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Marginal Tax Rates and Income in the Long Run: Evidence from a Structural Estimation*

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Abstract: We estimate a life-cycle model of savings, labor productivity and entrepreneurs to measure the long-run response of income to marginal tax rate cuts in the US. Long-run tax elasticities of income are largest for the richest 1% but are also positive and substantial for other income groups. In equilibrium, entrepreneurs obtain higher returns on wealth. This increases the investment response of rich, high-return entrepreneurs, amplifying their income elasticity to tax cuts. This leads to a reallocation of capital which increases TFP, and generates a boost in wages that magnifies the estimated income response of the bottom 90% as well.

Keywords: marginal tax rate changes; elasticity of taxable income; life-cycle; entrepreneurs; structural estimation

JEL Classification Numbers: E62, H21, H24

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1 Introduction

Are marginal tax rates important for long-run behavioral responses of income and investment? Are incomes at the top of the distribution, who pay a large share of total fiscal revenues, responsive to tax incentives in the long run? Answering these questions is essential for understanding the transmission of tax policies and their role in dealing with economic growth and inequality. Nevertheless, the existing empirical literature studying US tax returns concentrates on short- to medium-run effects of marginal tax rate changes (e.g., Feldstein, 1995 and Mertens and Montiel Olea, 2018). This is because estimates of the effects of marginal tax changes in the long run (i.e., exceeding a few years) are plagued by extremely difficult identification issues (e.g., Saez et al., 2012). For instance, the overall implications of a tax reform on households' investment and entrepreneurial decisions may not be reached for several years and hence they are very hard to trace back empirically to the original policy change. However, these long-run effects are of first-order relevance for policymaking and they represent a key motivation for legislated tax reforms in the US and other industrialized economies (e.g., Romer and Romer, 2010 and Cloyne, 2013).

To tackle this problem, we adopt a structural approach and estimate a life-cycle model of the US economy with savings, labor productivity and entrepreneurial choice that allows us to study the long-term behavioral and general equilibrium effects of marginal tax changes. We estimate that the long-run elasticity of total taxable income (ETI) with respect to net-of-tax rates – 1 minus the marginal tax rate – is substantial and statistically significant for all income groups, and is centered at 0.66. We also find that incomes in the top 1 percent of the distribution are the most responsive to marginal tax rate changes, displaying a long-run ETI of 0.77.

Our economy features rich heterogeneity through overlapping generations, incomplete markets and progressive income taxation. Agents face persistent heterogeneity in their labor income as it is standard in Aiyagari-Huggett economies (e.g., Conesa et al., 2009) and can obtain higher-than-average returns on their wealth by choosing to be entrepreneurs (e.g., Cagetti and De Nardi, 2006). For several reasons, this latter ingredient is increasingly becoming a prominent feature in heterogeneous-agent models. First, the empirical evidence finds that there is substantial heterogeneity in capital income (e.g., Bach et al., 2020; Fagereng et al., 2020) and that the richest individuals with high returns are likely to be entrepreneurs (e.g., Smith et al., 2019; Smith et al., 2023). Second, return heterogeneity through entrepreneurial activity has been shown to have important consequences for the setting of fiscal policies (e.g., Brüggemann, 2021; Guvenen et al., 2023). Third, an active literature on power law models shows that heterogeneity in returns to savings is an effective device to match the fat Pareto tail of wealth and income and their dynamics emerging from cross-sectional data (e.g., Benhabib et al., 2011).

In our framework, financially-constrained entrepreneurs trigger productivity spillovers that greatly amplify the effects of tax policies. A cut in the average marginal tax rate (AMTR) strongly increases the incentive to save and invest for entrepreneurs in the top of the income distribution, who due to lower tax rates, can relax their financial constraints and expand their business. As a result, in the long run, capital reallocates towards individuals with higher average entrepreneurial skills. This endogenously raises capital intensity and aggregate productivity, increasing the response of macroeconomic aggregates and generating a large general equilibrium boost in wages, in turn benefiting the bottom of the income distribution (who mostly rely on labor income). Nevertheless, their response is smaller than at the top.

We estimate our model via Simulated Method of Moments (SMM), in order to match cross-sectional variation in income and wealth at the household level, together with a broader set of distributional moments, as well as standard macroeconomic aggregates. This is an important consideration for the purposes of this paper. Since income and wealth are extremely concentrated and income taxes are progressive, a big chunk of the tax burden falls on a relative small fraction of rich and wealthy individuals. In the US, the richest top 1, 5 and 10 percent pay 42, 66 and 88 percent of overall tax revenues, respectively. Thus, it is crucial for our policy exercise not only to generate the high concentration of income and the even higher concentration of wealth at the top, but also to be consistent with other features of the data (such as the entrepreneurship rate) that are relevant for capturing the spillovers and trade-offs that rich and wealthy individuals face.

In particular, we show that return heterogeneity through entrepreneurial activity, earnings risk and progressive taxation are important elements that allow our model to match the salient distributional characteristics of the US economy and shape the transmission of tax cuts. We also find that our model is consistent with several key features of the US economy, such as the correlation between wealth and returns, capital income shares along the income distribution, income specialization of the richest individuals, the short-run economic response to cuts in AMTR, *et cetera*. While all these elements increase the credibility of our quantitative exercise, the main point of the paper is to analyze fiscal policy in the long run, within a state-of-the-art model, with ingredients well-established in the literature, where entrepreneurial activity generates an endogenous response of TFP to tax changes.

On this point, we show that an alternative model where return heterogeneity does not reflect any differences in entrepreneurial ability, but instead emerges exogenously (e.g., Benhabib et al., 2011), implies a radically different transmission of tax policy. Here, the reallocation of capital that a cut in AMTR brings about does not trigger an increase in efficiency nor a boost in real wages. Instead, it generates a bottom-up net transfer of resources from households with low returns to those with high ones. As a result, ETIs at the top of the distribution further increase relative to our benchmark model, while those at the bottom are greatly reduced, eventually turning negative. Overall, the effects of tax policy on the elasticity of taxable income and macroeconomic aggregates is dampened relative to our benchmark model. This is an additional interesting contribution of the paper and it highlights in a transparent manner the effects of modeling return heterogeneity through a parsimonious framework of entrepreneurial activity.

The remainder of the paper is the following. Section 2 explains how this paper relates with the literature. Section 3 presents our benchmark structural model. Section 4 describes the main estimation exercise. Section 5 presents the main policy experiment. Finally, Section 6 concludes.

2 Relation to the Literature

On top of the works already cited, we contribute to other strands of the literature in empirical macroeconomics/public finance. First of all, our paper relates to the public finance literature estimating the short-run tax elasticity of reported income, surveyed by Saez et al. (2012). We contribute to this literature by providing structural estimates of long-run ETIs, which have proven difficult to obtain with standard empirical identification schemes based on tax returns.

Moreover, our results about long-run ETIs along the income distribution contribute to the age-old debate on whether agents at the top or bottom of the distribution react the most to marginal tax changes (Feldstein, 1995; Mertens and Montiel Olea, 2018; Zidar, 2019). On this, we provide a realistic general equilibrium mechanism and point out that in the long run, the richest households display the highest elasticities, that importantly, are statistically different than those for the bottom 99 percent.

Second, our paper relates to the emerging literature on structural estimation of heterogeneous agents models that combines cross-sectional micro data with time-series macro data (e.g., Auclert et al., 2021 and references within). The common approach of this literature is to use full-information econometric methods, which are generally implemented by approximating the structural model via perturbation techniques. For this reason, this identification scheme is local in nature and most suited for inference in analysis of the short-run, such as the cyclical properties of inequality (e.g., Bayer et al., 2020). Differently, our SMM technique belongs to the family of limited-information estimators and is global in nature. As such, it allows us to consider complex non-linearities on the model's long-run equilibrium. Therefore, it is most suited for the research question at hand about long-run spillovers of tax policy. From a technical point of view, we adopt the approach presented in Cocci and Plagborg-Møller (2021), which amounts to estimating the standard errors using the worst-case correlations for the unknown covariances between cross-sectional micro data and time-series macro data.

