Use It Or Lose It: Efficiency Gains from Wealth Taxation*

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November 19, 2018. (**Preliminary Draft. Comments Welcome.**)

Abstract

This paper studies the quantitative implications of wealth taxation (tax on the *stock* of wealth) as opposed to capital income taxation (tax on the income *flow* from wealth) when individuals differ from each other in the rate of return they earn on their investments. With such heterogeneity, capital income and wealth taxes have opposite implications for efficiency as well as for some key distributional outcomes. Under capital income taxation, entrepreneurs who are more productive, and therefore generate more income, pay higher taxes. Under wealth taxation, on the other hand, entrepreneurs who have similar wealth levels pay similar taxes regardless of their productivity, which expands the tax base, shifts the tax burden toward unproductive entrepreneurs, and raises the savings rate of productive ones. This reallocation increases aggregate productivity and output. In the simulated model parameterized to match the U.S. data, a revenue-neutral tax reform that replaces capital income tax with a wealth tax raises average welfare by about 8% in consumption-equivalent terms. Moving on to optimal taxation, the optimal wealth tax is positive, yields larger welfare gains than the tax reform, and is preferable to optimal capital income taxes. Interestingly, the optimal wealth tax results in more equal consumption and leisure distributions (despite the wealth distribution becoming more dispersed), which is the opposite of what optimal capital income taxes imply. Consequently, wealth taxes can yield both efficiency *and* distributional gains.

JEL Codes: E21, E22, E62, H21.
Keywords: Wealth tax, Capital income tax, Optimal taxation, Rate of return heterogeneity, Power law models, Wealth inequality.

*For comments and critiques, we thank Mark Aguiar, Adrian Auclert, Jess Benhabib, Alberto Bisin, Richard Blundell, V. V. Chari, Cristina De Nardi, Andres Erosa, Priscilla Fialho, Mike Golosov, Joao Gomes, Pierre-Olivier Gourinchas, Luigi Guiso, Bob Hall, Hugo Hopenhayn, Nobu Kiyotaki, Dirk Krueger, Per Krusell, Guido Menzio, Claudio Michelacci, Ben Moll, Victor Ríos-Rull, Martin Schneider, Aleh Tsyvinski, Gabriel Zucman, and seminar and conference participants at various institutions. For funding, Guvenen thanks the National Science Foundation; Kuruscu thanks the Marie Sklodowska-Curie programme under Horizon 2020; and Kambourov and Kuruscu thank the Social Sciences and Humanities Research Council. Guvenen: U of Minnesota, FRB of Minneapolis, and NBER; guvenen@umn.edu; Kambourov: U of Toronto; g.kambourov@utoronto.ca; Kuruscu: U of Toronto; burhan.kuruscu@utoronto.ca; Ocampo: U of Minnesota; ocamp020@umn.edu; Chen: Econ One

1 Introduction

In this paper, we ask a simple question: How does taxing the income flow from capital ("capital income tax") differ from taxing the stock of wealth ("wealth tax")?[1] To fix ideas, let a denote wealth, r denote the rate of return on wealth, and τ_k and τ_a denote the flat tax rates on capital income and wealth, respectively. Under a capital income tax, the after-tax wealth of individual i is given by

$$a^i_{\text{after-tax}} = a^i + (1 - \tau_k) \times ra^i,$$

whereas under the wealth tax, it is

$$a^i_{\text{after-tax}} = (1 - \tau_a) \times a^i + (1 - \tau_a) \times ra^i.$$

In a variety of benchmark economic models, the answer to the question we posed above is not very interesting: the two tax systems are equivalent, with $\tau_a = \frac{r\tau_k}{1+r}$. Partly due to this equivalence, the academic literature on capital taxes most often focuses on capital income taxes, with the understanding that they can be reinterpreted as wealth taxes. However, the equivalence result relies on the assumption that all individuals face the same rate of return on wealth, which we also made implicitly above by not indexing r with a superscript i. What happens if this assumption does not hold—that is, if rates of return vary across individuals as some recent empirical evidence (we review below) shows?

To see some of the implications for taxation, consider the following stark but illustrative example. Two entrepreneurs start out with the same wealth level—say \$1,000 each—but earn different returns on their wealth, say, $r^1 = 0$ and $r^2 = 20\%$. Under capital income taxation, the unproductive (first) entrepreneur will escape taxation because he generates no income, and the tax burden will fall entirely on the more productive (second) entrepreneur because he generates positive capital income. Under wealth taxation, on the other hand, both entrepreneurs will pay the same amount of tax regardless of their productivity, which will expand the tax base, shift the tax burden toward the unproductive entrepreneur, and reduce (potential) tax distortions on the productive entrepreneur.[2] To the extent that these differences in productivity are persistent, a wealth

[1] We use capital and wealth interchangeably throughout the paper.
[2] Table I povides some illustrative calculations for this example.

tax will gradually prune the wealth of idle entrepreneurs and boost that of successful ones, leading to a more efficient allocation of the aggregate capital stock, in turn raising productivity and output. In this sense, wealth taxation has a "use it or lose it" effect that is not present in capital income taxation.

While this is a very stylized example, it illustrates how (rate of) return heterogeneity can activate interesting new mechanisms that drive a wedge between the implications of the two ways of taxing capital. The main contribution of this paper is to study these implications in a full-blown quantitative overlapping-generations model with return heterogeneity. As we elaborate in a moment, we find that the two taxes have very different–sometimes opposite–implications.

There are two more considerations that motivate us to take return heterogeneity seriously for studying capital taxation. First, a growing number of new empirical studies cast strong doubt on the assumption of homogenous returns across households. Using recently available administrative panel data sets that track millions of individuals over long periods of time, these studies document large and persistent differences in rates of return across individuals, even after adjusting for risk and other factors (e.g., Fagereng et al. (2016), Bach et al. (2018), and Smith et al. (2017)).[3] In our view, these new pieces of evidence make studying the tax implications of return heterogeneity more than a theoretical curiosity.

Second, another growing literature—on power law models—shows that rate of return heterogeneity is a powerful modeling tool that can generate key features of inequality that have proved challenging to explain by other mechanisms.[4] This is an important benefit for the purposes of this paper: because the wealth distribution is extremely concentrated in the United States—as well as in many other countries—the bulk of the capital tax burden falls on a small fraction of wealthy households. This makes capital taxation much more about the "right tail" than taxes on consumption and labor income, which are more evenly distributed than wealth. Thus, it seems a priori important for our model not only

[3] Among these, Fagereng et al. (2016) study a 20-year-long panel that covers all households in Norway and contains extensive details about their portfolios and investments during this time. They find large differences across individuals in their (risk-adjusted) rates of return averaged over 20 years. Bach et al. (2018) analyze a similar panel data set from Sweden and conclude that the main driver of wealth inequality at the top is heterogeneity in rates of return. Finally, for the United States, Smith et al. (2017) use a unique panel data set from the US Treasury Department that contains information on 10 million firms and their owners; they document persistent heterogeneity in firm profitability even after adjusting for risk and size.

[4] See Gabaix (2009) and Benhabib and Bisin (2018) for excellent recent reviews of this literature.

to generate the extreme wealth concentration at the top but also to be consistent with other features that are likely to be relevant for capturing the key trade-offs faced by very wealthy individuals.

One such feature is the thick Pareto tail of the wealth distribution seen in many countries around the world (Vermeulen (2016)), which is challenging to generate by many models of inequality (even by some of those that match the share of wealth held by the top 1%) but emerges naturally in models with return heterogeneity (Benhabib, Bisin and Zhu, 2011; Benhabib, Bisin and Luo, 2017). Further, if return heterogeneity is persistent, these models also generate behavior consistent with the *dynamics* of wealth inequality over time (Gabaix, Lasry, Lions and Moll (2016) and Jones and Kim (2018)). Another important feature that determines the trade-offs faced by the wealthy is the extent to which their wealth is dynastic/inherited or self made/accumulated. In the United States, a significant fraction of the very wealthy are self made and accumulate wealth very rapidly during their lifetime. For example, about 53% of the individuals on the 2017 US Forbes 400 list were self-made billionaires, which implies a (conservative) lower bound of a 1000-fold increase in their wealth over the life cycle. In contrast, in models of inequality that rely on idiosyncratic labor income risk or discount rate heterogeneity it takes dozens of generations for extremely high wealthy individuals to emerge. A calibrated model featuring return heterogeneity can generate this pattern, as we show in this paper.

Finally, there is also an important practical motivation for studying wealth taxation—it is a tool that has long been used by governments around the world. Until the last decade or so, many of the richest OECD countries had wealth taxation (e.g., France, Germany, Spain, Italy, Netherlands, Nordic countries, among others). Although its popularity has waned significantly in recent decades, it is still being used in France, Spain, Netherlands, Switzerland, and Norway.[5] In light of this reality, studying the effects of wealth taxation (and how they differ from capital income taxation) is an important step toward providing better guidance to policy makers.

For the quantitative analysis, we study an overlapping-generations model where individuals derive utility from consumption and leisure. The key ingredient of the model is persistent heterogeneity in investment/entrepreneurial skills, which, together with incomplete financial markets that prevent free flow of funds across agents, allows some

[5]As of 2017. See OECD (2018) for a recent review of the use of wealth taxes across OECD countries.

individuals to earn persistently higher returns on their wealth than others. Individuals can borrow from others in a bond market to invest in their firm over and above their own saved resources. The same bond market can also be used as a savings device, which will be optimal for individuals whose entrepreneurial skill (and hence private return) is low or have too much wealth or both.

Each individual/entrepreneur produces a differentiated intermediate good using a linear technology and individual-specific productivity levels. These intermediates are combined in a Dixit-Stiglitz aggregator by a final goods producing firm, which pins down each entrepreneur's production scale and profits. In our calibrated economy, most individuals earn the bulk of their income from wages, and only a small fraction (10–20%, depending on the exact definition) of individuals produce large enough output to be considered an entrepreneur/investor. Individuals also face idiosyncratic labor income risk, mortality risk, borrowing constraints in the bond market, and various intergenerational links (accidental bequests to offspring, correlated entrepreneurial and labor market skills, etc.), although plausible variations in these details do not change the substantive conclusions. The calibrated model is consistent key features of the U.S. wealth distribution mentioned above, including the high concentration of wealth, the Pareto right tail, the rapid wealth growth of the very wealthy, the cross-sectional dispersion in lifetime rates of return, and the amount of borrowing by US businesses. Further, the extent of capital misallocation generated in the model is in line with the U.S. data (e.g., Bils, Klenow and Ruane (2017)).

Our analysis produces three sets of results. First, we study a revenue-neutral tax reform that replaces the current U.S. tax system of capital income taxation with a flat wealth tax, keeping taxes on labor and consumption unchanged. Comparing across steady states, this reform raises average welfare significantly—equivalent to about 7–8% of consumption (per person per year) for newborn individuals in our baseline calibration. The gains come from a combination of more efficient allocation of capital and higher capital levels generated by the use-it-or-lose-it mechanism inherent in wealth taxation. Furthermore, these welfare gains are quite evenly distributed across the population because productivity improvements raise output and wages, benefitting workers across the board.

Second, we move to an optimal tax analysis, in which a utilitarian government chooses linear taxes on labor income and on wealth to maximize the ex ante expected lifetime utility of a newborn. We repeat the same analysis, this time having the government choose linear taxes on labor and capital income. In the first case, we find that the optimal wealth tax rate is positive and relatively high, at about 3%. This allows the government to reduce the tax on labor income (from 22.5% down to 14.5%), which is more distorting than the wealth tax in this environment. The lower labor income tax reinforces the rise in before-tax wages, in turn boosting labor supply and further raising output and welfare. That said, most of the welfare gain still comes from the reduced misallocation of capital (as in the tax reform), a smaller part from higher labor supply, and almost none of it from a change in the capital stock level—which remains almost unchanged—in the new steady state. In other words, the benefits of optimal wealth taxes in this experiment do not require more capital accumulation at the aggregate level.[6]

Turning to optimal capital income taxation, the optimal tax rate turns out to be negative and large: about –35%, implying a large subsidy to capital income. At first blush, this finding may seem surprising in light of earlier results in the literature, which found a high positive tax rate (of about +35%) using lifecycle models with incomplete markets that share many similarities to ours (c.f. Conesa, Kitao and Krueger (2009)). The main difference turns out to be return heterogeneity: shutting down return heterogeneity and recalibrating our model restores the high positive tax rate found in previous work. The intuition for the capital income subsidy being optimal is relatively simple: in the standard model, the wealthy are individuals who earned high labor income in the past but are not better at investing this wealth than others. With return heterogeneity, the wealthy are primarily those who are good investors, so the redistributional benefits from taxing their income is easily outweighed by the loss from distorting their savings and reducing their wealth. This result shows that two similar models of wealth inequality (versions of the same model with and without return heterogeneity) may have very different implications—not only for wealth taxation but also for capital income taxation.

Third, we find that among the two optimal tax systems, the one with wealth taxes yields higher welfare gains (9.5%) than the one with capital income taxes (6.5%). A decomposition analysis shows that the gains under wealth taxes come from both a rise in the *level* of consumption (driven by higher after-tax wages) and a decline in the *inequality* of consumption. Thus, optimal wealth taxes yield both first- and second-order gains. This is not the case with optimal capital income taxes: although they deliver an

[6]Based on this result, we cautiously conjecture that an experiment that incorporates transition analysis may not result in large losses along the transition path as there may not be a need for higher savings to achieve the new steady state.

even larger rise in output, providing capital subsidies requires higher taxes on labor income, resulting in only a small rise in *after-tax* wages and therefore in consumption. Furthermore, subsidies on capital lead to a significant rise in inequality—both in wealth but also more importantly in consumption—yielding distributional losses, which offsets some of the gains from levels—unlike under optimal wealth taxes.

