymmetric loss treatment*

		Type				
		I	II	III	IV	V
Mean bus income - INC	Baseline: no losses	10412	21587	19391	34572	80062
	Robustness: asymmetric loss treatment	10412	21640	19484	34580	80060
Mean bus income - SE	Baseline: no losses	7513	16764	15717	31550	77786
	Robustness: asymmetric loss treatment	7513	16747	15341	31545	77790
Std. dev. bus income - INC	Baseline: no losses	7451	15746	23487	17040	46881
	Robustness: asymmetric loss treatment	7451	15723	23759	17040	46887
Std. dev. bus income - SE	Baseline: no losses	5929	14116	21047	17306	47827
	Robustness: asymmetric loss treatment	5929	14075	20818	17305	47829
Coeff. on AR(1) of log bus income	Baseline: no losses	0.16	0.24	0.14	0.30	0.35
	Robustness: asymmetric loss treatment	0.16	0.26	0.15	0.30	0.38
Mean investment/mean bus income	Baseline: no losses	–	0.20	0.51	0.04	0.04
	Robustness: asymmetric loss treatment	–	0.20	0.49	0.04	0.04
Incorporation share - average	Baseline: no losses	0.03	0.11	0.20	0.24	0.72
	Robustness: asymmetric loss treatment	0.03	0.11	0.20	0.24	0.72
Entry rate for SE - 2002	Baseline: no losses	0.18	0.06	0.07	0.07	0.03
	Robustness: asymmetric loss treatment	0.18	0.06	0.07	0.07	0.03
Entry rate for SE - 2003	Baseline: no losses	0.18	0.08	0.07	0.08	0.03
	Robustness: asymmetric loss treatment	0.18	0.08	0.07	0.08	0.03
Entry rate for SE - 2004	Baseline: no losses	0.20	0.08	0.08	0.08	0.03
	Robustness: asymmetric loss treatment	0.20	0.07	0.09	0.08	0.03
Entry rate for SE - 2005	Baseline: no losses	0.18	0.08	0.07	0.06	0.02
	Robustness: asymmetric loss treatment	0.18	0.08	0.07	0.06	0.02
Entry rate for SE - average	Baseline: no losses	0.19	0.09	0.08	0.07	0.02
	Robustness: asymmetric loss treatment	0.19	0.09	0.08	0.07	0.02
Entry rate for INC - 2002	Baseline: no losses	0.00	0.00	0.01	0.01	0.07
	Robustness: asymmetric loss treatment	0.00	0.00	0.01	0.01	0.07
Entry rate for INC - 2003	Baseline: no losses	0.00	0.01	0.01	0.02	0.08
	Robustness: asymmetric loss treatment	0.00	0.01	0.01	0.02	0.08
Entry rate for INC - 2004	Baseline: no losses	0.00	0.01	0.01	0.02	0.06
	Robustness: asymmetric loss treatment	0.00	0.01	0.01	0.02	0.06
Entry rate for INC - 2005	Baseline: no losses	0.00	0.00	0.01	0.01	0.04
	Robustness: asymmetric loss treatment	0.00	0.00	0.01	0.01	0.04
Entry rate for INC - average	Baseline: no losses	0.00	0.00	0.01	0.01	0.04
	Robustness: asymmetric loss treatment	0.00	0.00	0.01	0.01	0.04
Incorporation rate - 2002	Baseline: no losses	0.10	0.13	0.12	0.14	0.15
	Robustness: asymmetric loss treatment	0.10	0.13	0.11	0.14	0.15
Incorporation rate - 2003	Baseline: no losses	0.21	0.23	0.17	0.22	0.16
	Robustness: asymmetric loss treatment	0.21	0.25	0.16	0.22	0.16
Incorporation rate - 2004	Baseline: no losses	0.21	0.20	0.13	0.16	0.13
	Robustness: asymmetric loss treatment	0.21	0.20	0.11	0.16	0.13
Incorporation rate - 2005	Baseline: no losses	0.13	0.10	0.11	0.08	0.08
	Robustness: asymmetric loss treatment	0.13	0.10	0.11	0.08	0.08
Incorporation rate - average	Baseline: no losses	0.14	0.11	0.10	0.09	0.08
	Robustness: asymmetric loss treatment	0.14	0.11	0.10	0.09	0.08
Incorporation rate (from SE only) - 2002	Baseline: no losses	0.04	0.08	0.06	0.07	0.05
	Robustness: asymmetric loss treatment	0.04	0.08	0.06	0.07	0.05
Incorporation rate (from SE only) - 2003	Baseline: no losses	0.11	0.17	0.11	0.12	0.05
	Robustness: asymmetric loss treatment	0.11	0.18	0.10	0.12	0.05
Incorporation rate (from SE only) - 2004	Baseline: no losses	0.10	0.14	0.06	0.08	0.04
	Robustness: asymmetric loss treatment	0.10	0.14	0.05	0.08	0.04
Incorporation rate (from SE only) - 2005	Baseline: no losses	0.05	0.07	0.06	0.04	0.02
	Robustness: asymmetric loss treatment	0.05	0.08	0.06	0.04	0.02
Incorporation rate (from SE only) - average	Baseline: no losses	0.07	0.07	0.06	0.05	0.02
	Robustness: asymmetric loss treatment	0.07	0.07	0.06	0.05	0.02
p.50 retained profits for high-income businesses	Baseline: no losses			2287		
	Robustness: asymmetric loss treatment			2248		
p.75 retained profits for high-income businesses	Baseline: no losses			16385		
	Robustness: asymmetric loss treatment			16435		
p.90 retained profits for high-income businesses	Baseline: no losses			34586		
	Robustness: asymmetric loss treatment			34641		

Notes: The table shows sensitivity of the model moments to introducing losses with an asymmetric treatment between the self-employed and incorporated owner-managers.

Table F.7: *Robustness of efficiency results to model extensions*

	Average capital tax rate increase	CGT rate increase + base unchanged	CGT rate increase + base reform
Baseline	1.116	0.591	0.530
Lower capital costs for INC	1.123	0.586	0.520
Differential tax treatment of losses	1.110	0.581	0.523

Notes: Each number shows the marginal cost of funds—defined as lump sum compensation (calculated as the sum of equivalent variation necessary to make individuals indifferent between the baseline regime and the tax reform package) over revenue raised—associated with the tax reform listed in the table headers. The first row shows the MCFs under the baseline specification. The second row shows the MCFs under the extended model in which incorporated owner-managers are assumed to have a 20% lower cost of financing investments (i.e. their δ is 20% lower than baseline), with the incorporation costs adjusted to match the baseline share of incorporated business owners (Table F.5 shows the model moments for this extension). The third row shows the MCFs under the extended model in which individuals can make a loss, with self-employed loss-making owner-managers receiving a tax refund at the basic rate of income tax (Table F.6 shows the model moments for this extension).
Source: Model simulations.