Finally, our paper relates to the empirical literature that links aggregate productivity and taxes. In a growth model with entrepreneurs, Jaimovich and Rebelo (2017) find higher capital income tax rates reduce incentives for the entrepreneurs in the right tail of the distribution to invest and innovate. Guvenen et al. (2023) find that a wealth tax reduces misallocation and increases aggregate TFP by re-allocating capital toward more productive entrepreneurs. Differently, we focus on the effect of progressive income taxes on entrepreneurial activity, its size and quality, particularly in terms of productivity spillovers (see also Guzman and Stern, 2020). In this respect, our paper extends to the long run a number of well established empirical results for short-run analysis, such as the relation between tax rates and aggregate productivity (e.g., Cloyne, 2013) and the relationship between tax progressivity and misallocation (e.g., Fajgelbaum et al., 2019). Our analysis also supports and complements the recent empirical literature on the long-run positive spillovers of marginal tax cuts on innovation (e.g., Akcigit et al., 2022), a concept that traditionally closely relates to productivity (e.g., Aghion et al., 2009). These contributions further indicate the importance of micro-founding return heterogeneity through entrepreneurial activity, particularly for capturing the endogenous spillover of marginal tax rates on productivity, a characteristic that has far-reaching consequences for tax policy in practice.

3 The Model

We present an incomplete-markets life-cycle model consisting of households, firms and a government who interact in competitive good and factor markets.

3.1 Households

The economy is populated by a continuum of households, who differ by age, labor productivity and entrepreneurial ability. Each period, a mass of new households is born, where the rate of population growth is exogenous and assumed to be n. During their life, households choose consumption, savings, and labor supply and whether or not to engage in entrepreneurial activity. Importantly, individuals can be workers and entrepreneurs at the same time. Households also pay progressive taxes on total income and flat social security taxes on labor earnings (up to a cap). After retirement at age R, households receive social security benefits from the government.

Households also face a risk of early death. We denote by s_j the probability of surviving to age j, conditional on surviving to age $j-1$, where $s_1 = 1$ and $s_{J+1} = 0$. The demographic patterns are stable, so that age-j agents make up a constant fraction μ_j of the total population.[1] Accidental bequests are redistributed to all living consumers as a lump-sum transfer, T_b.

Preferences All agents have identical preferences for consumption c_j and hours worked h_j over their lifetime:

$$E\left\{\sum_{j=1}^{J}\beta^{j-1}\left(\prod_{k=1}^{j}s_k\right)u(c_j,h_j)\right\}, \tag{1}$$

where $\prod_{k=1}^{j} s_k$ is the unconditional probability an age-1 agent will survive to age j. As it is standard in the literature (e.g., Conesa et al., 2009), we assume period utility is of the form $u(c,h) \equiv \frac{\left(c^{\gamma}(1-h)^{1-\gamma}\right)^{1-\sigma}}{1-\sigma}$, where γ is the consumption utility share and σ controls the household's risk aversion.[2]

Labor Productivity In each period before retirement, agents receive labor earnings equal to weh, where w is the real wage rate, e is the household's labor ability and h is hours worked. When households reach age R, they retire so that hours worked and total labor earnings become zero for ages $j \geq R$.

We assume ex-ante and ex-post heterogeneity in labor abilities as in, inter alia, Kaplan and Violante (2014) and Guvenen et al. (2023). A household's labor ability $e_{i,j}(z_h)$ is given by

$$\log e_{i,j}(z_h) = \bar{e}_i + \alpha_0 + \alpha_1 j + \alpha_2 j^2 + \alpha_3 j^3 + \alpha_4 j^4 + \log z_h \tag{2}$$

Labor productivity depends on three factors. First, labor ability depends on a household-specific innate ability, $\bar{e}_i$. At birth, the household learns her type $i \in \{1,\ldots,I\}$ which indexes its overall level of labor ability. We denote by π_i the probability a household will become type i. Second, labor ability explicitly depends on a fourth-order polynomial in age j. Third, labor ability is also affected by an idiosyncratic shock, z_h, which follows an AR(1) process:

$$\log z_h' = \rho_h \log z_h + \varepsilon_h, \quad \varepsilon_h \sim N\left(0, \sigma_{\varepsilon h}^2\right), \tag{3}$$

where the initial $\log z_h$ is set to zero.

We assume that the household's innate ability, $\bar{e}_i$, is drawn from $N(0, \sigma_e^2)$. In our quantitative analysis, we will construct a discrete approximation for innate ability using I individual types. As a result, the innate abilities $\{\bar{e}_i\}_{i=1}^{I}$ and the type probabilities $\{\pi_i\}_{i=1}^{I}$ are all parameterized by one parameter, σ_e. See Appendix B for details.

Asset Return Risk Through Entrepreneurship We introduce a role for entrepreneurship. This allows us to micro-found in a transparent way stochastic returns on wealth.

[1] The measure μ_j can be defined recursively, where $\mu_{j+1} = s_{j+1}\mu_j/(1+n)$ for $j = 1,\ldots,J-1$ and μ_1 is set to normalize $\sum_{j=1}^{J}\mu_j = 1$.

[2] Given the assumption of a Cobb-Douglas utility function, the coefficient of relative risk aversion in consumption is $-cu_{cc}/u_c = 1 - \gamma(1-\sigma)$.

All households can choose to be an entrepreneur, whereby they access a "backyard technology" that uses k units of capital to produce q units of an intermediate capital service. We assume a linear technology

$$q = z_r k \tag{4}$$

where z_r characterizes the household's entrepreneurial productivity. We also assume that entrepreneurial productivity follows an AR(1) process of the type:

$$\log z_r' = \rho_r \log z_r + \varepsilon_r, \quad \varepsilon_r \sim N\left(0, \sigma_{\varepsilon r}^2\right) \tag{5}$$

where the initial shock is drawn from the distribution $N\left(0, \sigma_{\varepsilon r}^2/(1-\rho_r^2)\right)$.

All households lend on the bond market their whole wealth at the riskless rate r. Those who also choose to be entrepreneurs borrow at rate r on the same market and use their own backyard technology to produce the intermediate capital service q. Entrepreneurs must also decide how much capital k to invest in their backyard technology. They are subject to a collateral constraint, i.e., $k \leq \lambda a$, where $\lambda \geq 1$ is exogenous and controls the leverage level, while a is the individual entrepreneur's wealth (e.g., see Moll, 2014, and Guvenen et al., 2023). Entrepreneurs then maximize the following profit function,

$$\pi(a, z_r) = \max_{0 \leq k \leq \lambda a} \left\{ p z_r k - (r+\delta) k \right\}, \tag{6}$$

where p is the price of the capital service, $r+\delta$ is the rental rate of capital, with δ representing the depreciation rate. The associated optimal capital demand is

$$k(a, z_r) = \begin{cases} \lambda a & \text{if } z_r \geq (r+\delta)/p \\ 0 & \text{if } z_r < (r+\delta)/p \end{cases} \tag{7}$$

Therefore, there exists an endogenous productivity threshold,

$$\bar{z}_r = (r+\delta)/p, \tag{8}$$

such that only households that are sufficiently productive will choose to be entrepreneurs, while the others will simply engage in lending activities. This feature derives from our assumption of constant returns to scale and it allows the model to match the entrepreneurship rate observed in the data, which turns out to be crucial for a quantitative assessment of tax policy. Furthermore, Equation (8) links in a transparent way returns to private equity (p) to the entrepreneurship rate (implicitly defined by $\bar{z}_r$). That is, *ceteris paribus*, in economies where returns to private business increase, the ability threshold ($\bar{z}_r$) decreases and more agents decide to invest in private equity and become entrepreneurs, as it is easier to do so. Similar mechanisms and implications would emerge in standard theoretical models of occupational choice (e.g., Levine and Rubinstein, 2018), and it is consistent with the observation that entrepreneurs earn, on average, higher returns (e.g., Kartashova, 2014; Smith et al., 2023).[3]

To summarize, all households earn the interest rate r by lending their wealth on the bond market. Those households with sufficiently high entrepreneurial ability also choose to run a business, whereby they borrow at rate r, produce the intermediate good q and earn $\pi(a, z_r)$. Using the solution for $\pi(a, z_r)$, the household's total return on its wealth is given by

$$r_a(z_r) = r + \lambda \max\left(p z_r - (r+\delta), 0\right).$$

Therefore, there will be persistent idiosyncratic variation in returns across households, which is a crucial ingredient for the model's ability to match the fat tail of wealth and taxable income (e.g., Benhabib et al., 2011). Furthermore, despite no explicit link between wealth and returns, high-wealth households will, on average, earn higher returns, consistent with the empirical evidence (e.g., Bach et al., 2020; Fagereng et al., 2020). Finally, it is important to note that in our economy, entrepreneurs still face persistent earnings risk. As we will show later, this is an important feature for the analysis of long-run ETIs.