Finally, we conduct various sensitivity checks to gauge the robustness of these conclusions. In particular, we have considered progressive labor income taxes, optimal wealth taxes with an exemption level, introducing estate taxation, relaxing or eliminating borrowing constraints, different assumptions about the stochastic process governing entrepreneurial productivity, and various changes in key parameters. While these changes affect the various magnitudes of welfare gains (as would be expected), they do not overturn any of the main substantive conclusions of our analysis.

The rest of the paper is organized as follows. Section 2 elaborates on the simple static example described above. Section 3 lays out the full-blown model, and Section 4 describes the parameterization and model fit. Sections 5 and 6 present the quantitative results from the tax reform and optimal taxation, respectively. Section 7 discusses sensitivity analyses; Section 8 concludes.

Related Literature

Although the "use-it-or-lose-it" feature of wealth taxes has been discussed by some authors, we are not aware of prior academic work studying its effects as we do in this paper. Maurice Allais was probably one of the best-known proponents of wealth taxes who spelled out the use-it-or-lose-it rationale in his book on wealth taxation.[7] More recently, Piketty (2014) has revived the debate on wealth taxation and proposed using a combination of capital income and wealth taxes to balance these efficiency and inequality tradeoffs. Piketty mostly focused on equity considerations, but also described the use-it-or-lose-it mechanism without providing a formal analysis.[8]

The broader literature on capital taxation is vast, so we will not attempt to review it here. For thorough recent surveys, see, Chari and Kehoe (1999) and Golosov et al. (2006). This paper is more closely related to the strand that conducts quantitative

[7]He observed that "[a] tax on the capital stock represents a bonus to production and penalizes the inefficient owner, passive, for whom income taxes encourage inaction (Allais, 1977, p. 501, translated)."

[8]The work of Shourideh (2013) shares some similarities to ours. He provides a theoretical analysis of the Mirleesian taxation problem of wealthy individuals who face a risk-return trade-off in their investment choice. He finds a progressive saving tax to be the optimal policy.

analyses of capital taxation when financial markets are incomplete, tax instruments are restricted (in plausible ways), and/or individuals are finitely lived (Hubbard, Judd, Hall and Summers (1986), Aiyagari (1995), Imrohoroglu (1998), Erosa and Gervais (2002), Garriga (2003), Conesa et al. (2009), Kitao (2010)). Some of these studies found that the optimal capital tax rate may be positive and large. The two main differences of our analysis are (i) the presence of heterogeneous returns and (ii) considering wealth taxation.[9] On capital income taxation, our contribution is to show that the presence of return heterogeneity can alter the substantive conclusions and turn the optimal policy from a tax to a subsidy when the heterogeneity is sufficiently large. On wealth taxation, we show that its effects can be qualitatively very different from taxing capital income and yield larger and more broad-based welfare gains.

As noted above, this paper is also related to the literature on power law models of inequality.[10] This literature points out that the well-established thick Pareto tail of the wealth distribution is difficult to explain in Bewley-Aiyagari style models where wealth inequality is due to precautionary savings in response to idiosyncratic income shocks. This is because the wealth distribution inherits the Pareto tail of the income distribution (as shown by Benhabib et al. (2017) theoretically and by Hubmer et al. (2017) via simulations), which is significantly thinner than the tail for wealth in the data. Furthermore, when the idiosyncratic income process is estimated to match micro evidence on income dynamics, these models are able to generate plausible implications for the bottom 95% or so of the wealth distribution but severely miss inequality at the top (e.g., generate 1/3 of the wealth holdings for the top 1% and fail to generate individuals with more than $20 million in wealth, among others; see De Nardi et al. (2016), Guvenen et al. (2016), and Carroll et al. (2017).

The power law literature identifies various plausible mechanisms—such as birth/death processes, creative destruction, stochastic discount factors, and heterogeneity in returns (or growth rates)—that can give rise to a Pareto tail in the steady state distribution

[9]An exception is Kitao (2008) who studies the differences between taxing capital income from entrepreneurial activities (namely profits) and capital income from rents (namely bonds). She does this in an occupational choice model where entrepreneurs differ in their productivity.

[10]We discuss here the most recent strand that focuses on inequality in income and wealth. Earlier important contributions include Gabaix (1999) on Zipf's law in city size distribution, Gabaix (2011) on whether idiosyncratic shocks to firms can cause aggregate fluctuations, Luttmer (2007, 2011) on the dynamics of firm growth and the Pareto tail in firm size distribution, as well as the much earlier literature in the 1950s that these papers build upon and extend. See Gabaix (2009); Benhabib and Bisin (2018) for detailed surveys.

of wealth or income (Benhabib et al. (2011, 2013, 2014)). Furthermore, as Gabaix et al. (2016) show, when the heterogeneity in returns rates is persistent, these models generate behavior also consistent with the *dynamics* of inequality. Our model shares similarities to Jones and Kim (2018), who emphasize the creative destruction process in entrepreneurial production to explain the Pareto tail of the income distribution. Despite the rapid growth in this literature, the implications of capital taxation in these models have been unexplored, and our paper fills this gap.

Finally, our paper has some useful points of contact with several papers that feature (entrepreneurial) firms with heterogeneous productivity facing financial frictions, leading to misallocation of capital, lower productivity, underdevelopment, among others. Examples include Restuccia and Rogerson (2008) and Hsieh and Klenow (2009) in the context of aggregate TFP; Buera, Kaboski and Shin (2011), Moll (2014), and Itskhoki and Moll (2019) in the context of economic development; Quadrini (2000) and Cagetti and De Nardi (2009) in the context of entrepreneurship, among others. These papers do not study tax policy in general, and none of them study differences between capital income and wealth taxes as we do in this paper. One recent exception is Itskhoki and Moll (2019) who study optimal dynamic Ramsey policies in such an environment but focus on labor tax policies and capital subsidies.

2 A Simple One-Period Example

It is useful to elaborate on the simple example described in the Introduction. Consider two brothers, named Fredo and Michael, who each has \$1000 of wealth at time zero. Fredo has low entrepreneurial skills, and so he earns a return of $r_F = 0\%$ on his investments, whereas Michael is a highly skilled business man, and so he earns a return of $r_M = 20\%$. Both brothers invest all their wealth in their business and make no other decisions (such as consumption or saving choice). To introduce taxation, suppose that there is a government that needs to finance an expenditure of $G = \$50$ through tax revenues collected at the end of the period. The example is summarized in Table I.

Now, suppose that the government taxes capital income at a flat rate. To raise \$50, the required tax rate is 25% on income and is paid entirely by Michael, who is the skilled entrepreneur and the only one earning any capital income. Consequently, the after-tax return is 0% for Fredo and 15% for Michael. By the end of the period, Fredo's wealth remained unchanged, whereas Michael experienced an increase from \$1,000 to \$1,150 after paying his taxes.

Next, suppose that the government decided to raise the same revenue with a wealth tax. Now the base of taxation is broader, because Fredo does have wealth and cannot avoid taxation as he did under the capital income tax. Specifically, the tax base covers the entire wealth stock, or \$2200, at the end of the period. The tax rate on wealth is $\$50/\$2,200 \approx 2.27\%$. More importantly, Fredo's tax bill is now \$23, up from zero, whereas Michael's tax bill is cut by almost half, from \$50 before down to \$27. The after-tax rate of return is, respectively, $(\$0 - \$23)/\$1000 \approx -2.3\%$ for Fredo and $(\$200 - \$27)/\$1000 \approx 17.3\%$ for Michael. Notice that the dispersion in after-tax returns is higher under wealth taxes and the end-of-period wealth inequality is also higher: $\$1,173/\$977 \approx 1.20$ versus $\$1,150/\$1,000 = 1.15$ before. Most crucially, the more productive entrepreneur (Michael), ends up with a larger fraction of aggregate wealth: 54.6% vs. 53.5% under capital income taxes.

To sum up, wealth taxation has two main effects that are opposite to capital income taxes. First, by shifting some of the tax burden to the less productive entrepreneur, it allows the more productive one to keep more of his wealth, thereby reallocating the aggregate capital stock towards the more productive agent. Second, wealth taxes do not compress the after-tax return distribution nearly as much as capital income taxes do, which effectively punish the successful entrepreneur and reward the inefficient one. In a (more realistic) dynamic setting, such as the one we study in the next section, this feature will yield an endogenous response in savings rates, further increasing the reallocation of capital to the more productive agent, leading to a rise in productivity and output. At the same time, this reallocation process also increases wealth concentration, which may conflict with distributional goals of the society. So, overall, relative to the capital income tax, the wealth tax generates efficiency gains but can lead to distributional losses. As we shall see in the quantitative analysis, however, distributional losses are not a robust feature of wealth taxes and are mitigated or reversed (into gains) when a proper production function is introduced and wage income is added to the model. In that case, wealth taxes yield both efficiency and distributional gains.

Before we conclude this example, an important remark is in order. If this one-period example were to be repeated for many periods, all aggregate wealth—both in the capital income tax and the wealth tax cases—will eventually be owned by the more productive investor, Michael. As it turns out, as long as there are variations in the rates of return, the main arguments in favor of a wealth tax, highlighted in the simple model, remain valid. Variations in the rates of return are realistic features of the data: both over the life

Table I – Capital Income Tax vs. Wealth Tax

	Capital Income Tax		**Wealth Tax**	
	$r_F = 0\%$	$r_M = 20\%$	$r_F = 0\%$	$r_M = 20\%$
Wealth	\$1,000	\$1,000	\$1,000	\$,1000
Pre-tax income	\$0	\$200	\$0	\$200
Tax rate	$\tau_k = \frac{\$50}{\$200} = 0.25$		$\tau_a = \frac{\$50}{\$2{,}200} = 2.27\%$	
Tax liability	\$0	\$50	$\$1,000 \times \tau_a \approx \$23$	$\$1,200 \times \tau_a \approx \$27$
After-tax rate of return	0%	$\frac{\$200-\$50}{\$1{,}000} = 15\%$	$-\frac{\$23}{\$1{,}000} = -2.3\%$	$\frac{\$200-\$27}{\$1{,}000} = 17.3\%$
After-tax wealth ratio	$\frac{W_M}{W_F} = \frac{\$1{,}150}{\$1{,}000} = 1.15$		$\frac{W_M}{W_F} = \frac{\$1{,}173}{\$977} = 1.20$	

cycle (the fortunes of entrepreneurs do fluctuate over time) and from one generation to the next (the entrepreneurial ability of children often differs from that of their parents). Thus, we incorporate these features in the rich dynamic model we consider next.

3 Full OLG Model

We study an economy populated by overlapping generations of finitely-lived individuals, two sectors (producing intermediate-goods and the final good, respectively), and a government that raises revenues through various taxes.

3.1 Individuals

Individuals face mortality risk and can live up to a maximum of H years. Let ϕ_h be the unconditional probability of survival up to age h and let $s_h \equiv \phi_h/\phi_{h-1}$ be the conditional probability of surviving from age $h-1$ to h. When an individual dies, she is replaced by an offspring that inherits her wealth.

Individuals derive utility from consumption, c, and leisure, ℓ, and maximize expected lifetime utility without any bequests motives:

$$\mathbb{E}_0 \left(\sum_{h=1}^{H} \beta^{h-1} \phi_h u(c_h, \ell_h) \right).$$

Individuals make four decisions every period: (i) leisure time vs. labor supply to the market (until retirement age, $R < H$), (ii) consumption today vs saving for tomorrow,

(iii) portfolio choice: how much of his own assets/wealth to invest in his own business versus how much to lend to others in the bond market, and (iv) how much to produce (of an intermediate good) as an entrepreneur. We now describe the endowments of various skills, production, technologies, and the market arrangements, and then spell out each of the four decisions in more detail.

3.2 Skill Endowments and their Evolution

Each individual is endowed with two types of skill: one that determines his productivity in entrepreneurial activities and another that determines his productivity as a worker. We now describe these two skills, how they evolve across generations and over the life cycle, and how they enter the two activities undertaken by the individuals.

Entrepreneurial productivity

Let z_{ih} denote the entrepreneurial productivity of individual i at age h, which has two components: $\overline{z}_i$, which is fixed over the life cycle but changes across generations (inherited from the parent), and a second component that varies stochastically over the life cycle. Specifically, a newborn inherits $\overline{z}_i$ imperfectly from her parent:

$$\log(\overline{z}_i^{\text{child}}) = \rho_z \log(\overline{z}_i^{\text{parent}}) + \varepsilon_{\overline{z}_i},$$

where $\varepsilon_{\overline{z}_i}$ is an i.i.d. normal innovation with mean zero and variance $\sigma^2_{\varepsilon_{\overline{z}}}$. Because $\overline{z}_i$ is imperfectly inherited, some children with low entrepreneurial skills will inherit large amounts of wealth from their successful parent, and vice versa, causing misallocation of productive resources.

Whereas $\overline{z}_i$ captures an individual's more permanent traits, we also want to allow for the fact that these entrepreneurial skills can be augmented with external factors (such as a lucky head-start on a new idea, good health and energy that can allow skills to be fully utilized) or hampered again by factors (such as competitors entering the field, opportunity cost of time rising due to family factors, negative health shocks, among others). To allow for these variations, we allow the individual to be in different "phases" of productivity, modeled as a three-state Markov chain that can take on the values high, low, and zero: $\mathbb{I}_{ih} \in \{\mathcal{H}, \mathcal{L}, 0\}$ at h. Together with $\overline{z}_i$, this determines the entrepreneurial productivity of an individual at a given age:

$$z_{ih} = f(\overline{z}_i, \mathbb{I}_{ih}) = \begin{cases} (\overline{z}_i)^\lambda & \text{if } \mathbb{I}_{ih} = \mathcal{H} \qquad \text{where } \lambda > 1 \\ \overline{z}_i & \text{if } \mathbb{I}_{ih} = \mathcal{L} \\ 0 & \text{if } \mathbb{I}_{ih} = 0 \end{cases}$$

and transition between these states is governed by the transition matrix:

$$\Pi_z = \begin{bmatrix} 1 - p_1 - p_2 & p_1 & p_2 \\ 0 & 1 - p_2 & p_2 \\ 0 & 0 & 1 \end{bmatrix}.$$

Finally, individuals whose permanent ability is above the median permanent ability—i.e., $\overline{z} > \overline{z}_{med} = 1$—start life in state $\mathbb{I}_{ih} = \mathcal{H}$ while the rest start in state $\mathbb{I}_{ih} = \mathcal{L}$. Overall, this structure is intended to capture the fact that many individuals who are extremely wealthy go through a very high growth phase especially, in the early stages of their business, followed by a slowdown as their business matures or their competitors catch up.

Labor market productivity

At a given age individuals differ in their labor market productivity, y_{ih}, which consists of three components

$$\log y_{ih} = \underbrace{\theta_i}_{\text{permanent}} + \underbrace{\kappa_h}_{\text{lifecycle}} + \underbrace{e_{ih}}_{\text{AR(1)}}$$

where θ_i is an individual fixed effect, κ_h is a life-cycle component that is common to all individuals and e_{ih} follows an AR(1) process during working years ($h < R$):

$$e_{ih} = \rho_e e_{i,h-1} + \epsilon_e,$$

where ϵ_e is an i.i.d. shock with mean zero and variance $\sigma^2_{\epsilon_e}$. Individual-specific labor market ability θ is imperfectly inherited from parents:

$$\theta^{child} = \rho_\theta \theta^{parent} + \epsilon_\theta,$$

where ϵ_θ is an i.i.d. Gaussian shock with mean zero and variance $\sigma^2_{\epsilon_\theta}$.

Let $n_{ih} = 1 - \ell_{ih}$ denote the labor hours supplied in the market. Individuals supply their labor services to the final goods producer, so they make up the aggregate labor supply,

$$L = \int (y_{ih} n_{ih})\, didh, \tag{1}$$

used in the aggregate production function (2) described in a moment. Therefore, for a given market wage rate per efficiency units of labor, w, an individual's labor income is given by $wy_{ih}n_{ih}$.

3.3 Production Technology

Final Goods Producer

The final good, Y, is produced according to a Cobb-Douglas technology,

$$\mathcal{Y} = Q^{\alpha} L^{1-\alpha}, \tag{2}$$

where L is the aggregate labor input defined in (1), and Q is the CES composite of intermediate inputs, x_i:[11]

$$Q = \left(\int x_{ih}^{\mu} didh \right)^{1/\mu}. \tag{3}$$

Each x_i is produced by a different individual in a way that will be specified in a moment. The final goods producing sector is competitive, so the profit maximization problem is:

$$\max_{\{x_{ih}\},L} \left(\int x_{ih}^{\mu} didh \right)^{\alpha/\mu} L^{1-\alpha} - \int p_{ih} x_{ih} didh - wL,$$

where p_i is the price of the intermediate good i. The first order optimality conditions yield the inverse demand (price) function for each intermediate input and the wage rate:

$$p\,(x_{ih}) = \alpha x_{ih}^{\mu-1} Q^{\alpha-\mu} L^{1-\alpha} \qquad w = (1-\alpha) Q^{\alpha} L^{-\alpha}. \tag{4}$$

Intermediate Goods Producers

There is a continuum of intermediate goods, each produced by a different individual according to a linear technology:

$$x_{ih} = z_{ih} k_{ih} \tag{5}$$

[11] To distinguish Q from the unadjusted capital stock $K := \int k_{ih} didh$, we will often refer to the former as the "quality-adjusted capital stock" since its level depends on the allocation of the capital stock across entrepreneurs (and reflects the extent of misallocation).

where k_{ih} is the final good (consumption/capital) used in production by entrepreneur i and z_{ih} is her stochastic and idiosyncratic entrepreneurial productivity at age h.

3.4 Markets and the Government

Financial markets

There is a bond market where intra-period borrowing and lending takes place at a risk-free rate of r. Individuals with sufficiently high entrepreneurial productivity relative to their private assets may choose to borrow in this market to finance their business. Similarly, those with low productivity relative to their assets may find it optimal to lend for a risk-free return. Following a large literature, we impose borrowing constraints to capture information frictions or commitment problems, which we do not model explicitly (among others, Cagetti and De Nardi (2006) and Buera et al. (2011)). In particular, an individual with asset level a faces a financial constraint

$$k \leq \vartheta(z_{ih}) \times a,$$

where $\vartheta(z_{ih}) \in [1, \infty]$. The (potential) dependence of ϑ on z_{ih} is to allow for the fact that more productive agents could potentially borrow more against their personal assets.[12] When $\vartheta = 1$, the financial constraint is extreme, since individuals can only use their own assets in production. When $\vartheta = \infty$ there is no longer a financial constraint since there is no longer a restriction on the amount that an individual can borrow. We explore this last case in Section 7, where we show that even without misallocation of capital in the economy there is scope for efficiency and welfare gains from changing to wealth taxes. The reason for this result is the effect on capital accumulation of higher after-tax returns under wealth taxes.

Tax Systems

In the benchmark economy that aims to represent the current U.S. tax system, the government is assumed to impose flat taxes at rate τ_c on consumption (expenditures), τ_l

[12]We allow for this possibility to capture the idea that the market could (perhaps partially) observe individuals' productivity level and know they are able to produce a lot and pay back their debt. We model this feature as a possibly realistic aspect of financial markets that mitigates the constraints on investment and the extent of misallocation, thereby reducing the role of wealth taxes that we study later. Li (2016) finds evidence of this relation between borrowing constraints and productivity for young, unlisted firms in Japan. With homogenous constraints, $\vartheta(z_{ih}) = \overline{\vartheta}$, the impact of wealth taxes are larger.

on labor income, and τ_k on capital income. In the tax experiment we consider, we will study a revenue-neutral switch to an alternative system where the government will replace taxes on capital income (i.e., set $\tau_k \equiv 0$) with flat taxes on individuals' end of period wealth stock, τ_a, leaving labor and consumption tax rates intact. In the robustness analysis, we will consider various forms of progressivity in taxes (especially on labor income and on wealth).

The government taxes to finance social security pension payments to the retirees in the economy and an exogenously given level of government spending G.

Social Security Pension System

When an individual retires at age R, she starts receiving social security income $y^R(\theta, e)$ that depends on her type θ in the following way:

$$y^R(\theta, e) = \Phi(\theta, e)\,\overline{E}.$$

$\overline{E}$ corresponds to the average earnings of the working population in the economy, and Φ is the agent's replacement ratio, a function that depends on the agent's permanent type θ and the last transitory shock to labor productivity. The replacement ratio is progressive and satisfies:

$$\Phi(\theta, e) = \begin{cases} 0.9\frac{y_1^R(\theta,e)}{\overline{y}_1^R} & \text{if } \frac{y_1^R(\theta,e)}{\overline{y}_1^R} \leq 0.3 \\ 0.27 + 0.32\left(\frac{y_1^R(\theta,e)}{\overline{y}_1^R} - 0.3\right) & \text{if } 0.3 < \frac{y_1^R(\theta,e)}{\overline{y}_1^R} \leq 2 \\ 0.91 + 0.15\left(\frac{y_1^R(\theta,e)}{\overline{y}_1^R} - 2\right) & \text{if } 2 < \frac{y_1^R(\theta,e)}{\overline{y}_1^R} \leq 4.1 \\ 1.1 & \text{if } 4.1 < \frac{y_1^R(\theta,e)}{\overline{y}_1^R} \end{cases}$$

where $y_1^R(\theta, e)$ is the average efficiency units over lifetime that an agent of type θ gets conditional on having a given $e_R = e$.

$$y_1^R(\theta, e_R) = \frac{1}{R}\int_{h<R,a,\mathbf{S}} y_h(\theta, e)\, d\Gamma(h, a, \mathbf{S})\,.$$

$\mathbf{S} = (\overline{z}, \mathbb{I}, \theta, e)$ is the vector of exogenous states of an individual, and the integral is taken with respect to the stationary distribution (Γ) of agents such that e_R is the one given in the left hand side. Finally $\overline{y}_1^R$ is the average of $y_1^R(\theta, e)$ across θ and e.

For future reference let SSP denote the aggregate value of "social security pension" payments:

$$SSP := \int_{h \geq R, a, \mathbf{S}} y^R (\theta, e) \, d\Gamma (h, a, \mathbf{S}) .$$

3.5 Individual's problem

For clarity of notation, in this subsection we suppress the individual subscript i. The production problem of each individual is static: funds for investment are borrowed z is observed in a period and are repaid at the end of the period. So, this problem can be solved in isolation of her other decisions.

Individual/Entrepreneur's Problem

First, as an entrepreneur, the individual chooses the optimal capital level to maximize profit:

$$\pi (a, z) = \max_{k \leq \vartheta(z) a} \{ p (zk) \times zk - (r + \delta) k \} \quad (6)$$
$$\text{s.t. } p (zk) = \mathcal{R} \times (zk)^{\mu - 1} ,$$

where δ is the depreciation rate of capital, $z = f(\overline{z}_i, \mathbb{I}_{ih})$, and $\mathcal{R} = \alpha Q^{\alpha - \mu} L^{1-\alpha}$, which yields the solution:

$$k (a, z) = \min \left\{ \left(\frac{\mu \mathcal{R} z^{\mu}}{r + \delta} \right)^{\frac{1}{1-\mu}} , \vartheta(z) a \right\} . \quad (7)$$

Then, the maximized profit function is:

$$\pi (a, z) = \begin{cases} \mathcal{R} \left(z \vartheta(z) a \right)^{\mu} - (r + \delta) \vartheta(z) a & \text{if } k (a, z) = \vartheta(z) a \\ (1 - \mu) \mathcal{R} z^{\mu} \left(\frac{\mu \mathcal{R} z^{\mu}}{r+\delta} \right)^{\frac{\mu}{1-\mu}} & \text{if } k (a, z) < \vartheta(z) a \end{cases} . \quad (8)$$

The after-tax non-labor income, $Y(a, z, \tau_k, \tau_a)$, is given by after-tax profits from their firm and interest payments obtained from the financial market:

$$Y(a, z, \tau_k, \tau_a) = [a + (\pi (a, z) + ra) (1 - \tau_k)] (1 - \tau_a) . \quad (9)$$

Individual's Dynamic Programming Problem

The individual's problem then is given by:

$$V_h(a, \mathbf{S}) = \max_{c,n,a'} u\,(c, 1-n) + \beta s_{h+1} E\left[V_{h+1}(a', \mathbf{S}') \mid \mathbf{S}\right]$$
$$\text{s.t. } (1+\tau_c)\,c + a' = Y\,(a, z, \tau_k, \tau_a) + y_h^W(\theta, e)$$
$$a' \geq 0,$$

where

$$y_h^W(\theta, e) = \begin{cases} (1-\tau_l) w y_h n & \text{if } h < R \qquad \text{where } \log y_h = \theta + \kappa_h + e \\ y^R(\theta, e) & \text{if } h \geq R. \end{cases}$$

We assume that $e_h = e_{h-1}$ for $h \geq R$, thus the retirement income is essentially conditioned on the earnings shock in period $R-1$.

3.6 Equilibrium

Let $c_h(a, \mathbf{S})$, $n_h(a, \mathbf{S})$ and $a_{h+1}(a, \mathbf{S})$ denote the optimal decision rules and $\Gamma\,(h, a, \mathbf{S})$ be the stationary distribution of agents. A competitive equilibrium is given by the following conditions:

1. Consumers maximize given $p(x)$, w, r and taxes.
2. The solution to the final goods producer gives pricing function $p(x)$ and wage rate w.
3. $Q = \left(\int_{h,a,\mathbf{S}} (z \times k(a,z))^{\mu}\, d\Gamma\,(h, a, \mathbf{S})\right)^{1/\mu}$ and $L = \int_{h,a,\mathbf{S}} (y_h\,(\theta, e)\, n_h(a, \mathbf{S}))\, d\Gamma\,(h, a, \mathbf{S})$, where $\log y_h = \theta + \kappa_h + e$.
4. The government budget balances.

$$\begin{aligned} G + SSP &= \tau_k \int_{h,a,\mathbf{S}} (\pi\,(a,z) + ra)\, d\,\Gamma\,(h, a, \mathbf{S}) \\ &+ \tau_a \int_{h,a,\mathbf{S}} (\pi\,(a,z) + (1+r)\,a)\, d\,\Gamma\,(h, a, \mathbf{S}) \\ &+ \tau_L \int_{h,a,\mathbf{S}} (w y_h\,(\theta, e)\, n_h(a, \mathbf{S}))\, d\,\Gamma\,(h, a, \mathbf{S}) \\ &+ \tau_c \int_{h,a,\mathbf{S}} c_h(a, \mathbf{S}) d\,\Gamma\,(h, a, \mathbf{S}) \end{aligned}$$

where

$$SSP = \int_{h \geq R, a, \mathbf{S}} y^R(\theta, e)\, d\Gamma(h, a, \mathbf{S}).$$

We will compare the the equilibrium of the economy under capital income taxes ($\tau_k \neq 0$, $\tau_a = 0$) and under wealth taxes ($\tau_k = 0$, $\tau_a \neq 0$).