[3] Note that our mechanism differs from the occupational choice model with no capital presented in Jaimovich and Rebelo (2017), where private businesses all have the same size and the endogenous productivity threshold to become an entrepreneur does not depend on the price of intermediate input p, which is instead constant in their model.

3.2 Final Production Firm

The final good is produced according to a Cobb-Douglas production function,

$$Y = F(Q, L) = Q^{\alpha} L^{1-\alpha},$$

where L is aggregate labor and Q is the aggregate of the intermediate capital service produced by entrepreneurs. It is straightforward to derive the following aggregate relationship:

$$Y = AK^{\alpha} L^{1-\alpha}$$

where K is aggregate capital and A is aggregate TFP. Aggregate TFP is $A = (Q/K)^{\alpha}$, where Q/K is the average productivity of entrepreneurs. Therefore, aggregate productivity depends crucially on the allocation of capital across entrepreneurs, which, importantly, will be responsive to tax policy.

The market for the intermediate capital service and the market for labor are both perfectly competitive. Therefore, the representative firm takes as given the prices (w, p) and chooses Q and L to maximize profits, $\Pi = Q^{\alpha} L^{1-\alpha} - pQ - wL$.

3.3 Government

The government taxes income in order to finance a fixed and exogenous level of government spending, G, which provides agents no utility. The government operates a balanced budget and does not use debt, implying that G is just equal to aggregate income tax revenues. The government also runs a social security system with a dedicated budget.

Income Tax Labor and capital income are jointly taxable. This assumption derives from the difficulties in the data to precisely estimate separate tax functions for capital and labor, and it is standard in the literature (e.g., Heathcote et al., 2014).[4] Households can also deduct part of the social security contribution (described below), up to an upper limit $\bar{y}$. The resulting household's taxable income is

$$y = we_{i,j}(z_h)h + r_a(z_r)a - \frac{1}{2}\tau_{ss} \min\left(we_{i,j}(z_h)h, \bar{y}\right). \tag{9}$$

We adopt a tax specification function belonging to a flexible three-parameter family, originally proposed by Gouveia and Strauss (1994) and popular in applied works (e.g., Conesa et al., 2009 and Guner et al., 2014),

$$\mathcal{T}_y(y) = \tau_0 y \left(1 - (\tau_2 y^{\tau_1} + 1)^{-1/\tau_1}\right). \tag{10}$$

Roughly speaking, τ_0 governs the maximum tax rate, while τ_1 and τ_2 determine the progressivity of the tax schedule. For $\tau_1 \to 0$, the tax system reduces to a pure flat tax, while other values encompass a wide range of progressive and regressive tax functions. According to this specification, the marginal income tax rate converges to zero as taxable income converges to zero, while the marginal tax rate converges to the upper bound of τ_0 as taxable income grows large.

Social Security Scheme The government runs a pay-as-you-go social security scheme. Taxpayers pay a social security tax only out of their labor income (at the flat tax rate τ_{ss}), up to an upper bound $\bar{y}$. The government pays a type-specific social security benefit, $b_{i,j}$:

$$b_{i,j} = \begin{cases} 0 & \text{if } j < R \\ \bar{b}_i & \text{if } j \geq R. \end{cases}$$

We assume that $\bar{b}_i = \chi w L_i$, where L_i is the average labor input of type-i agents and χ is the replacement rate.

Social security benefits are financed by a flat tax τ_{ss} on all labor earnings weh below $\bar{y}$. That is, a household with labor earnings weh will pay a social security tax of $\tau_{ss} \min(weh, \bar{y})$. Given the tax rate τ_{ss} and the cap $\bar{y}$, we internally set the replacement rate χ so that aggregate social security tax revenue equals aggregate social security benefits.

[4] We relax this assumption in Appendix G.1 and assume instead a progressive labor income tax alongside a flat capital income tax.

3.4 Equilibrium

We focus on a stationary equilibrium, in which capital, labor, transfers and government consumption are all constant in per-capita terms. See Appendix A for a standard description of the household's problem in recursive form and a formal definition of the equilibrium.

4 Quantitative Analysis

In this section, we outline our estimation strategy, and then evaluate the model's ability to account for a number of features in the data for the US. In our main exercise, we solve and estimate the model assuming the economy is in a steady state. One period corresponds to one year and we convert all nominal values into 2010 dollars. As the numerical strategy used to solve the model is completely standard, we relegate its description to Appendix B, while precise variable definitions and additional empirical calculations are described in Appendix C.

In the tradition of Gourinchas and Parker (2002), we adopt a two-step estimation procedure that allows us to consider a rich equilibrium model that would otherwise be intractable to estimate. This consists of splitting our parameters into two main groups: (i) a group of parameters that is externally set, either according to previous literature, via direct observation or through estimation; and (ii) a group of parameters that is internally set, estimated using a Simulated Method of Moments (SMM) estimator, in order to match relevant distributional moments in the Survey of Consumer Finances (SCF) for 2016 and other standard macroeconomic moments from national accounts.

4.1 Externally Set Parameters

Externally Fixed Parameters We fix two parameters consistently with the literature (see panel A, Table 1). The first of these is σ, which controls households' risk aversion. We fix this parameter to 2, consistent with a large bulk of applied works in the life-cycle literature (e.g., Benhabib et al., 2019). Second, we fix the capital income share α, to 0.36, which is standard in the macroeconomics literature.

Then, we fix J, the maximum age in the model, to 85 and R, the retirement age, to 45. Assuming that age 1 in the model corresponds to age 21 in the real life, these choices for (J, R) correspond to ages 105 and 65 in real life/years. We set the population growth rate n to 0.7 percent, to be consistent with the US population growth rate in the World Bank's World Development Indicators. We obtained estimates of the survival probabilities s_j from the United States Mortality Database (see Appendix C.1 for details). Then, we use data from the Internal Revenue Service (IRS) to set the linear social security tax ($\tau_{ss} = 12.4\%$) and the upper limit on the social security contribution ($\bar{y} = 107.7$k). Finally, we internally set the parameter governing Social Security benefit (i.e., χ) to 0.305, to balance the government budget on Social Security contributions.

Externally Estimated Parameters Next, we focus on a set of parameters that we estimate outside the model (see panel B, Table 1). We estimate the parameters of the tax functions (τ_0, τ_1, τ_2) via a non-linear weighted least squares method (e.g., Guner et al., 2014). Using our SCF data, we construct a measure of income that includes all income flowing to households. We then calculate federal income tax liabilities using NBER's TAXSIM program. See Appendix C.2 for details.

One important drawback of our analysis is that we consider a tax function for total income, where the tax authority does not discriminate between labor and capital income. This is mainly due to data limitation, as in microeconomic surveys like the SCF there is not a clear way to estimate distinct tax functions for labor and capital income. For this reason, our approach is canonical in the empirical public finance literature, where the elasticity of taxable income generally utilizes a broad definition of the tax base (e.g., Saez et al., 2012, Heathcote et al., 2014, and Mertens and Montiel Olea, 2018). However, in reality, the US tax authority taxes differently at least part of income based on its origin (i.e., labor or capital). Our main results follow through in the alternative scenario where labor and capital incomes are taxed differently, with a progressive tax on earnings and a linear tax on capital income (see Appendix G.1 for details).

Next, we focus on the challenge of how to estimate the labor ability process in Equation (2). On the one hand, this fixed effects model would conform very well with the panel dimension of the Panel Study of Income Dynamics (PSID). The problem with this approach is that the labor earnings inequality and other inequality measures recorded in the PSID are much lower than that observed in the SCF – e.g., the earnings Gini coefficient is more than 10 percentage points lower in the PSID than in the SCF. As such, by using this method, one would lose on a fundamental aspect of inequality, particularly for the top 1 percent of the distribution. Alternatively, one could only use the SCF, which is more reliable for measuring earnings at the top of the distribution. The fundamental issue with this dataset is that it lacks a panel dimension, and so it would be very difficult to credibly estimate, for instance, dynamic features of the transitory idiosyncratic risk in (3).

[Table 1 about here.]