5. The bond market clears:

$$0 = \int_{h,a,\mathbf{S}} (a - k(a, z))\, d\Gamma(h, a, \mathbf{S})$$

4 Quantitative Analysis

4.1 Model Parameterization

The benchmark model is calibrated to the U.S. data. The model period is one year.

Government policy. The current U.S. tax system is modeled as a triplet of tax rates: on capital income (τ_k), labor income (τ_l), and consumption expenditures (τ_c). Following McDaniel (2007) who measures these tax rates for the U.S. economy, we set the capital income tax rate to $\tau_k = 25\%$, the labor income tax rate to $\tau_\ell = 22.4\%$, and the consumption tax rate to $\tau_c = 7.5\%$.

Demographics. Individuals enter the economy at age 20 and can live up to age 100 (i.e., a maximum of 81 periods). They retire at age 64 (model age $R = 45$). The conditional survival probabilities from age h to $h+1$ are taken from Bell and Miller (2002) for the U.S. data.

Preferences. In the baseline analysis, we consider a Cobb-Douglas utility function:

$$u(c, \ell) = \frac{(c^\gamma \ell^{1-\gamma})^{1-\sigma}}{1-\sigma}.$$

We set $\sigma = 4$ following Conesa et al. (2009). We then choose γ and β (the subjective time discount factor) to generate an average of 40 hours of market work per week for the working-age population (i.e., $\ell = 0.6$, assuming 100 hours of discretionary time per week) and a wealth-to-output ratio of 3, which requires $\gamma = 0.46$ and $\beta = 0.9475$.

Labor market efficiency. The deterministic life-cycle profile, κ_h, is modeled as a quadratic polynomial that generates a 50% rise in average labor income from age 21 to age 51.[13] The annual persistence of the autoregressive process for labor income, ρ_e, is set to 0.9.[14] The standard deviation of the innovation, σ_e, is set to 0.2. The intergenerational correlation of the fixed effect of labor market efficiency, ρ_θ, is set to 0.5, which is broadly consistent with the estimates in the literature (see Solon (1999) for a survey). Finally, with these parameters fixed, we set $\sigma_{\epsilon_\theta} = 0.305$ so as to match our empirical target of a cross-sectional standard deviation of log labor earnings of 0.80 (Guvenen, Karahan, Ozkan and Song, 2015).

Entrepreneurial productivity. The evolution of entrepreneurial ability across generations is governed by the parameters ρ_z and $\sigma_{\varepsilon_{\overline{z}}}$. Unfortunately, there is not much empirical evidence on either parameter from the U.S. data that we are aware of. In light of this, we turn to evidence from other countries. In particular, Fagereng et al. (2016) estimate individual fixed effects in rates of return over a 20-year period for parents and their children from administrative panel data on Norwegian households. They report a small correlation of about 0.1, which we take as our empirical value of ρ_z. We also conducted robustness analysis using a value of $\rho_z = 0.5$ but did not find any substantive differences. As for, $\sigma_{\varepsilon_{\overline{z}}}$ we choose it so as to match the share of aggregate wealth held by the top 1% of the wealth distribution.

In calibrating the stochastic component of entrepreneurial ability, one concern we have in mind is the inability of many models of wealth inequality to generate the speed at which the super wealthy—or the self-made billionaires—emerge in the data. In contrast, in these models the extreme wealth concentration emerges at a very slow pace and often requires hundreds of years. Thus, one target we match is the fraction of self-made billionaires in the Forbes 400 list. The classification adopted by Forbes is shown in Table A.1 in the appendix. We define a self-made billionaire to be one who came from an upper-middle-class or lower-income family (Categories 8–10 in Table A.1). By this definition 54% of individuals on the list are self made. The model counterpart is defined as an individual who inherits less than one million dollars and goes on to become a billionaire. We set $\lambda = 5$, $p_1 = 0.05$, and $p_2 = 0.03$, which generates a self-made ratio of billionaires of 50%.

Production. We target a labor share of output of 0.60 by setting $\alpha = 0.4$. The curvature parameter of the CES aggregator of intermediate inputs, μ, is set to 0.9. With

[13] $\kappa_{ih} = \frac{60(h-1)-(h-1)^2}{1800}$

[14] See Guvenen (2007) and others.

TABLE II – Benchmark Parameters

Parameters Calibrated Outside of the Model		
Parameter		Value
Capital income tax rate	τ_k	0.25
Labor income tax rate	τ_l	0.224
Consumption tax rate	τ_c	0.075
Exponent of labor tax function (baseline)	ψ	0.00
Wealth tax rate (baseline)	τ_a	0.00
Autocorrelation for idiosyncratic labor efficiency	ρ_e	0.9
Std. for idiosyncratic labor efficiency	σ_{ϵ_e}	0.2
Interg. correlation of labor fixed effect	ρ_θ	0.5
Intermediate goods aggregate share in production	α	0.4
Curvature parameter of CES production func.	μ	0.9
Depreciation rate	δ	0.05
Curvature of utility function	σ	4.0
Maximum age	H	81
Retirement age	R	45
Survival probabilities	ϕ_h	Bell and Miller (2002)
Parameters Calibrated Jointly in Equilibrium		
Discount factor	β	0.9475
Consumption share in utility	γ	0.460
Std. dev. of interg. transmission of entrepreneurial ability	$\sigma_{\varepsilon_{\bar{z}}}$	0.072
Std. dev. of interg. transmission of labor fixed effect	σ_{ϵ_θ}	0.305
Productivity boost	λ	5.0

this value, our model generates the Pareto tail of the wealth distribution as it is observed in the U.S. data (see Figure 1). Later, we will provide robustness checks on its value. The depreciation rate of capital is set to 5%.

Financial constraint. We allow firms with higher productivity to borrow more. In particular, we choose

$$\vartheta(\bar{z}_i) = 1 + 1.5(i-1)/8 \text{ for } i = 1, ..., 9.$$

Note that we have 9 grid points for the permanent component of z. Table II summarizes the parameters that we calibrate independently (top panel) and those that are calibrated jointly (bottom panel) in equilibrium to match the moments shown in Table III.

Table III – Targeted Moments

	U.S. Data	Benchmark
Top 1%	0.36	0.36
Wealth-to-output ratio	3.00	3.00
Std. dev. of log earnings	0.80	0.80
Average Hours	0.40	0.40
Fraction self made	54%	50%

Table IV – Statistics of the Benchmark Model

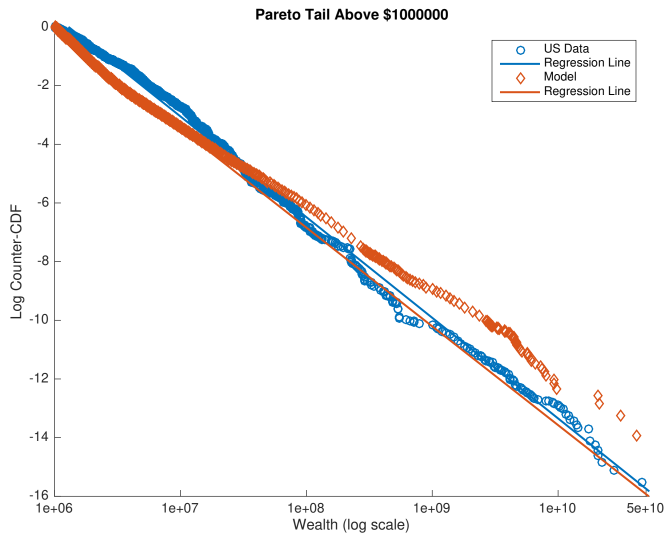
	U.S. Data	Benchmark
Bequest/Wealth	1–2%	0.99%
GDP share of total tax revenue	0.295	0.25
Revenue share of capital tax	0.280	0.25
GDP share of capital tax	0.083	0.063
Mean return on wealth	6.9	8.33
GDP share of aggregate debt	1.29	1.27

4.2 Performance of the benchmark model

The parametrized model is consistent with the facts on wealth inequality, the distribution of average lifetime returns on investment, the level of non-financial business liability, and the overall level of misallocation in the economy. As reported in Table IV, the model also matches several other moments that are not targeted in the calibration. First, the model generates bequest-to-wealth ratio that is broadly consistent with the data despite all bequests being accidental in the model. Second, tax revenues as a fraction of GDP and the capital tax share of total tax revenues the model generates are close to their counterparts in the data. The fact that the model is consistent with the data along these key dimensions implies that this framework is appropriate for studying capital—either capital income or wealth—taxation.

Wealth Inequality. Figure 1 plots the Pareto tail, for those with a wealth level higher than one million, from the benchmark calibration and the one reported in Vermeulen (2016) who merges Survey of Consumer Finance (SCF) and Forbes 400 data in 2010.

Figure 1 – Pareto Tail - Wealth above 1 Million



Note: The Pareto tail is computed for agents with wealth of at least one million dollars. U.S. data is taken from Vermeulen (2016) who merges SCF and Forbes 400 data for 2010.

The model generates a clear Pareto tail of the wealth distribution that is remarkably similar to the one in the U.S. data. As discussed earlier, most models fail to generate a realistic Pareto tail of the wealth distribution; however, power law models with rate-of-return heterogeneity are successful in generating a realistic Pareto tail. The model also matches the concentration of wealth: the top 1% of wealthiest individuals hold 36% of the wealth in the economy. At the top of the wealth distribution, as reported in Table V and Figure 1, the concentration of wealth is slightly higher in the model than in the data – the top 0.1% of wealthiest individuals hold 14% of the wealth in the U.S. and 23% in the benchmark model. The shape of the Pareto tail is closely linked to the curvature parameter μ, which determines the degree to which returns fall as an individual becomes richer (or, to be more precise, the capital employed in his business grows). In the robustness analysis, we have experimented with different values of μ and found that the Pareto shape is preserved for values of μ higher than 0.8 while for lower values it becomes concave. Finally, note that we targeted the fraction of billionaires that are self-made and importantly the model is consistent with the data along that dimension.

Lifetime returns in the benchmark model. The heterogeneity in the rates of returns is an important mechanism in the model for generating a wealth distribution that is consistent with the data in numerous dimensions. Therefore, it is of interest to com-

Table V – Wealth Concentration in the Benchmark Model

	U.S. Data	Benchmark
Top 0.1%	0.14	0.23
Top 0.5%	0.27	0.31
Top 1%	0.36	0.36
Top 10%	0.75	0.66
Top 50%	0.99	0.97
Wealth Gini	0.82	0.78

Note: Wealth shares are computed using data for the U.S. from Vermeulen (2016) who merges SCF and Forbes 400 data for 2010. The wealth Gini is computed from 2001 SCF and is taken from Wolff (2006).

pare the dispersion in the rates of return in the model and in the data. Even though, the empirical evidence is scarce, Fagereng et al. (2016) report the rates of returns in the Norwegian data. Rather encouragingly, the dispersion observed in the model matches well with the facts reported in Fagereng et al. (2016).

The return at age h for individual i is given by:

$$\text{Return}_{ih} = 100\frac{ra_{ih} + \pi\left(a_{ih}, z_{ih}\right)}{a_{ih}}$$

where π is defined as in equation (6). The lifetime return for individual i is computed as the weighted average over the individual's working life, weighted by the individual's wealth at each age:

$$\text{Return}_i = \sum_{h=1}^{R} \frac{a_{ih}}{\sum\limits_{h=1}^{R} a_{ih}} \text{Return}_{ih}.$$

Table VI reports various percentiles in the lifetime rates of return distribution in the data and in the model, relative to the median return in the data and in the model, respectively. The lifetime rate of return at the 99.9th percentile, relative to the median return, is around 20% both in the model and in the data. The lifetime returns at other percentiles above the median, however, are slightly higher than the returns observed in the data–e.g., the lifetime return at the 99th percentile is around 10% in the data and around 13-14% in the model. As expected, the rates of return are substantially higher

TABLE VI – Deviation of percentiles of the distribution of lifetime returns relative to the median

	p99.9	p99	p90	p75	p25	p10
Norwegian Data	19.9%	9.7%	4.1%	2.1%	-1.3%	-2.4%
Working life	19.4%	13.3%	7.8%	4.5%	-2.9%	-3.7%
Ages 20-24	55.4%	32.7%	13.3%	4.9%	-5.6%	-10.0%
Ages 25-65	19.9%	13.6%	8.0%	4.7%	-2.9%	-3.4%

Note: Lifetime returns are weighted by the individual's wealth at each age. All numbers are before tax. All numbers are presented as differences from the median. The Norwegian data is taken from Fagereng et al. (2016), Table 4, which reports percentiles of fixed effects of individual returns to wealth.

at high percentiles when individuals are young. As productive individuals experience significant growth early in the life cycle, between the ages of 20 and 24, they experience rates of return as high as 55% at the 99th percentile. Overall, the distribution of lifetime rates of returns in the model is consistent with the distribution observed in the Norwegian data.[15]

Non-financial business liability to GDP ratio. The Federal Reserve Statistical Release (2015Q3) reports that in the first quarter of 2015, the total nonfinancial business liability in the United States was $22.79 trillion compared to the nominal GDP for that quarter of $17.65 trillion, which implies an aggregate debt-to-GDP ratio of 1.29.[16] Asker, Farre-Mensa and Ljungqvist (2011) report an average debt-to-asset ratio of 0.20 for publicly-listed firms and a ratio of 0.31 for private firms in the United States. Given that the capital-to-output ratio is 3 in our model, these numbers correspond to an aggregate debt-to-output ratio of between 0.60 to 0.93. The aggregate debt-to-GDP ratio in the model is the same as in the Federal Reserve Statistical Release (2015Q3) and slightly higher than the numbers reported in Asker, Farre-Mensa and Ljungqvist (2011). The severity of the financial constraint is a quantitatively important aspect of the analysis. The fact that the financial constraint is, if anything, lower in the model than in the data indicates that in the benchmark analysis we will not be overstating the extent of capital

[15]The overall message remains unchanged if we instead compute the lifetime rates of return percentiles in the model relative to the median return in the Norwegian data.

[16]See line 19 of Table L.102 of the Flow of Funds Z1 Integrated Macroeconomic Accounts in Federal Reserve Statistical Release (2015Q3). In a previous version of this draft, we used the figure on credit market borrowing by Nonfinancial Sectors, Table L2, line 18 (page 10) from Federal Reserve Statistical Release (2015Q1)). The figure used to be $12.2 trillion implying a ratio of 0.68.

misallocation: a tighter financial constraint, which will results in a debt-to-GDP ratio similar to the level of leverage reported in Asker, Farre-Mensa and Ljungqvist (2011), will yield even higher welfare gains from wealth taxation in the analysis that follows.

Misallocation in the benchmark model. Our benchmark economy is distorted due to the existence of financial frictions in the form of borrowing constraints, and we can measure the effects of these distortions on aggregate TFP and output and compare them to those obtained in other studies. A large and growing literature frames the discussion on misallocation in terms of various wedges, such as capital, labor, and output wedges. The analysis in Hsieh and Klenow (2009) is particularly useful since, in a similar model environment, they study the degree of misallocation and its effect on TFP in manufacturing in China, India, and the United States. Hsieh and Klenow (2009) use detailed firm-level data from the U.S. Census of Manufacturers (1977, 1082, 1987, 1992, and 1997) and find that the TFP gains from removing all distortions (wedges), which equalizes the "Revenue Productivity" (TFPR) within each industry, is 36% in 1977, 31% in 1987, and 43% in 1997.

We can follow the approach of Hsieh and Klenow and compute the same measures of misallocation for the U.S. as in their analysis. Instead of modeling and capturing the effect of a particular distortion, or distortions, the approach in Hsieh and Klenow (2009), and the related misallocation literature, is to infer the underlying distortions and wedges in the economy by studying the extent to which the marginal revenue products of capital and labor differ across firms in the economy (or in a particular industry). This is based on the insight that absent any distortions, the marginal revenue products of capital and labor have to be equalized across all firms.[17]

Appendix B provides the details as to how we map our model into the wedge analysis environment in Hsieh and Klenow (2009). Their analysis measures the improvement in total output as a result of an improvement in TFP in all industries. In our model, this corresponds to the improvement in TFP in the Q sector. We find that removing the capital wedges would increase total output, through its effect on TFP in the Q sector, by 20%—this is approximately half of the gains reported by Hsieh and Klenow. However, in ongoing research Bils et al. (2017) propose a method for correcting measurement error

[17]This is the case in the monopolistic competition models, such as in Hsieh and Klenow (2009). Alternatively, in environments such as in Lucas (1978) and Restuccia and Rogerson (2008), in which firms feature decreasing returns to scale, but produce the same homogeneous good, in the non-distorted economy the marginal products of capital and labor have to be equalized.

in micro data and find that TFP gains from removing distortions in the U.S. are rather in the range of 20%, very much in line with the results from our benchmark economy. Therefore, we conclude that the level of distortion in our model environment is not far from the actual amount of distortion present in the U.S. economy.

5 Tax Reform: Replacing Capital Income Tax with Wealth Tax

Our first major experiment is to study the effects of a tax reform in which the government eliminates capital income taxes (setting $\tau_k = 0$) from the baseline economy, keeps τ_l and τ_c unchanged, and levies a flat-rate wealth tax so as to keep the tax revenue fixed at its level in the baseline economy.

An important detail in the analysis, however, is the fact that pension benefits, as described in Section 3.4, are a function of the average labor income in the economy, and thus any change in the level of income implies a change in the level of aggregate social security payments and hence would lead to an unbalanced budget if revenue is kept constant. To deal with this issue, we consider two cases. In the first case, which is our main "revenue neutral" tax reform experiment, we keep the pension income of every individual fixed at its baseline value after the wealth tax reform. In the second case, the "balanced budget" tax reform experiment, we allow pension benefits to scale up or down with the level of average labor income in the economy, while choosing the level of wealth taxes to keep the government budget balanced. Except where we note explicitly, all results we discuss pertain to the first case – the revenue neutral tax reform.

5.1 After-tax Returns and Reallocation of Wealth

Variable changes. Table VII lists the values of the aggregate variables in the baseline economy and their percentage change after the wealth tax reform. A revenue-neutral tax reform requires that the capital income tax of 25% be replaced with a wealth tax of 1.13%. If the tax reforms allows for pension benefits to be indexed to the average labor income in the economy, then a slightly higher wealth tax of 1.54% is required.

All variables of interest increase substantially. Aggregate capital increases by 19.4% with the tax reform. Moreover, Q (effective or quality-adjusted capital) increases even more, by 24.8%. The larger increase in Q relative to $\bar{k}$ reflects the fact that wealth

Table VII – Tax Reform: Macro Variables in the Baseline Economy and After Reform

		Benchmark	Tax Reform	
			τ_a	τ_a + SS
Capital income tax rate	τ_k	25%	0.0	0.0
Wealth tax rate	τ_a	0	1.13%	1.54%
		Level	(Δ% from benchmark)	
Aggregate capital	$\bar{k}$	3.50	19.4	12.3
Intermediate goods	Q	3.51	24.8	18.4
Wage	w	1.25	8.7	6.4
Output	$\mathcal{Y}$	1.17	10.1	7.9
Labor	L	0.56	1.3	1.4
Consumption	C	0.83	10.0	8.4

Note: The last column labeled "$\tau_a + SS$" reports the results from the "balanced budget" experiment in which pensions payments are allowed to change as average labor income changes with the tax reform.

is more concentrated in the hands of more productive agents under the wealth tax, reflecting the efficiency gains associated with the wealth tax. The increase in Q drives up other aggregate variables as well. The aggregate output increases by 10.1%, labor supply increases by 1.3%, and the wage rate increases by 8.7%. The general equilibrium increase in the wage rate is critical in distributing more evenly the welfare gains from the tax reform to the whole population since labor efficiency is more evenly distributed than wealth.

Table VIII shows some key statistics on wealth in the benchmark and the tax-reform economies. The wealth distribution becomes more concentrated at the top under the wealth tax: the share of wealth held by the top 1% increases from 36% to 46%, while the fraction held by the top 10% increases from 66% to 72%. The wealth-to-output ratio also increases from 3.0 to 3.25.

Mechanisms at play. The simple one-period example in Section 2 provided the main insights for the effects of a change from a capital income tax to a wealth tax. Most importantly, productive entrepreneurs face a higher after-tax rate of return on their investment under the wealth tax than under the capital income tax while the opposite was true for low productive entrepreneurs. The same key mechanism is at play in the much

TABLE VIII – Key Variables: Benchmark Calibration vs. Tax Reform

	Data	Benchmark	Tax Reform
Top 1%	0.36	0.36	0.46
Top 10%	0.75	0.66	0.72
Wealth/Output	3.00	3.00	3.25
Average hours	0.40	0.40	0.41
Std of log earnings	0.80	0.80	0.80
Bequest/Wealth	1–2%	0.99	1.07

TABLE IX – Changes in the Return Distribution

	P10	P50	P90	P95	P99
	Before-tax				
Benchmark	2.00	2.00	17.28	22.35	42.36
Wealth Tax	1.74	1.74	14.62	19.04	36.91
	After-tax				
Benchmark	1.50	1.50	12.96	16.76	31.77
Wealth Tax	0.59	0.59	13.32	17.69	35.35

Note: Each cell reports the rate of return in percentages.

richer benchmark environment. To illustrate that, Table IX shows various percentiles of the after-tax return distribution. Indeed, the after-tax rates of return at the 99th (10th) percentile are around 35.4% (0.6%) under the wealth tax and 31.7% (1.5%) under the capital income tax – after-tax returns increase at upper percentiles and decrease at lower percentiles of the return distribution. This increase in the dispersion in after-tax returns mechanically increases the concentration of wealth.

Overall, there is substantial reallocation of wealth towards more productive agents when the capital income tax is replaced with a wealth tax. Table X reports, for a particular top x% of the wealth distribution, the percentage change in the fraction of agents with a particular entrepreneurial productivity. For example, among the top 1% in the wealth distribution, the fraction of individuals in the top 10% of the productivity distribution increased at the expense of less productive agents, resulting in a reallocation of wealth towards more productive entrepreneurs. This increased aggregate efficiency is reflected in higher quality-adjusted capital, Q, and results in higher output, consumption, and wages, as we already pointed out.

Table X – Tax Reform from τ_k to τ_a: Change in Wealth Composition

	Productivity group (Percentile)						
Top x%	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
1	-12.0	-13.0	-10.8	10.5	11.2	9.8	6.9
5	-8.2	-3.3	1.6	8.3	8.9	8.1	6.2
10	-6.4	-1.3	2.9	6.4	6.9	6.3	5.0
50	-2.5	0.9	1.8	1.6	1.2	1.1	1.1

Note: The table shows the percentage change induced by the tax reform from τ_k to τ_a of the share of agents in each entrepreneurial productivity group (ranked based on the permanent component of entrepreneurial productivity $\bar{z}$) among the top x% wealth holders (i.e. agents above the x^{th} percentile of the wealth distribution). Each entry is computed as $100 \times \frac{s_{ij}(\tau_a)-s_{ij}(\tau_k)}{s_{ij}(\tau_k)}$, where i indexes groups of top $x\%$ wealth holders, j indexes entrepreneurial productivity groups and τ the tax regime.

5.2 Welfare Analysis

In order to quantify the welfare consequences of the tax reform, we use the following two measures.

CE_1 : This measure is constructed at the individual level and then aggregated up. In particular, we first compute the consumption equivalent welfare for each individual in a particular state and then integrate it over the population, using the stationary distribution in the benchmark economy:[18]

$$V_0((1+CE_1(\mathbf{s}))c^*_{\text{US}}(\mathbf{s}), \ell^*_{\text{US}}(\mathbf{s})) = \mathbb{V}_0(c(\mathbf{s}), \ell(\mathbf{s}))$$

$$\overline{CE}_1 \equiv \sum_{\mathbf{s}} \Gamma_{\text{US}}(\mathbf{s}) \times CE(\mathbf{s}),$$

[18]Given our utility function specification, the welfare consequences of switching from the benchmark economy to a counterfactual economy with a wealth tax for an individual in state $\mathbf{S}$ with age h and wealth a is given by

$$CE_h(a,\mathbf{S}) = 100 \times \left[\left(\frac{V_h(a,\mathbf{S};\tau^{policy})}{V_h(a,\mathbf{S};\tau^{bench})}\right)^{1/\gamma(1-\sigma)} - 1\right].$$

This measure specifically gives what fraction of consumption an individual is willing to pay in order to move from the steady state of the economy with a capital income tax to the steady state of the economy with a wealth tax.

Table XI – Average Welfare Gains from Tax Reform

	Baseline		Baseline + SS reform	
	$\overline{CE}_1$	$\overline{CE}_2$	$\overline{CE}_1$	$\overline{CE}_2$
Average CE for newborns	7.40%	7.86%	5.58%	4.71%
Average CE	3.14%	5.14%	4.95%	4.10%
% in favor of reform	67.8%		94.8%	

where $\mathbf{s} = (a, h, \mathbf{S})$ and V_0 and $\mathbb{V}_0$ are the lifetime value functions in the benchmark (U.S.) capital income tax economy and the counterfactual wealth tax economy, respectively. This measure allows us to discuss individual-specific outcomes and to understand "who gains, and who loses, and by how much" from the tax reform.

CE_2 : The second measure is simpler, and more similar to the famous Lucas (1987) calculation: it measures the fixed proportional consumption transfer to all individuals in the benchmark economy so that the average utility is equal to that in the tax-reform economy:

$$\sum_{\mathbf{s}} \Gamma_{\text{US}}(\mathbf{s}) \times V_0((1+\overline{CE}_2)c^*_{\text{US}}(\mathbf{s}), \ell^*_{\text{US}}(\mathbf{s})) = \sum_{\mathbf{s}_0} \Gamma(\mathbf{s}) \times \mathbb{V}_0(c(\mathbf{s}), \ell(\mathbf{s})).$$

Findings. Table XI provides the overall welfare gains from switching from a capital income to a wealth tax. The welfare gains are large: 3.14% for the whole population using the CE_1 measure and 5.14% using the CE_2 measure. The average welfare gain for newborn individuals is even higher: 7.40% and 7.86%, respectively, for the two different welfare measures. Overall, 68% of all individuals across the whole population in the benchmark economy prefer to be in an economy with a wealth tax.