We tackle these issues by adopting a hybrid approach between the two datasets. In particular, we start by estimating the parameters of the fourth order age-profile (α_1, α_2, α_3, α_4) directly using the SCF. Then, following the approach of Kaplan (2012), we recollect the process of transitory idiosyncratic risk by estimating a fixed effects model on the PSID (see Appendix C.3 for details). This method relies on the assumption that the dynamics of idiosyncratic risk do not depend upon the mass in the right tail of the distribution. In this way, we estimate a persistence, $\rho_h = 0.972$, and a standard deviation $\sigma_{\varepsilon h} = 0.135$. Interestingly, these numbers are similar to the large body of literature estimating the process of the transitory component of labor abilities in linear Gaussian models (e.g., Guvenen et al., 2021). The remaining two parameters of the ability process, σ_e and α_0, will be internally estimated using data from the SCF (see the discussion in the next section). In Appendix G.3, we consider a model where earnings dynamics also include an extra idiosyncratic transitory shock, as in, inter alia, Heathcote et al. (2014) and Guvenen et al. (2021). Implications for our main policy exercise are unaffected.

4.2 Internally Estimated Parameters

We use SMM to estimate the remaining eight parameters, $(\gamma, \sigma_e, \alpha_0, \rho_r, \sigma_{\varepsilon r}, \beta, \lambda, \delta)$, which we cannot directly observe from the data but have a theoretical link with specific moments in the data that we target. Intuitively, this consists of picking the parameters such that the moments computed from real data are as close as possible to those computed from data simulated from our model. In particular, denoting the vector of parameters to be estimated by Θ, the SMM estimator solves the following minimum distance problem:

$$\hat{\Theta} = \arg\min_{\Theta} \left(\hat{M} - \hat{m}(\Theta)\right)' W \left(\hat{M} - \hat{m}(\Theta)\right), \tag{11}$$

where $\hat{M}$ identifies the targeted cross-sectional moments from the 2016 SCF as well as macroeconomic moments from the NIPA tables and Jordà et al. (2019). The matrix $\hat{m}(\Theta)$ represents the moments implied by the model for a given set of parameters Θ, and W is a weighting matrix.[5]

In order to be transparent about our identification, we need to clarify how the parameters are relevant for individual moments. The preference parameter γ governs the utility weight of consumption. This parameter is useful for matching labor supply moments, such as average hours. The parameter σ_e is the standard deviation of permanent labor ability and it assists in matching the distribution of earnings, given the estimation of labor productivity risk. The parameter α_0 is the constant term in the ability profile and is useful for capturing average earnings. The parameters $(\rho_r, \sigma_{\varepsilon r})$ govern the capital income risk faced by individuals. These parameters are crucial for matching the right tails of wealth and taxable income, as well as the share of entrepreneurs. The parameter β is the discount factor and, as in the canonical macroeconomics literature, it assists in capturing the economy-wide capital-income-ratio. The parameter λ governs the collateral constraint on the leverage ratio and it helps in matching the risk-free rate. Finally, δ is the capital depreciation rate and it is used to match the economy-wide investment-to-output ratio.

[Table 2 about here.]

In order to compute the standard errors for our estimated parameters and thus to conduct inference, we need to obtain the variance-covariance matrix of the data moments. This represents a challenge, since the correlation between cross-sectional household-level data and time-series data is generally unobservable. We get around this problem by adopting the approach presented in Cocci and Plagborg-Møller (2021), whereby the standard errors are computed using the worst-case correlations for the unknown covariances. See Appendix D.1 for further details. One potential concern

[5] We freely picked the weighting matrix W. In particular, we assumed the off-diagonal elements are all zero. For the diagonal elements, we assume $W_{ii} = 1/\hat{M}_i^2$, where $\hat{M}_i$ is data moment i. This approach is common in the literature, in light of the Monte Carlo results presented by Altonji and Segal (1996), who argue that in standard applications there is a non-negligible small sample bias when using the optimal weighting matrix.

when calculating standard errors is that we do not take into account the uncertainty of the externally set parameters presented in Table 1. This is standard practice in the literature, and unfortunately, to the best of our knowledge, there is no easy fix for this. However, given that those parameters are estimated precisely, it is unlikely this concern would change things in practice. Nevertheless, in Appendix D.2, we re-estimate the standard errors in Table 2 with a bootstrapping approach that takes into account the uncertainty of estimates presented in Table 1. Confidence bounds are, for all practical purposes, similar to those presented here.

[Table 3 about here.]

The estimated parameters are reported in Table 2, while the moments are reported in Table 3. All parameters are statistically different from zero and precisely estimated. This finding is not obvious and shows a tight link between the targeted moments and structural parameters. As parameter identification in SMM requires choosing moments whose predicted values are sensitive to the model's underlying parameters, the results presented here indicate that we picked the right targets.

Furthermore, the model does very well in matching the moments from the SCF. It matches the wealth Gini and the wealth shares of the wealthiest top 1, 5 and 20 percent, respectively. Similarly, our model matches the right tail in the distribution of taxable income and earnings. Interestingly, our model captures the wealth-income slope, average hours worked, the entrepreneurial rate as well as average earnings.[6] Our model also matches almost perfectly the macroeconomic targets, such as the capital- and investment-to-GDP ratios and the market borrowing rate. The key ingredients of our model (wealth return risk, earnings risk, fixed labor productivity heterogeneity and progressive taxation) are crucial for matching the distributional and macroeconomic moments of interest presented in Table 3.[7]

Most estimated parameters have values that are, broadly speaking, consistent with those found in the literature. This is the case for the discount factor β, the utility parameter γ, the collateral constraint λ and the depreciation rate δ.[8] We have no good prior for the parameters governing the return profiles, although recent quantitative studies point to substantially persistent and moderately variable processes (e.g., Guvenen et al., 2023). As such, our estimates are consistent with these results.

Differently, the parameter governing the variability of the labor ability permanent component, σ_e, is larger than is generally estimated in the literature using the PSID. On the one hand, this may simply reflect that earnings inequality recorded in the SCF is much greater than measured in the PSID. Given we estimate the transitory component from the PSID and the permanent component from the SCF, σ_e mechanically absorbs the residual variation in earnings. On the other hand, similar variability in the permanent component of labor abilities has been recently recorded in applied works using detailed administrative data, when estimating linear Gaussian models (e.g., Guvenen et al., 2021). That said, one might rightly wonder whether we are assigning too much variability to the permanent component of earnings and how this could affect or bias our results. It turns out that the variability in the permanent component of labor abilities dampen the sensitivity of income to marginal tax changes. This effect appears to be particularly strong at the top of the income distribution. In other words, amplifying the transitory stochastic component of the earnings process would increase ETI at the top of the distribution and for all taxpayers. As such, our results are conservative in this sense.[9] See Appendix G.2 for a detailed description of this case.

4.3 Untargeted Moments

Next, we evaluate the performance of our model on a set of untargeted moments. See Appendix E for the full results. First, we show that our estimated model can produce thicker tails in wealth than in income, as microeconomic data suggest. This is a convenient feature of our model with heterogeneous returns to wealth, whereas the incentive to further accumulate savings does not vanish at high levels of wealth for those individuals enjoying high returns.

Second, we show that the return profiles at the top of the wealth distribution generated by our model replicate those found in the data and indicates that our microfoundation for wealth and income distributions is both quantitatively and qualitatively realistic (see Appendix E for details).

[6] In our model, the Frisch elasticity of labor supply is equal to $\frac{1}{h} - 1 \approxeq 2$. This value is in line with the macroeconomic estimates, see Peterman (2016).

[7] On this last point, Appendix H shows how the model performs when each key ingredient is shut down in isolation.

[8] In particular, the value of the estimated leverage parameter (λ) is 3.037, which corresponds to a corporate debt-to-GDP ratio of 1.57 and is consistent with the empirical value of 1.52 reported by Guvenen et al. (2023).

[9] Intuitively, the more important the transitory stochastic part of labor earnings, the larger the precautionary saving effect of marginal tax changes at the top of the distribution.

Third, we show that our model matches the capital income shares at the top of the income distribution. This is important as various empirical studies have indicated that the distribution of capital income is pivotal for the understanding of income and wealth inequality in the US (e.g., Piketty et al., 2018). It is important to note that it is difficult to categorize precisely the source of income (whether comes from labor or capital) at the top of the distribution. For example, using administrative tax data, Smith et al. (2019) analyze the composition of income at the top of the distribution and find that labor income has somewhat more importance for the richest individuals, relative to what was measured by Piketty et al. (2018). To address this issue, we show in Appendix G.3 that a model with further individual transitory earnings risk increases the share of labor income at the top of the distribution and produces results similar to the benchmark.