Table XII illustrates the extent to which individuals in different parts of the state distribution gain from the tax reform, based on the CE_1 welfare measure. Panel A reports the results when the pension benefits are not adjusted for changes in the average labor income in the economy. Young individuals, at the age of 20, experience substantial welfare gains, and these gains increase with productivity. Those at the top of the productivity distribution experience the largest welfare gains – they are able to grow faster and get higher after-tax returns under the wealth tax than under the capital income tax. Young individuals at the bottom of the productivity distribution also experience

Table XII – Welfare Gain by Age Group and Entrepreneurial Ability

(a) Baseline Tax Reform

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	7.0	7.3	7.9	8.9	10.6	11.6	12.4
21–34	6.5	6.3	6.3	6.6	7.0	6.9	5.7
35–49	5.1	4.4	3.9	3.3	1.7	0.4	-2.2
50–64	2.3	1.8	1.4	0.8	-0.6	-1.7	-3.5
65+	-0.2	-0.3	-0.4	-0.6	-1.2	-1.7	-2.7

(b) Tax Reform with Social Security Reform

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	4.9	5.3	6.0	7.2	9.3	10.4	11.4
21–34	4.7	4.6	4.8	5.4	6.1	6.3	5.2
35–49	4.2	3.7	3.4	2.8	1.4	0.0	-2.8
50–64	4.9	4.3	4.0	3.2	1.4	0.0	-2.3
65+	7.2	6.7	6.4	5.8	4.3	3.2	1.2

Note: Each entry reports the average welfare gain (CE_1) from the tax reform from τ_k to τ_a of agents in a given age and entrepreneurial productivity group (ranked based on the permanent component of entrepreneurial productivity $\bar{z}$). The average is computed with respect to the benchmark distribution.

substantial welfare gains even though they hold very little wealth – those gains are due to higher wages in the wealth-tax economy.

The welfare gains decline with age for all levels of productivity and even become negative for individuals over the age of 65. Low productive agents do save for precautionary reasons and for retirement and imposing a wealth tax instead of a capital income tax late in life results in lower after-tax returns and is costly for them. Older high productivity entrepreneurs, on the other hand, experience low welfare gains, and even welfare losses, since some of them have lost their productivity and the wealth tax is costlier for them

Table XIII – Fraction with Positive Welfare Gain by Age Group and Entrepreneurial Ability

(a) Baseline Tax Reform

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	96.1	95.8	97.2	98.0	98.7	98.9	99.0
21–34	97.3	96.3	95.8	95.0	92.6	89.9	82.5
35–49	95.8	92.7	89.5	83.9	70.7	60.7	43.7
50–64	79.4	74.5	70.2	62.9	51.1	44.1	34.4
65+	8.0	9.5	9.5	8.8	7.3	6.2	4.8

(b) Tax Reform with Social Security Reform

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	94.3	94.6	95.9	97.3	98.6	98.9	99.0
21–34	95.9	94.7	94.4	94.0	91.7	89.1	82.0
35–49	95.4	92.3	89.5	84.2	71.4	61.4	44.4
50–64	96.6	93.7	90.7	83.7	70.1	61.1	48.5
65+	99.5	98.6	97.5	92.8	82.0	73.9	60.3

Note: Each entry reports the share of agents in a given age and entrepreneurial productivity group (ranked based on the permanent component of entrepreneurial productivity $\bar{z}$) that would experience a positive welfare gain (CE_1) from the tax reform from τ_k to τ_a. The shares are computed with respect to the benchmark distribution.

than the capital income tax. Retirees mostly lose from the reform since their benefits are fixed at the benchmark level, and they mostly face lower after-tax return on their savings under the wealth-tax economy. These considerations are reflected in the observed support for the reform from various part of the age-productivity distribution, as reported in Panel A in Table XIII.

Panel B in Table XII reports the welfare gains in the case when the pension benefits are adjusted for changes in the average labor income in the economy and the wealth tax is chosen in order to keep the government budget balanced. The main difference of note is the fact that individuals over the age of 65 now experience welfare gains rather than welfare losses. They are benefiting from the higher efficiency in the economy under the wealth tax since their pensions reflect the higher average labor income in the economy. This results in larger support for the reform from those groups of the population, as reported in Panel B in Table XIII.

6 Optimal Taxation

The discussion so far illustrates that a wealth tax is a better way of taxing capital than a capital income tax. A natural question, however, is whether taxing capital in this framework would be a part of the optimal tax schedule to begin with, and, if so, whether it is better to do it through capital income or wealth taxes. We study quantitatively this question by performing two experiments: (i) we find the optimal taxes in an environment where the government uses proportional labor income taxes and proportional capital income taxes, and (ii) we find the optimal taxes in an environment where the government uses proportional labor income taxes and proportional wealth taxes.

6.1 Main Results

An overview. Table XIV summarizes the main results: the optimal capital income tax is negative at -34.4% with a corresponding labor income tax of 36% while the optimal wealth tax is positive at 3.06% with a corresponding labor income tax of 14.1%. The optimal wealth tax delivers the highest welfare gain, 9.61%, while under the optimal capital income tax the welfare gain, 6.28%, is even lower than the 7.86% welfare gain in the tax reform experiment.

Table XV shows the percentage change in aggregate variables relative to their benchmark levels once the optimal taxes are implemented. As can be seen from the table, the optimal capital income tax leads to much larger increases in output and wages. However, after-tax wages increase significantly more under the optimal wealth tax.

Figure 2 provides a more comprehensive picture of the optimal taxation results. It illustrates the average welfare gain of a newborn, using the CE_2 measure, relative to the benchmark, as we vary the taxes on capital or wealth. The red line corresponds to the welfare gain in the capital income tax economy and the blue line corresponds to the one in the wealth tax economy. The x-axis corresponds to the tax revenue from capital as a fraction of total tax revenue. Note that total tax revenue $(G + SSP)$ is

Table XIV – Optimal taxation: statistics

	τ_k	τ_ℓ	τ_a	$\frac{Thresh.}{\overline{E}}$	% Taxed	Top 1%	$\overline{CE}_2$ (%)
Benchmark	25%	22.4%	–	–	100%	0.36	–
Tax reform	–	22.4%	1.13%	0	100%	0.46	7.86
Opt. τ_k	–34.4%	36.0%	–	–	100%	0.56	6.28
Opt. τ_a	–	14.1%	3.06%	0	100%	0.47	9.61
Opt. τ_a – Threshold	–	14.2%	3.30%	25%	63%	0.48	9.83

Note: The optimal threshold amounts to 25% of the average earnings of the working population in the benchmark economy $(\overline{E})$.

Table XV – Optimal Taxation: Percentage Change in Aggregate Variables

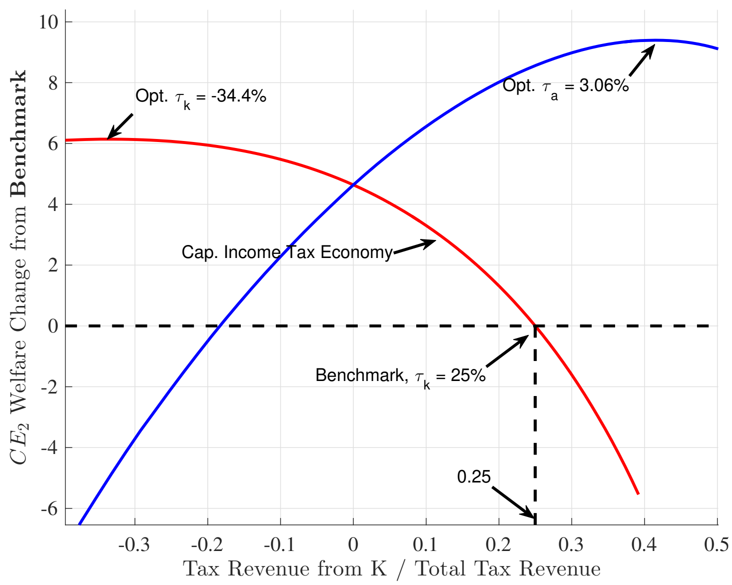
	$\%\Delta K$	$\%\Delta Q$	$\%\Delta L$	$\%\Delta Y$	$\%\Delta w$	$\%\Delta w$ (net)	Δr	Δr (net)	$\%\Delta TFP$
Tax Reform	19.37	24.79	1.28	10.10	8.70	8.70	–0.25	–0.90	4.60
Opt. τ_k	68.97	79.57	–1.16	25.51	26.97	4.72	–1.51	–0.87	6.29
Opt. τ_a	2.76	10.26	3.90	6.40	2.41	13.42	0.68	–1.92	7.29
Opt. τ_a Threshold	0.41	8.12	3.67	5.42	1.70	12.48	0.78	-2.07	7.70

Note: Percentage changes are computed with respect to the benchmark economy without wealth taxes and capital income taxes of 25%. Changes in the interest rate are computed in percentage points. The net wage is defined as $(1-\tau_l)\,w$, and the net interest rate is defined as $(1+(1-\tau_k)\,r)\,(1-\tau_a)-1$. The TFP variable is measured in the intermediate goods market.

fixed in this experiment. Thus, as we vary the taxes on capital, the labor income tax adjusts to balance the government budget. The benchmark capital income tax economy with capital income tax economy corresponds to 0.25 on the x-axis since the capital tax revenue as a fraction of total tax revenue is 0.25 in that economy.

The first observation from Figure 2 is that the average welfare gain of the newborn increases as the capital *income* tax is reduced below its benchmark level in the capital income tax economy so that the optimal capital income tax turns out to be –34.4%. This is in sharp contrast to the findings in the recent literature on capital income taxation, most notably Conesa et al. (2009) who find that the optimal capital income tax is 36%. We will discuss in Section 7 the reasons for obtaining a different policy recommendation.

FIGURE 2 – Welfare Gain from Optimal Taxes



In the wealth-tax economy, the average welfare of the newborn increases as we increase the wealth tax, and the optimal wealth tax is positive and substantial at 3.06%. At the optimal wealth tax, the tax revenue from capital/wealth is more than 40% of the total tax revenue, which is higher than the benchmark level of 25%.

We have also studied the optimal wealth tax allowing for a threshold level below which the wealth is not taxed. In this experiment, the government maximizes welfare by choosing jointly the wealth threshold level, the wealth tax rate that applies above that threshold, and the labor income tax rate. We find that the optimal threshold level is 25% of the average earnings of the working population in the benchmark economy and the optimal wealth tax rate is 3.3%. In this case, only 63% of the population pays wealth taxes. The aggregate welfare gain from its implementation is 9.83%, which is higher than the 9.61% welfare gain from the optimal linear wealth tax. The additional aggregate welfare gain is small relative to the overall welfare gains from the implementation of the wealth tax instead of capital income tax. However, there are some important differences in distribution of welfare gains and political support for wealth taxes between a linear wealth tax system and a wealth tax system with a threshold, which we report in Section 6.2.

Mechanisms at play. These results can be intuitively explained using the information provided in Panels A-D of Figure 3. As Panel A illustrates, raising taxes on capital –

either through a capital income tax or a wealth tax – reduces aggregate capital $\overline{k}$ and Q. However, there are two notable differences between these two ways of raising taxes. First, aggregate capital $\overline{k}$ decreases less under the wealth tax system than under the capital income tax system. Second, Q declines more than $\overline{k}$ under the capital income tax system while it declines less than $\overline{k}$ under the wealth tax system.

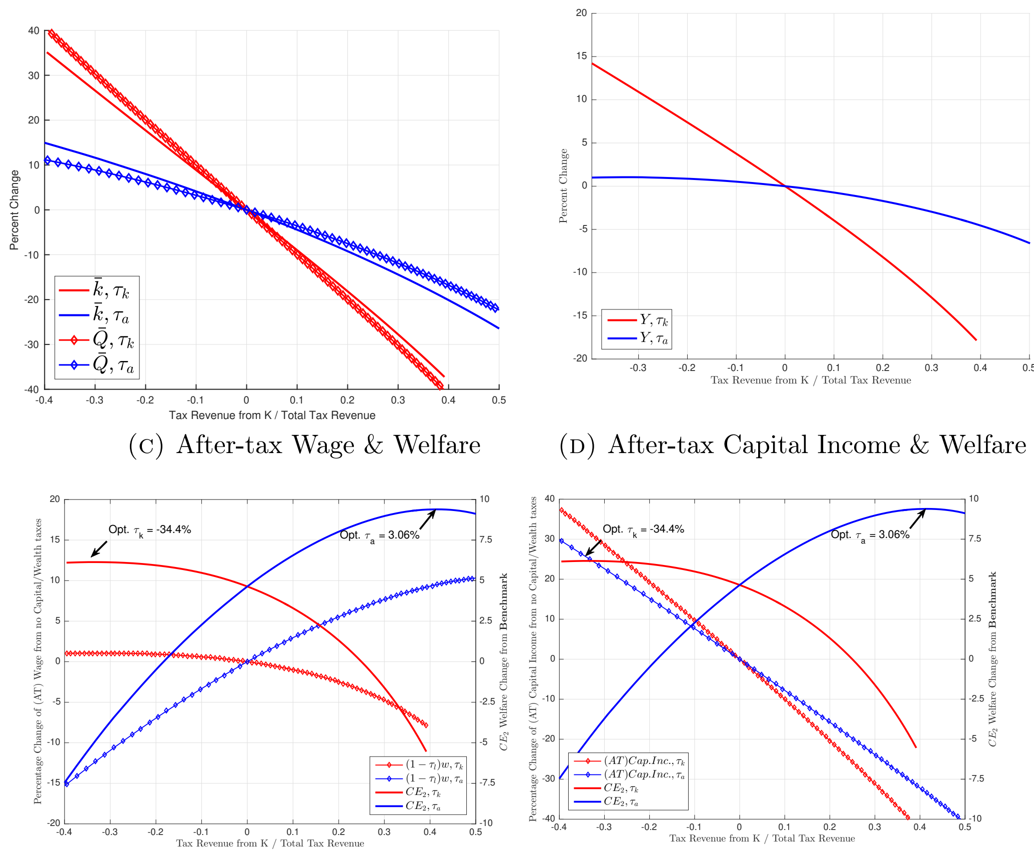
We first explain the second result since it is critical for understanding the first one. Consider a simplified version of our model where before-tax gross return is given as $1+Pz$, with z being the entrepreneurial productivity and P being the price of Q. The after-tax gross returns are then $1 + Pz(1 - \tau_k)$ and $(1 + Pz)(1 - \tau_a)$ under the capital income and wealth taxes, respectively. Consider two individuals as in our simple example, i.e. Michael and Fredo such that $z_M > 0$ and $z_F = 0$. The first observation to point out is that an increase in the capital income tax has no effect on Fredo's after tax gross return since $z_F = 0$, but reduces Michael's after-tax return, as in Section 2. Thus, the capital income tax mainly distorts the wealth accumulation of more productive agents, which reduces their wealth share, increases the misallocation of capital, and leads to a larger decline in Q than $\overline{k}$. With the wealth tax on the other hand, $(1 + Pz)(1 - \tau_a)$ is affected at the same rate for both agents for a given P. However, with a higher wealth tax, Q goes down and P increases. Now consider these two individuals' after-tax returns: $(1 + Pz_F)(1 - \tau_a)$ versus $(1 + Pz_M)(1 - \tau_a)$. The general equilibrium increase in P partially offsets the decline in the after-tax return $(1 + Pz_M)(1 - \tau_a)$ for Michael when the wealth tax is increased. However, Fredo's after-tax return does not benefit from the increase in P since $z_F = 0$. Thus, a higher τ_a has a smaller negative impact on the more productive Michael's after-tax return. This mechanism reallocates wealth to productive agents and reduces the misallocation of capital, and leads to a smaller decline in Q than $\overline{k}$ as the wealth tax is increased.

Since the distortionary effects of capital taxes is much smaller under the wealth tax than under the capital income tax, the government can increase the wealth tax without significantly distorting output (and wages) as seen in Panel B, and can reduce the labor income tax so that the after-tax wage increases with the wealth tax. Panel C shows that the after-tax wage rate indeed increases with the wealth tax but declines with the capital income tax. Panel D illustrates that capital income is declining with capital taxes under both tax systems but it declines by less under the wealth tax system. Thus, for a given tax revenue from capital, since the after-tax wage and capital income are higher under wealth taxes, people will accumulate more assets and aggregate capital will be higher

Figure 3 – Optimal Taxes on Capital

(A) Efficiency Gains (B) Output

(C) After-tax Wage & Welfare (D) After-tax Capital Income & Welfare



under the wealth tax.

The mechanisms described above are also closely linked to the optimal tax level found under these two tax systems. Individuals whose resources mostly consist of labor income will gain from the wealth tax. Those whose resources are mainly from wealth, will lose from it. Since wealth is much more concentrated in the hands of very few agents and labor income is more evenly distributed across the population, our welfare measure, which weighs rich and poor at the same rate and maximizes the welfare of a newborn whose income is more influenced by wages, picks up a rate that is close to the rate that actually maximizes the after-tax wage rate. This point is illustrated in Panel C. Similarly, under the capital income tax economy, the after-tax wage is maximized when the capital income tax is negative. Thus, we obtain a negative optimal capital income tax.

6.2 Distribution of Welfare Gains and Political Support

The two panels in Table XVI illustrate the welfare gains, by age and entrepreneurial ability, when the benchmark capital income tax is replaced with the following two tax systems: the optimal capital income tax and the optimal (linear) wealth tax.[19] Welfare gains are typically higher for younger agents in all of these tax systems. However, there are some important differences. First, focusing on the working age population, we observe that the welfare gains are typically higher under wealth taxes than under capital income taxes for agents with lower entrepreneurial ability. This is directly related to the fact that after-tax wages are much higher under optimal wealth taxes than under optimal capital income taxes. Second, retirees typically experience welfare losses with the implementation of the optimal tax system under both tax systems. However, welfare losses are higher in the optimal wealth tax case. This is mainly because the after-tax interest rate is lower in this case: for example, Table XV shows that the after-tax interest rate r(net) is 1.92% lower under wealth taxes than in the benchmark economy, while it is lower by only 0.87% under capital income taxes relative to the benchmark. Thus, retirees whose retirement benefits are fixed at the benchmark level and whose capital income declines due to the decline in the after-tax interest rate experience larger welfare losses when wealth taxes are implemented rather than capital income taxes. We also analyzed separately the optimal wealth tax with a threshold and found that in that case many of the low ability retirees experience lower welfare losses since they no longer pay taxes on wealth as their wealth is not that high.

Table XVII reports the fraction of households with positive welfare gains for each age-ability group. Red numbers correspond to less than 50% support within a group. We notice that the fraction of retirees that prefer wealth taxes is smaller than the fraction of retirees that prefer capital income taxes – that reduces the support for wealth taxes. Thus while, overall, 69.7% of the population prefers to be in the capital income tax economy, 60.7% of the population prefers to be in the wealth tax economy, and the retirees are key for understanding the larger support for capital income taxes. Once we introduce a threshold in the wealth tax, the support for the wealth tax increases among the retirees and 78.9% of the population are now in favor of the optimal wealth tax with a threshold, as shown in Table (XVIII).

[19]The results based on an optimal (linear) wealth tax with a threshold limit are similar to those in the optimal wealth tax, and we refer to them when appropriate.

Table XVI – Welfare Gain by Age Group and Entrepreneurial Ability

(a) Optimal **Capital Income Taxes**

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	4.0	5.6	7.2	9.5	13.0	14.8	16.1
21–34	3.7	5.0	6.2	7.9	10.4	11.4	11.2
35–49	2.7	3.3	3.8	4.0	3.5	2.7	0.7
50–64	1.1	1.4	1.6	1.5	0.6	-0.2	-1.9
65+	-0.1	0.1	0.2	0.2	-0.2	-0.7	-1.6

(b) Optimal **Wealth Taxes**

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	10.0	9.7	10.1	11.1	13.1	14.3	15.3
21–34	9.2	7.9	7.3	7.1	6.6	5.9	3.1
35–49	6.8	4.9	3.7	2.1	-1.3	-3.9	-8.8
50–64	2.7	1.4	0.6	-0.8	-3.7	-5.8	-9.3
65+	-0.6	-0.9	-1.2	-1.8	-3.2	-4.3	-6.3

(c) Optimal **Wealth Taxes - Threshold**

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	9.9	9.8	10.3	11.4	13.4	14.6	14.5
21–34	9.1	8.0	7.4	7.2	6.6	5.6	5.9
35–49	6.7	4.9	3.6	1.9	-1.6	-4.9	-4.4
50–64	2.7	1.5	0.6	-0.8	-3.9	-6.5	-6.2
65+	-0.4	-0.7	-1.0	-1.6	-3.2	-4.6	-4.4

Note: Each entry reports the average welfare gain (CE_1) from the corresponding optimal tax experiment of agents in a given age and entrepreneurial productivity group (ranked based on the permanent component of entrepreneurial productivity $\bar{z}$). The average is computed with respect to the benchmark distribution.

Table XVII – Fraction with Positive Welfare Gain by Age Group and Entrepreneurial Ability

(a) Optimal **Capital Income Taxes**

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	95.4	98.6	99.3	99.6	99.8	99.8	100.0
21–34	96.3	97.7	97.7	97.3	96.0	94.9	92.3
35–49	91.7	92.8	91.1	87.8	80.3	74.5	63.7
50–64	74.2	76.2	73.8	69.4	60.3	53.8	43.8
65+	13.8	18.6	18.7	18.2	16.6	15.2	13.0

(b) Optimal **Wealth Taxes**

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	94.5	93.1	93.3	94.6	95.8	96.1	95.8
21–34	95.7	92.6	90.5	88.8	84.2	79.4	67.0
35–49	91.3	82.8	76.5	68.2	53.6	44.6	34.0
50–64	72.6	62.9	56.1	49.4	39.8	34.5	27.2
65+	2.1	2.3	1.8	1.4	0.9	0.7	0.4

(c) Optimal **Wealth Taxes - Threshold**

	Productivity group (Percentile)						
Age	0-40	40-80	80-90	90-99	99-99.9	99.9-99.99	99.99+
20	94.5	93.1	93.3	94.6	95.8	95.9	96.0
21–34	95.6	92.4	90.4	88.5	83.8	77.6	78.9
35–49	91.1	82.4	76.0	67.8	53.2	43.3	44.3
50–64	76.4	66.7	59.6	52.5	42.3	35.8	36.6
65+	75.9	68.6	63.7	57.9	48.7	42.1	42.9

Note: Each entry reports the share of agents in a given age and entrepreneurial productivity group (ranked based on the permanent component of entrepreneurial productivity $\bar{z}$) that would experience a positive welfare gain (CE_1) from from the corresponding optimal tax experiment. The shares are computed with respect to the benchmark distribution.

Table XVIII – Welfare Gains and Political Support

	$\overline{CE}_2$ (%)	Vote (%)
Benchmark	–	–
Tax reform	7.86	67.8
Opt. τ_k	6.28	69.7
Opt. τ_a	9.61	60.7
Opt. τ_a – Threshold	9.83	78.9

Table XIX – Decomposition of Welfare Gain – CE_2 for Newborn

	Tax Reform	Opt. τ_k	Opt. τ_a
$CE_2(NB)$ (%)	7.86	6.28	9.61
		Consumption	
Total	8.27	5.90	11.02
Level	10.01	21.04	8.28
Distribution	–1.58	–12.51	2.53
		Leisure	
Total	–0.38	0.36	–1.27
Level	–0.66	0.73	–2.21
Distribution	0.27	–0.38	0.76

Decomposition of the welfare gains. Following Conesa et al. (2009), we decompose the aggregate welfare gain into a component arising from changes in consumption and a component arising from changes in leisure. Further, these changes in welfare can be decomposed into components arising from the change in average consumption (leisure) and changes in the distribution of consumption (leisure).[20][21] Table XIX reports these decomposition results. First, notice that the 9.61 percent welfare gain under the optimal

[20] A similar decomposition was earlier proposed by Flodén (2001), where total welfare changes are expressed in terms of changes in levels, changes in uncertainty, and changes in inequality.

[21] Let CE be the aggregate welfare gain, and CE_C and CE_L be the components of the aggregate welfare gain arising from changes in consumption and leisure respectively. CE_C is given by

$$V_0((1+CE_C(\mathbf{s}))c^*_{\mathrm{US}}(\mathbf{s}), \ell^*_{\mathrm{US}}(\mathbf{s})) = \widetilde{\mathbb{V}}_0(c(\mathbf{s}), \ell^*_{\mathrm{US}}(\mathbf{s}))$$

and CE_L is given by

$$V_0((1+CE_L(\mathbf{s}))c^*_{\mathrm{US}}(\mathbf{s}), \ell^*_{\mathrm{US}}(\mathbf{s})) = \widetilde{\mathbb{V}}_0(c^*_{\mathrm{US}}(\mathbf{s}), \ell(\mathbf{s})).$$

wealth tax (τ_a) is due to an 11.02 percent welfare gain in consumption and a 1.27 percent welfare loss in leisure. Second, focusing on consumption, we observe that both an increase in the level and an improvement in the distribution positively contribute to the total welfare gain: by 8.28 percent and 2.53 percent, respectively. This is an important point worth emphasizing – despite the fact that wealth inequality becomes much higher under the optimal wealth tax, the distribution of consumption becomes more equal relative to our benchmark, which contributes to the overall welfare gain from wealth taxes. This pattern is different from the determinants of the 5.90 percent welfare gains due to consumption under the capital income tax (τ_k)—a large 21.04 percent is due to an increase in the average level of consumption which is offset by a 12.51 percent welfare loss due to a substantial increase in consumption inequality.

7 Robustness

In this section, we explore the robustness of our results by conducting a sensitivity analysis with respect to the following changes in the economic environment: 1) the labor income tax is allowed to be progressive, 2) the stochastic component of entrepreneurial ability is eliminated, and we consider only permanent productivity differences, 3) the constraint on borrowing for the entrepreneur is eliminated, i.e. $\vartheta = \infty$, 4) the curvature of intermediate good production is decreased to $\mu = 0.8$, 5) estate tax is allowed, 6) wealth is measured as present value rather than book value, and 7) the rate of return heterogeneity is eliminated by setting $z_i = 1$ for all i and $\mu = 1$ (we refer to this case as "CKK" since this framework then becomes quite similar to the framework used in Conesa et al. (2009)). In all of these cases, we follow the same calibration procedure as in our benchmark economy – i.e., we target the same set of moments with the same set of parameters, except in (i) the permanent productivity type case, where we do not target the fraction of self-made billionaires, and (ii) the CKK case, where the model

Note that $1 + CE = (1 + CE_C)(1 + CE_L)$. Furthermore, CE_C can be decomposed into level $CE_{\overline{C}}$ and distribution component CE_{σ_C} as

$$V_0((1 + CE_{\overline{C}}(\mathbf{s}))c^*_{\text{US}}(\mathbf{s}), \ell^*_{\text{US}}(\mathbf{s})) = \widehat{\mathbb{V}}_0(\widehat{c}(\mathbf{s}), \ell^*_{\text{US}}(\mathbf{s}))$$

where $\widehat{c}(\mathbf{s}) = c^*_{\text{US}}(\mathbf{s})\frac{\overline{C}}{\overline{C}^*_{US}}$ and

$$\widehat{\mathbb{V}}_0\left((1 + CE_{\sigma_C})\,\widehat{c}(\mathbf{s}), \ell^*_{\text{US}}(\mathbf{s})\right) = \widetilde{\mathbb{V}}_0(c(\mathbf{s}), \ell^*_{\text{US}}(\mathbf{s}))$$

where one can show that $1 + CE_C = (1 + CE_{\overline{C}})(1 + CE_{\sigma_C})$. Similar decomposition applies to leisure.

is unable to match the wealth concentration in the data. The results from the tax reform experiments are presented in Table XX, and the results from the optimal tax experiments are presented in Table XXI. The message from all of these experiments is that our substantive quantitative conclusions are robust to any of these changes in the economic environment.