Fourth, we further analyze the composition of income in the top 1 percent and show that our model can match relatively well the degree of specialization of the richest individuals as measured in the SCF. This is another important feature of our model that further increases the credibility of the elasticities at the top of the distribution. Moreover, while in the baseline framework, labor productivity and entrepreneurial abilities are uncorrelated, we show that a model featuring positive correlation between abilities leads to very similar results (see Appendix G.4).

Fifth, we show that our model produces short-run ETIs and multipliers that are consistent with a large chunk of the empirical evidence, both in public economics (e.g., Kumar and Liang, 2020) and in macroeconomics (e.g., Mertens and Ravn, 2013). This latter result further increases the credibility of both the internal transmission mechanism at play in our model as well as of our estimates of long-run ETIs.

Finally, our baseline model also captures the observed short-run inverse relationship between marginal tax changes and productivity (e.g., Cloyne, 2013 and Fajgelbaum et al., 2019). This feature of our model derives from the the microfoundation of return heterogeneity based on entrepreneurial activity and, as we will show later in the paper, is a fundamental feature for the long-run response of the economy to cuts in the AMTR.

Overall, while our mechanism driving return heterogeneity is tractable and parsimonious, we nevertheless show that we capture remarkably well, both directly and indirectly, a number of cross-sectional and short-run empirical features that are quantitatively important to correctly identify the response of individuals to marginal tax changes along the income distribution.

5 The Tax Policy Exercise

We use our structural model to analyze the long-run distortionary effects of a change in marginal income tax rates. In particular, the main policy experiment we consider consists of measuring the steady-state effects of a permanent change in τ_0, assuming that government spending adjusts accordingly. This type of tax changes mimics various policy reforms implemented by the US federal government and affects the marginal tax rates of all income groups. In this sense, our policy experiment differs from Guner et al. (2016), Badel et al. (2020), Brüggemann (2021) and Kindermann and Krueger (2022), who instead focus on the effects of changing taxes for the top 1 percent of the income distribution.[10]

ETI and Policy Elasticity We analyze the effects of our tax change by computing the elasticity of taxable income (y) with respect to net-of-tax rates (1 minus the average marginal tax rate) in the long run:[11]

$$ETI = \frac{d \ln y}{d \ln(1 - AMTR)}.$$

This measure can also be interpreted as a *policy elasticity* in the sense of Hendren (2016). As described in Saez et al. (2012), in settings without fiscal externalities and income shifting, like the one under consideration here, the ETI represents a sufficient statistic to evaluate the efficiency effects of a tax change. As such, it is a fundamental measure for policy analysis that can be used in wide range of applications.[12]

In particular, our long-run measure of the ETI captures how individuals in the future long-run steady state would respond to marginal tax changes. As a consequence, it compares individual incomes in the long run to what they would

[10]In Appendix I, we analyze the effect of a reform which increases marginal tax rates only for the top 1 percent. In this scenario, we obtain similar results, but marginal tax changes are more distortionary. In this sense, the exercise presented here is more conservative from a quantitative point of view.

[11]In Appendix A.3, we define taxable income and the average marginal tax rate explicitly in terms of model variables.

[12]In Appendix K.2, we show how the ETI can be related to the amount of revenue the government loses to behavioral responses.

have been absent the tax change.

We proceed by explaining our results as follows. First, we study how the ETI varies for different income sources (i.e., capital and labor), and how it varies along income distribution and whether or not a household decides to run a business. Second, we study the aggregate implications of marginal tax rate policies, particularly for prices, macroeconomic aggregates, the entrepreneurial rate, productivity and misallocation and show the importance of general equilibrium spillovers for tax policy in practice. Third, in order to isolate the role of various ingredients of our model, we compare our benchmark economy with alternative scenarios where we separately shut down the key ingredients of the model (e.g., return heterogeneity, earnings risk and tax progressivity). Finally, we analyze the effects of a marginal tax rate change in an alternative life-cycle model calibrated to match the same moments as the benchmark (see Table 3) through an exogenous return heterogeneity mechanism (Benhabib et al., 2011).

5.1 Benchmark Estimates

We start by reporting the benchmark estimates and confidence bounds for the long-run effects of marginal tax rate changes. Table 4 presents the ETIs along the income distribution (Panel A), by type of income (Panels B and C), and by occupation (Panel D), while a description of ETI by age can be found in Appendix K.1. A few results are worth stressing. First, all measures of interest (e.g., ETIs) are statistically different from zero and precisely estimated. This is reassuring and brings further evidence in favor of our identification strategy. This said, our estimates also show heterogeneous degrees of uncertainty. For example, estimates about elasticities in the top 1 percent of the distribution come with wider confidence bounds than those in the bottom 99 percent. Similarly, we find that the ETI for entrepreneurs is less precisely estimated than those for the rest of population. This finding reflects how the uncertainty in the measurement of the data (e.g., the entrepreneurial rate) translates into the distribution of our statistics of interest (e.g., ETIs).

The second important result is that while ETIs are substantial for all taxpayers (0.66) as well as for the poorest 90 percent of individuals (0.70), they are largest for households in the top 1 percent of the income distribution (0.77). As we will show in a moment, this is the result of different responses of income sources and their composition along the distribution. In particular, the elasticity of capital income is three times as large for the richest 1 percent of the population as it is for the economy as a whole (0.95 vs. 0.36) and it turns negative for the poorest 90 percent of the population (-4.02). Differently, the labor income elasticity is twice as large for the poorest 90 percent than for the richest 1 percent (1.26 vs. 0.51). Finally, the ETI is around 37 percent higher for entrepreneurs than for the rest of the population (0.78 vs. 0.57).

In order to have a prime understanding of these results, it is instructive to inspect the long-run effects of a cut in AMTR on macroeconomic aggregates, such as quantities, prices and productivity. These are presented in Table 5 as elasticities with respect to the average net of marginal tax rate.

First, individuals will naturally use the extra resources that the cuts in AMTR bring about to increase their self-insurance, as implied by incomplete markets. Hence savings, K, rise (+1.13). These extra resources also expand the overall entrepreneurial size, via an increase in quality-adjusted capital, Q (+1.58), that in turn also increases the equilibrium labor input, L (+0.24), and output, Y (+0.72).

Second, the increase in capital intensity decreases both the borrowing rate, r (-3.08), and the price of capital services, p (-0.86). For this reason, agents in the bottom of the distribution whose capital income mainly consists of lending at the riskless rate, have a negative elasticity of capital income (e.g., -4.02 for the bottom 90%). At the same time, the increase in quality-adjusted capital intensity (Q/L) pushes up real wages, w (+0.48), thus benefiting those individuals in the bottom 90 percent of the income distribution, who mostly rely on labor income. As these individuals have a strong substitution effect in their labor supply, their elasticity of labor income is more than twice as large compared to those in the top 1 percent (1.26 vs. 0.51).

Third, the increase in capital and in its quality-adjusted counterpart is mainly concentrated at the top of the distribution, where entrepreneurs use the extra resources coming from the marginal tax cut to relax their financial constraints and expand their businesses. For this reason, the capital income elasticity in the top 1 percent of the distribution is particularly high (+0.95). This effect pushes up the ETI for the richest individuals at the top of the distribution, as their income heavily relies on capital (see Appendix E, Table E.2).

Furthermore, due to borrowing constraints, this reallocation of capital towards private business boosts allocative efficiency and reduces capital misallocation, as the most productive individuals are now controlling a larger share of capital as measured by the increase in Q. At the same time, the overall quality of the entrepreneurial sector increases, so that in equilibrium there are fewer (-1.87) but more productive entrepreneurs in the economy (+0.45). This is due to the general equilibrium effects on the price of capital services, triggered by the increase in the quality-adjusted capital intensity that a tax cut brings about.

These long-run effects on entrepreneurial size and composition imply that the overall long-run elasticity of TFP (+0.16) to an AMTR cut can be decomposed into intensive and extensive margins:[13]

$$\varepsilon_A = \underbrace{\frac{\alpha\,(dQ_{int}/Q - dK_{int}/K)}{d\ln(1-AMTR)}}_{\varepsilon_{A,int}} + \underbrace{\frac{\alpha\,(dQ_{ext}/Q - dK_{ext}/K)}{d\ln(1-AMTR)}}_{\varepsilon_{A,ext}}. \tag{12}$$

In this expression, we impose $K = K_{int} + K_{ext}$ and $Q = Q_{int} + Q_{ext}$, where K_{int} and Q_{int} are the capital and quality-adjusted capital for households who are entrepreneurs in both the baseline and the counterfactual economy with a tax cut, and K_{ext} and Q_{ext} are the same variables for those individuals who are entrepreneurs in the baseline but not in the counterfactual. From (12) one can see the decomposition of the TFP elasticity, ε_A. First, there is an intensive margin ($\varepsilon_{A,int}$) – i.e., among those who are entrepreneurs before and after the tax cut, more quality-adjusted capital (Q) is allocated to relatively-more productive entrepreneurs. Second, there is an extensive margin ($\varepsilon_{A,ext}$), as the least productive entrepreneurs in the baseline choose to close down in the counterfactual, increasing the average productivity of operating businesses. Table 5 shows that both margins are quantitatively important, with the intensive margin accounting for around one-third of the TFP change and the extensive margin for the remaining two-thirds. As such, even though the entrepreneurial rate decreases, a cut in marginal tax rate crowds in the entrepreneurial sector in quality-adjusted terms, in the sense that in the long-run equilibrium, private businesses control a larger share of capital and have higher average quality.

These results are interesting for various reasons. First of all, they show a tight link between general-equilibrium macroeconomic effects and the ETI along the income distribution. Second, our results shed light on the spillover of AMTR cuts on productivity and in turn on real wages. This endogenous general equilibrium effect coming from capital redistribution is particularly important for the ETI at the bottom of the distribution, who mostly rely on earnings (see Appendix E, Table E.2). As we will describe later in the paper, absent this effect on TFP, for example in models with homogeneous returns or where heterogeneity is modeled as an exogenous process, the labor income elasticity is reduced for the poorest 90 percent of the population. Finally, and related to this last point, our results also show the importance of matching the entrepreneurship rate, as long-run changes in its size and quality are crucial for understanding the productivity spillovers that a cut in AMTR brings about.[14]

[Table 4 about here.]

[Table 5 about here.]

5.2 Analyzing the Mechanism

One of the main advantages of our structural identification is that it permits us to be as transparent as possible about how the different features of our model affect the transmission of tax policies on the economy. Results are presented in Tables 6 and 7. First, we will highlight the importance of general equilibrium price and spillover effects on the analysis of long-run ETIs. Next, we will measure the effects of a marginal tax rate change by selectively removing individual ingredients from the benchmark framework. While the main text will principally focus on the consequences of removing entrepreneurial activity, we will also briefly discuss the quantitative importance for tax analysis in practice of earnings risk and progressive taxation, and we relegate to Appendix G the full description of these cases.

Role of General Equilibrium Effects In this section, we present the results from the benchmark model but in partial equilibrium in which factor prices are not allowed to change following the marginal tax change. Appendix J.1 also analyzes intermediate assumptions about factor price changes, where we allow prices in the long run to adjust by 50, 75 and 90 percent relatively to the whole general equilibrium response. The main take home from these exercises is that general equilibrium macroeconomic effects are fundamental for the quantitative and qualitative analysis of the long-run effects of AMTR cuts. First, the long-run ETI for all taxpayers is almost three times larger in partial

[13]See Appendix F for a detailed derivation of decomposition of the TFP elasticity into intensive and extensive margins.

[14]It is interesting to note that in Jaimovich and Rebelo (2017), a cut in tax rate increases the number of equally-sized private business, obtaining in this way a positive spillover of a tax cut on growth.

equilibrium. Similarly, all macroeconomic aggregates experience a much amplified response relative to their general equilibrium counterparts. This is strongly driven by the response of capital income, which is an order of magnitude higher in partial equilibrium, both overall and along the income distribution.

[Table 6 about here.]

Along the same line, without the endogenous price effects on capital income, a marginal tax cut triggers an even larger incentive for entrepreneurs to scale up their businesses via further accumulation of wealth. This creates a strong increase in the savings of entrepreneurs, whose long-run ETI becomes over 5 times larger in partial equilibrium. As the most productive entrepreneurs have the stronger incentive to increase savings, this is beneficial for the intensive margins of total factor and entrepreneurial productivity, which also increase by similar factors. Not surprisingly, absent any price adjustment, the entrepreneurship rate is not affected by tax changes, and as such, the extensive margin of an AMTR cut on TFP is zero.

Moreover, in partial equilibrium, the increase in quality-adjusted capital intensity does not spill over to real wages. The lack of this price effect makes the long-run ETI of workers lower than its general equilibrium counterpart. Overall, the elasticity of earnings in partial equilibrium reduces by about a third.

[Table 7 about here.]

These results point out important qualitative and quantitative general equilibrium effects for the understanding of income responses to marginal tax rates in the long-run. In contrast, general equilibrium effects appear quantitatively less important for the short-run effects of temporary tax changes, as reported in Appendix E, Table E.3.

Finally, we further decompose the overall ETI into price and behavioral effects (see Appendix J.2). That is, in response to an AMTR tax cut, we isolate the change in taxable income due to (1) price changes (i.e., higher wages and lower borrowing rates), and (2) changes in household behavior (i.e., households on average supply more capital and labor). We find that for the the richest households, the behavioral effect is positive (i.e., higher wealth holdings). This is offset by a negative price effect, as the general equilibrium response of interest rates reduces top capital incomes. In contrast, for households in the bottom 90 percent, who mostly rely on labor earnings, the price and behavioral effects are both positive. For these households, the general equilibrium increase of wages explains around 35 percent of the overall elasticity, but their behavioral effects are still sizable.

Role of Return Heterogeneity In this section, we present the benchmark policy experiment in a model where all agents have the same entrepreneurial productivity. As a result, everyone is indifferent between being an entrepreneur or not, and so all households earn the same return on their wealth, r. Thus, this setting is equivalent to the standard case with a single final-good production sector. Comparing this model without return heterogeneity to our benchmark economy will isolate the effects of return heterogeneity through entrepreneurial activity on the transmission of cuts in AMTR.

The main result from this exercise is that entrepreneurs substantially affect the transmission mechanism of marginal tax policies. From a quantitative point of view, the presence of financially constrained entrepreneurs increases the ETI for all taxpayers from 0.49 to 0.66 (+34%). This effect is strongest for the top 1 percent of the income distribution (+111%), but it is also high for the bottom 90 percent (+18%), with the smallest increase accruing to the bottom 99 percent (+5%). Moreover, in this case, the ETI decreases monotonically with income. In contrast, our benchmark economy exhibits a U-shaped relationship between the ETI and income, with the top 1 percent of the income distribution displaying the highest ETI.

Comparing the two models, it can be seen that return heterogeneity through entrepreneurial activity amplifies the ETI for the top 1 percent because it increases the response of their capital income to marginal tax changes and as a consequence it also implies a larger response of the equilibrium prices of capital. It also shifts the composition of their income towards capital, where the elasticity is relatively higher. Intuitively, a cut in marginal taxes will generate an accumulation of wealth, most concentrated among high-return individuals at the top of the income distribution. In the benchmark economy, earnings are more elastic at the top as well because agents with high entrepreneurial ability react to a tax cut by working relatively more in order to accumulate more assets, relax their financial constraint and expand their backyard production.

Interestingly, in our model, return heterogeneity also amplifies the ETI at the bottom of the income distribution, mainly because it boosts the general equilibrium response of wages. As the central mechanism of our benchmark model, a cut in marginal tax rates leads to an increase in TFP (through a reallocation of capital), and this leads to a larger general equilibrium increase in wages (see Table 7). Furthermore, for the bottom 90 percent, the composition of income shifts more towards labor income (where the elasticity is relatively higher), which further increases the ETI at the bottom (see Appendix E, Table E.2).

Role of Earnings Risk Next, we analyze the quantitative effects of eliminating earnings risk (see Appendix G.5 for a full description). First, earnings risk has very little effect on the ETI for all taxpayers and on TFP and other macroeconomic aggregates, but has big effects along the income distribution. Intuitively, earnings risk strengthens the response of precautionary savings following a marginal tax change, particularly for high-return entrepreneurs with top incomes, who wish to hedge against the effects that negative earnings shock could have on the resources available to invest in their own business. As a result, earnings risk increases the capital income elasticity at the top of the distribution, contributing to boosting the ETIs for the richest 1 percent. Overall, earnings risk is important to explain the higher elasticities at the top of the distribution but not crucial for the transmission of tax cuts on the economy as a whole.

Role of Progressive Taxation Finally, we repeat the benchmark policy exercise in a scenario with linear taxes (see Appendix G.6 for the full results). The main result from this exercise is that progressive taxes increase the response to a tax change, both at the top and bottom of the income distribution. Intuitively, progressive taxes increase the distortionary effects of taxation. As a result, agents react more to tax changes, as households can control their marginal tax rate by adjusting their income. This is reflected on the elasticity of earnings (mainly for low-income households), as well as on that of capital. Not surprisingly, the macroeconomic responses of TFP, and hence of real wages and other macroeconomic aggregates, are smaller with linear taxes. As expected, the non-linearity of the tax schedule is important to understand the transmission of fiscal policy, but it does not alter the central role of entrepreneurs.

5.3 Exogenous Return Model

In this section, we redo the main tax experiment in a life-cycle setting disciplined to the same moments as the baseline, but where return heterogeneity is modeled through a simple, exogenous, household-specific process (e.g., see Benhabib et al., 2011).[15] That is, we postulate that household returns are given by

$$r_a(z_r) = r_m + z_r, \tag{13}$$

where z_r follows an AR(1) process:

$$\ln z_r' = \rho_r \ln z_r + \varepsilon_r, \quad \varepsilon_r \sim \text{i.i.d. } N(0, \sigma_{\varepsilon r}^2).$$

The variable r_m is an endogenous shifter, which adjusts to ensure that the marginal product of capital is equal to the aggregate return on capital plus the depreciation rate. See Appendix G.7 for a more comprehensive description of this alternative model, while Appendix H.1 shows how this model performs in matching a number of cross sectional moments.

We repeat the main policy exercise within this alternative model and report the results in Tables 6 and 7. Within a general equilibrium setting, the transmission of a cut in AMTR is fundamentally different from the benchmark, both quantitatively and qualitatively, while the two models produce similar results in partial equilibrium (see Appendix G.7, Table G.5). First of all, the overall long-run ETI is reduced by more than 60 percent relative to the baseline (0.66 vs. 0.16). Moreover, along the income distribution, the ETI is monotonically increasing, and compared to the benchmark model, ETIs are much larger for the richest 1 percent (1.22 vs. 0.77), while ETIs are smaller for everyone else, eventually turning negative at the bottom of the distribution.

The intuition for this result is the following. When differences in capital returns are driven by an exogenous process as in Equation (13), the (extra) concentration of wealth due to this feature does not imply any superior production ability and thus does not reflect any allocation efficiency. Indeed, contrary to the baseline model, in this alternative setting, there are no entrepreneurs, and thus there is no distinction between quality-adjusted capital, Q, and aggregate capital, K. As such, any difference in returns imply a net transfer of resources from those with low returns to those with high ones. For this reason, the model with exogenous returns (by construction) cannot capture the observed

[15] See also Appendix N.3 in Dyrda and Pedroni (2023).

relationship between marginal tax rates and productivity. This is the main feature driving the different transmission mechanism of tax policy between the benchmark and the framework presented here.

When faced with a lower AMTR, rich agents with high returns exploit their implicit transfer from those with low returns to further accumulate capital. This strong incentive increases the elasticity of capital income for the richest 1 percent by more than twice compared to the benchmark (2.27 vs. 0.95). Differently, the elasticity of capital income for those in the bottom 90 percent of the distribution is reduced, relative to the benchmark (-6.64 vs. -4.02). Within the model with exogenous returns, this redistribution of wealth does not trigger any productivity spillovers, and the negative response at the bottom of the distribution is so severe that the long-run equilibrium level of capital decreases in response to a cut in AMTR (i.e., -0.19, see Table 7). At the same time, agents increase their labor supply in order to compensate for the decrease in their capital income. As the capital intensity decreases, real wages shrink (-0.15) while the average interest rate soars (0.44). These general equilibrium price effects are the opposite of those emerging in the baseline model with entrepreneurs or in a model with equal returns (see Table 7). Lower real wages also trigger a wealth effect at the top of the distribution, implying a negative elasticity of earnings for the richest top 1 percent (-0.16) and, relative to the benchmark, a very small aggregate elasticity of earnings.

In summary, while this alternative model produces higher ETIs at the top of the distribution, absent the productivity spillover that an AMTR cut brings about in the baseline framework, the overall long-run effects of marginal tax policies are greatly reduced, to the point that it implies an almost muted elasticity of output in the long-run (0.07). Indeed, while in the benchmark model, return heterogeneity amplifies the expansionary effects of tax policies, the opposite is true in a framework with exogenous returns. At the core of this difference lay the general equilibrium effects on prices and productivity that the two models imply. Absent the general equilibrium spillovers (i.e., in partial equilibrium), the effects of tax policy in the two models are remarkably similar.[16]

6 Conclusion

This paper estimates the effects of tax policy in the long run within a state-of-the-art life-cycle model, where entrepreneurial activity triggers endogenous increases in TFP to marginal tax cuts. We find that long-run elasticity of total taxable income (ETI) with respect to net-of-tax rates – 1 minus the marginal tax rate – is substantial and statistically significant for all income groups and is centered at 0.66. We also find that incomes in the top 1 percent of the distribution, who contribute to more than 40 percent of all fiscal revenues, are the most responsive to marginal tax rate changes.

Our results are interesting for several reasons. First of all, they quantify the long-run efficacy of marginal tax reforms. These long-run effects are crucial for policymakers as they represent a key motivation behind discretionary tax reforms in the US and other industrialized economies (e.g., Romer and Romer, 2010 and Cloyne, 2013). In this respect, our paper naturally complements, not only the canonical public finance estimates on short-run ETIs, but also the studies that use narrative datasets to estimate the effects of marginal tax changes aimed to improve long-run economic performance (e.g., Mertens and Montiel Olea, 2018; Zidar, 2019).

Second, our results address one of the primary focuses in public economics, namely whether or not agents at the top end of the distribution are responsive to marginal income tax changes (e.g., Feldstein, 1995; Saez et al., 2012; Mertens and Montiel Olea, 2018; Zidar, 2019). This is a fundamental issue as agents in the top 1, 5 and 20 percent of the income distribution pay respectively the 42, 66 and 88 percent of total tax revenues. We contribute to this by providing a realistic general equilibrium mechanism based on incomplete markets and entrepreneurial activity that enables us to explain why ETIs, in the long run, are highest for the richest households.

One possible drawback of our approach is that our estimates are conditional on the assumed data generation process. While our model contains several important ingredients and heterogeneity over various dimensions, it almost surely misses on some features that could have a sizable impact on the transmission of marginal tax changes in the long run. For example, we do not include human capital accumulation (e.g., Badel et al., 2020), tax avoidance (e.g., Di Nola et al., 2021), endogenous choice of firm legal entity (e.g. Dyrda and Pugsley, 2019), and time effort in entrepreneurial production (Guvenen et al., 2023). Most of these factors are naturally expected to have important consequences for entrepreneurial activity, the quantitative assessment of the model and, ultimately, to modify the distortionary effects

[16] Appendix G.8 also presents the long-run effects of an AMTR cut in a model where the right cross-sectional variation in income and wealth is obtained through a superstate earnings model, similar to Castañeda et al. (2003) and Kindermann and Krueger (2022). In this alternative model, the macroeconomic effects of tax policies is still substantial, but ETIs at the top of the distribution are greatly reduced.

marginal tax rates. These extra features could be particularly important for households in the top end of income and wealth distributions, and we leave this analysis for future research.

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List of Tables

Table 1 – Externally Set Parameters

Parameters	Notation	Value	Std. Err.	Source
A: Fixed Parameters				
Risk Aversion	σ	2		Typical in lit.
Capital Share	α	0.36		Typical in lit.
Maximum Age	J	85		Corresp. to age 105
Retirement Age	R	45		Corresp. to age 65
Survival Prob.	s_j	Appendix C.1		USMD
Pop. Growth	n	0.007		World Bank
Soc. Sec. Tax	τ_{ss}	0.124		IRS
Soc. Sec. Cap	$\bar{y}$	107.7		IRS
Soc. Sec. Benefit	χ	0.311		Balanced budget
B: Estimated Parameters				
Maximal Tax Rate	τ_0	0.278	(0.003)	SCF/TAXSIM
Tax Progressivity 1	τ_1	2.85	(0.10)	SCF/TAXSIM
Tax Progressivity 2	τ_2	$1.14e^{-5}$	($4.03e^{-6}$)	SCF/TAXSIM
Ability Coef. 1	α_1	0.100	(0.014)	SCF
Ability Coef. 2	α_2	$-3.72e^{-3}$	($1.19e^{-3}$)	SCF
Ability Coef. 3	α_3	$6.37e^{-5}$	($3.87e^{-5}$)	SCF
Ability Coef. 4	α_4	$-4.20e^{-7}$	($4.24e^{-7}$)	SCF
Labor Ability Persist.	ρ_h	0.976	(0.005)	PSID
Labor Ability Std. Dev.	$\sigma_{\varepsilon h}$	0.135	(0.006)	PSID

Note: This table reports the externally set parameters. USMD stands for the United States Mortality Database. Standard errors are reported in parentheses.

Table 2 – Estimated Parameters

γ	σ_e	α_0	ρ_r	$\sigma_{\varepsilon r}$	β	λ	δ
0.362	0.985	2.741	0.968	0.172	0.989	3.037	0.050
(0.006)	(0.030)	(0.069)	(0.008)	(0.007)	(0.005)	(0.104)	(0.002)

Note: We report the parameters estimated via Simulated Method of Moments (SMM). Reported in parentheses are "worst-case" standard errors (see Cocci and Plagborg-Møller, 2021).

Table 3 – Targeted Moments

Moments (Cross-Section)	**Model**	**Data**	**Moments (Macro)**	**Model**	**Data**
Average Hours (working age)	0.299	0.304	Capital-to-output Ratio	2.947	2.950
Entrepreneurship Rate	0.087	0.085	Investment-to-output Ratio	0.220	0.222
Wealth Gini	0.862	0.860	Borrowing Rate	0.019	0.019
Wealth Share, Top 1%	0.406	0.386			
Wealth Share, Top 5%	0.638	0.651			
Wealth Share, Top 20%	0.888	0.883			
Earnings Gini	0.735	0.680			
Earnings Share, Top 1%	0.145	0.172			
Earnings Share, Top 5%	0.363	0.327			
Earnings Share, Top 20%	0.687	0.605			
Average Earnings	54.83	55.30			
Tax Revenue Share, Top 1%	0.419	0.424			
Tax Revenue Share, Top 5%	0.702	0.659			
Tax Revenue Share, Top 20%	0.959	0.881			
Wealth-Income Slope, Top 20%	1.574	1.638			
Wealth-Income Slope, Top 40%	0.915	0.959			
Wealth-Income Slope, Top 60%	0.693	0.717			

Note: We report the targeted moments. Cross-sectional moments are from the 2016 Survey of Consumer Finances (SCF), while macroeconomic moments are from national statistics and Jordà et al. (2019).

Table 4 – Elasticities of an Income Tax Change

	Point Estimates	95% Bands	
A. ETI			
All Taxpayers	0.66	[0.64	0.68]
Income Top 1%	0.77	[0.67	0.87]
Income Top 5%	0.62	[0.57	0.67]
Income Top 10%	0.60	[0.55	0.65]
Income Bottom 99%	0.55	[0.49	0.61]
Income Bottom 90%	0.70	[0.54	0.86]
B. Elasticity of Capital Income			
All Taxpayers	0.36	[0.30	0.42]
Income Top 1%	0.95	[0.77	1.12]
Income Top 5%	0.74	[0.61	0.88]
Income Top 10%	0.64	[0.50	0.77]
Income Bottom 99%	-1.76	[-2.49	-1.03]
Income Bottom 90%	-4.02	[-5.74	-2.31]
C. Elasticity of Earnings			
All Taxpayers	0.72	[0.70	0.75]
Income Top 1%	0.51	[0.48	0.54]
Income Top 5%	0.53	[0.52	0.55]
Income Top 10%	0.57	[0.55	0.59]
Income Bottom 99%	0.82	[0.79	0.86]
Income Bottom 90%	1.26	[1.14	1.38]
D. ETI by Occupation			
Entrepreneurs	0.78	[0.59	0.97]
Rest of Population	0.57	[0.47	0.67]

Note: We report the elasticities with respect to the average net of marginal tax rate. The elasticity for variable X is defined as $d\ln X/d\ln(1-AMTR)$. Earnings is total labor income. Income is total taxable income.

Table 5 – Macroeconomic Effects of an Income Tax Change

Variables	**Point Estimates**	**95% Bands**	
A. Aggregate Quantities			
Capital, K	1.13	[0.98	1.28]
Quality-Adj. Capital, Q	1.58	[1.55	1.61]
Labor, L	0.24	[0.21	0.27]
Output, Y	0.72	[0.70	0.75]
B. Prices			
Real Wage, w	0.48	[0.47	0.50]
Price of Capital, p	-0.86	[-0.88	-0.83]
Borrowing Rate, r	-3.08	[-4.30	-1.86]
C. Productivity			
Entrepreneurial Productivity	0.45	[0.29	0.61]
Entrepreneurial Rate	-1.87	[-2.72	-1.02]
Aggregate TFP ...	0.16	[0.10	0.22]
...of which: *intensive margin*	0.05	[0.03	0.07]
extensive margin	0.11	[0.07	0.15]

Note: We report the elasticities of macroeconomic variables with respect to the average net of marginal tax rate.

Table 6 – Elasticities of an Income Tax Change in Various Models

	Benchmark	Benchmark (PE)	No Return Heterogeneity	Exogenous Returns
A. ETI				
All Taxpayers	0.66	1.82	0.49	0.16
Income Top 1%	0.77	3.25	0.37	1.22
Income Top 5%	0.62	2.03	0.40	0.58
Income Top 10%	0.60	1.70	0.43	0.42
Income Bottom 99%	0.55	0.61	0.53	-0.39
Income Bottom 90%	0.70	0.95	0.59	-0.85
B.Elasticity of Capital Income				
All Taxpayers	0.36	5.90	0.01	0.31
Income Top 1%	0.95	5.64	0.78	2.27
Income Top 5%	0.74	5.12	0.76	1.49
Income Top 10%	0.64	4.92	0.70	1.14
Income Bottom 99%	-1.76	2.00	-0.13	-3.28
Income Bottom 90%	-4.02	2.48	-0.96	-6.64
C. Elasticity of Earnings				
All Taxpayers	0.72	0.28	0.62	0.07
Income Top 1%	0.51	-0.29	0.29	-0.16
Income Top 5%	0.53	0.03	0.33	0.01
Income Top 10%	0.57	0.12	0.37	0.07
Income Bottom 99%	0.82	0.43	0.71	0.12
Income Bottom 90%	1.26	0.74	1.18	0.04
D. ETI by Occupation				
Entrepreneurs	0.78	4.30	-	-
Rest of Population	0.57	0.46	0.49	0.16

Note: We report the elasticities with respect to the average net of marginal tax rate for four models: (1) benchmark model, (2) benchmark model in partial equilibrium, (3) model with no return heterogeneity, and (4) exogenous returns model.

Table 7 – Macroeconomic Effects in Various Models

	Benchmark	Benchmark (PE)	No Return Heterogeneity	Exogenous Returns
A. Aggregate Quantities				
Capital, K	1.13	3.89	1.17	-0.19
Quality-Adj. Capital, Q	1.58	6.53	1.17	-0.19
Labor, L	0.24	0.28	0.31	0.21
Output, Y	0.72	2.49	0.62	0.07
B. Prices				
Real Wage, w	0.48	0.00	0.31	-0.15
Price of Capital, p	-0.86	0.00	-0.55	-
Borrowing Rate, r	-3.08	0.00	-1.16	0.44
C. Productivity				
Entrepreneurial Productivity	0.45	2.54	-	-
Entrepreneurial Rate	-1.87	0.01	-	-
Aggregate TFP...	0.16	0.91	0.00	0.00
...of which: *intensive margin*	0.05	0.91	0.00	0.00
extensive margin	0.11	0.00	0.00	0.00

Note: We report the elasticities of the macroeconomic variables with respect to the average net of marginal tax rate for four models: (1) benchmark model, (2) benchmark model in partial equilibrium, (3) model with no return heterogeneity, and (4) exogenous returns model.

Highlights

- A life-cycle model of savings, labor productivity and entrepreneurs is estimated to measure the long-run response of income to marginal tax rate cuts in the US.
- Financially-constrained entrepreneurs trigger productivity spillovers that greatly amplify the effects of tax policies.
- With lower taxes, entrepreneurs relax their financial constraints and expand their businesses.
- In the long run, capital reallocates towards individuals with higher entrepreneurial skills, endogenously increasing TFP.
- We find a large response of macroeconomic aggregates and a general equilibrium boost in wages, benefiting the bottom of the income distribution.