Progressive labor income tax. We introduce progressive labor income taxation, letting the after-tax labor income be defined as $(1-\tau_l)(wy_hn)^{\psi}$, and following Heathcote, Storesletten and Violante (2014) we set $\psi = 0.815$. τ_l is chosen so that the average labor income tax rate is 0.224 – the same as in our benchmark. In the tax reform experiment, we keep the labor income tax unchanged. As seen in Table (XX) the results are quantitatively quite similar to those in our benchmark. In the optimal tax experiment, we search for the optimal level and progressivity of the labor income tax τ_l and ψ jointly with capital taxes. We find that the optimal progressivity of the labor income tax should be higher, which is reflected in a smaller ψ. The optimal levels of the capital income and wealth taxes are quite similar to those in the benchmark calibration.

Permanent productivity type. When we eliminate the stochastic component of entrepreneurial ability, we increase the dispersion of the permanent component in order to generate the same amount of wealth concentration. However, this version of the model can only generate 18.5% self-made richest individuals. We find that the welfare gains from the tax reform are smaller than in the benchmark, but still very large. In this version of the model there is less misallocation since more persistent productivity allows agents to self-finance and alleviate the restrictions of the borrowing constraint (see Moll (2014)). The optimal capital income tax is slightly negative at -2.33% while the optimal wealth tax is still positive and large at 2.21%.

No borrowing constraint: $\vartheta = \infty$ In this case, the marginal returns are equalized across individuals, and the misallocation of capital is completely eliminated. Yet, surprisingly, replacing the capital income tax with a wealth tax does increase welfare. Table XX shows that aggregate capital $\overline{k}$ and effective capital Q increase by 6.28%. Note that they increase at the same rate since there is no misallocation. Thus, the increase in aggregate capital generates the welfare gain from switching to a wealth tax. In order to illustrate why aggregate capital increases, consider an individual's after-tax non-labor income when the financial constraint is eliminated. The entrepreneurial profit is given as

$$\pi^*(z) = \max_k \left\{ \mathcal{R} \times (zk)^\mu - (r+\delta)k \right\}.$$

The after-tax non-labor income, $Y(a, z, \tau_k, \tau_a)$, is given by

$$Y(a, z, \tau_k, \tau_a) = \begin{cases} (1 + r(1-\tau_k))a + \pi^*(z)(1-\tau_k) & \text{under capital income tax} \\ \\ (1+r)(1-\tau_a)a + \pi^*(z)(1-\tau_a) & \text{under wealth tax.} \end{cases}$$

When the capital income tax is replaced with a wealth tax, there are two opposing mechanisms at play. We will illustrate these mechanisms for a given interest rate and distribution of agents across states. First, we can show that $(1+r)(1-\tau_a)a < (1+r(1-\tau_k))a$, which will reduce capital accumulation under wealth taxes. Second, $\pi^*(z)(1-\tau_a) > \pi^*(z)(1-\tau_k)$ – in fact, $\pi^*(z)(1-\tau_a)$ will be much larger than $\pi^*(z)(1-\tau_k)$ for high z types since $\tau_k = 25\%$ and τ_a is less than 2%. The second mechanism will increase capital accumulation, especially for the most productive agents with high $\pi^*(z)$ since their after-tax profits will increase substantially.[22] Ultimately, the second mechanism dominates resulting in an increase in the aggregate capital stock when the economy switches from a capital income to a wealth tax.

Turning to the optimal tax experiment, we find that the optimal capital income tax is positive at 13.6%, but still smaller than the benchmark level of 25%. The optimal wealth tax is 1.57%, which is close to the benchmark tax reform level of 1.65%. And finally, the optimal wealth tax delivers a higher welfare gain than the optimal capital income tax.

Estate taxes. We incorporate in the model an estate tax of 40%, with an exemption level of bequests below \$5 Million, in order to capture the level of estate taxation in the U.S.. We recalibrate the benchmark economy and conduct the tax reform and optimal tax experiments holding the estate taxes fixed. The results are not much different from those in the benchmark model. The welfare gains are larger in all three experiments:

[22]Note that $G = \tau_k \sum (ra + \pi^*(z)) \Gamma(a, z, :) = \tau_k (rK + \pi^*(z))$ under capital income tax and $G = \tau_a \sum ((1+r)a + \pi^*(z)) \Gamma(a, z, :) = \tau_a ((1+r)K + \pi^*(z))$ under wealth tax. Using these equations we can show that 1) $\tau_a << \tau_k$, thus $\pi^*(z)(1-\tau_a) > \pi^*(z)(1-\tau_k)$ and 2) $1 + r(1-\tau_k) = 1 + r - \frac{G}{K + \frac{\sum \pi^*(z)}{r}}$ is greater than $(1+r)(1-\tau_a) = 1 + r - \frac{G}{K + \frac{\sum \pi^*(z)}{1+r}}$.

tax reform, optimal capital income tax, and optimal wealth tax and all our conclusions remain unchanged.

Curvature parameter in the CES production function: $\mu = 0.80$. Holding other parameters fixed, a higher curvature (lower μ) in the CES production function implies lower efficiency gains from switching to a wealth tax since high productivity agents will face diminishing marginal productivity more quickly as they accumulate more wealth under the wealth tax. However, with a higher curvature, the model generates lower wealth concentration. Thus, recalibration requires a higher dispersion in $\bar{z}_i$ ($\sigma_{\varepsilon_{\bar{z}}}$) in order to match the wealth concentration in the top 1%. Table XX shows that the welfare gain from switching to a wealth tax is very similar to the one in our benchmark. Table XXI shows that the welfare gain is larger for the optimal capital income tax (7.38%) and lower for the optimal wealth tax (8.32%) as compared to those in the benchmark case But still the welfare gain under the optimal wealth tax remains larger than the one under the optimal capital income tax.

Present value. We measure wealth in the model based on the book value, a, of individual's assets. This is the approach followed in the related literature as well. However, some of the wealth moments and statistics from the data could potentially be based on the market (or discounted present) value rather than book value of assets. As a result, we have experimented with a case when wealth measures in the model are based on the expected present value of future earnings from the firm, discounted by the average rate of return in the economy. In this version of the model the dispersion of wealth turns out to be higher for given set of parameter values than in the benchmark. Thus, we recalibrate the model and reduce the dispersion in $\bar{z}_i$ ($\sigma_{\varepsilon_{\bar{z}}}$) in order to match the wealth concentration in the top 1%. This recalibration reduces somewhat the welfare gains in all our experiments, although they still remain large.

Comparison to Conesa et al. (2009). One of the major differences between our model and the one studied in Conesa et al. (2009) is the rate of return heterogeneity. For comparison, we eliminate the return heterogeneity by setting $z = 1$ for all individuals and $\mu = 1$. In this case, as we have mentioned earlier, capital income taxes and wealth taxes are equivalent. Column CKK in Table XX confirms this result – there are no changes in allocations nor any welfare gains from switching to a wealth tax. When we study optimal capital income taxes in this case, we find that the optimal capital income tax rate is 25.4%, which is consistent with the 36% value found in Conesa et al.

Table XX – Robustness: **Tax Reform** Experiments

	Baseline	Prog. Labor Tax	Constant z	No Constr.	$\mu = 0.8$	Estate Taxes	Present Value	CKK
τ_a	1.13%	0.90%	1.23%	1.65%	1.24%	0.95%	1.26%	1.92%
Welfare Gain from Tax Reform								
CE_1 (All)	3.14	2.79	2.29	0.44	3.07	3.56	2.47	0
CE_1 (New born)	7.40	6.48	5.46	1.86	7.54	8.22	6.07	0
CE_2 (All)	5.14	4.68	2.92	0.36	5.06	5.85	4.21	0
CE_2 (New born)	7.86	7.06	5.36	1.43	7.85	8.80	6.48	0
Vote (%)	67.7	69.0	68.3	55.9	70.2	68.4	66.9	-
Percentage Change in Aggregates								
$\overline{k}$	19.37	21.27	9.56	6.28	16.43	21.05	15.60	0
Q	24.79	25.61	22.37	6.28	21.25	27.90	19.87	0
w	8.70	9.25	7.66	2.10	7.77	9.75	7.08	0
Y	10.10	10.01	9.54	3.02	8.38	11.25	8.18	0
L	1.28	0.69	1.75	0.91	0.57	1.37	1.04	0
C	10.01	10.01	11.25	2.93	8.33	11.31	8.17	0

(2009). This confirms their result that in an OLG model with idiosyncratic labor income risk and incomplete markets, the optimal capital income tax is positive and substantial. However, note that we find a smaller optimal capital income tax in our CKK experiment than they do. The reason for that is that accidental bequests are inherited by newborn individuals in our version of the CKK model while they are distributed equally to the whole population in their framework. Thus, in their framework, newborns start their life with less wealth and as a result prefer a higher tax on capital income, which implies a lower labor income tax. Since the optimal policy maximizes the average utility of newborn, their framework generates a higher optimal capital income tax. We confirm this by distributing accidental bequests equally to all population, in which case the optimal capital income tax increases to 42.4%.

Then why do we find, in our benchmark model with *rate of return heterogeneity*, the optimal capital income tax to be negative and the optimal wealth tax to be positive? In both Conesa et al. (2009) and in our model, a higher capital income tax reduces capital accumulation and leads to lower output. However, in our model, a higher capital income tax hurts productive agents disproportionately, leading to more misallocation, and further reductions in output. Therefore, the capital income tax is much more distortionary in our environment with rate of return heterogeneity than in the environment in Conesa et al. (2009). With a wealth tax, the tax burden is shared between productive and unproductive agents, leading to a smaller misallocation and a lower decline in output as we increase wealth taxes. Thus, the government can increase the wealth tax without reducing output much, allowing it at the same time to reduce the labor income tax resulting in higher after-tax wages and thus higher welfare gains.

Transitions. Our analysis focuses on steady states and makes our results readily comparable to those in important recent papers on capital taxation such as Conesa et al. (2009). Steady-state welfare gains often are due to higher capital stocks, achieved through a transition period during which consumption is lower in order to allow the economy to invest towards building a larger capital stock. Thus, taking the transition period into account would usually lower the computed welfare gains of moving from one steady state to another. In our framework, with rate of return heterogeneity, however, the optimal wealth tax implies only a 2.76% increase in capital stock relative to the benchmark, and as a result it does not require much lower consumption during the transition. Most of the gain comes from a better allocation of capital. Thus we expect that not capturing the transition period would not change our results significantly.

Table XXI – Robustness: **Optimal Tax** Experiments

	τ_k	τ_ℓ		τ_a	Top 1%	$\overline{CE}_2$ (%)	Vote (%)
				Baseline Model			
Baseline U.S.	25%	22.4%		–	0.36		
Opt. τ_k	–34.4%	36.0%		–	0.56	6.28	69.7
Opt. τ_a	–	14.1%		3.06%	0.47	9.61	60.7
				Progressive Labor Income Tax			
			ψ				
Benchmark	25%	15.0%	0.815		0.36		
Opt. τ_k	–38.8%	29.3%	0.720	–	0.61	9.31	52.1
Opt. τ_a	–	12.7%	0.720	2.40%	0.53	10.71	48.9
				Constant z over the life cycle			
Opt. τ_k	–2.33%	29.0%		–	0.47	3.27	83.1
Opt. τ_a	–	18.5%		2.21%	0.46	5.80	61.6
				No Financial Constraint			
Opt. τ_k	13.6%	26.0%		–	0.39	0.41	59.9
Opt. τ_a	–	22.7%		1.57%	0.42	1.43	56.6
				$\mu = 0.8$			
Opt. τ_k	-38.6%	37.7%		-	0.52	7.38	67.1
Opt. τ_a	-	18.6%		2.12%	0.44	8.32	66.0
				Estate Taxes			
Opt. τ_k	-32.2%	33.7%		—	0.56	9.26	72.5
Opt. τ_a	-	13.0%		3.12%	0.49	11.02	60.7
				Present Value			
Opt. τ_k	–18.3%	33.56%			0.46	4.16	70.3
Opt. τ_a	–	16.45%		2.64%	0.43	7.38	60.4
				Conesa, Kitao and Krueger(2009)			
Opt. τ_k	25.4%	22.33%		—	0.09	0.25	42.8%
Opt. τ_a	-	22.33%		1.93%	0.09	0.25	42.8%

The case of an optimal wealth tax with a threshold—which delivers even larger welfare gains—requires an even smaller steady-state increase in capital stock of 0.41%. Therefore, although potentially interesting and worth exploring in future work, we conjecture that incorporating transitions is probably not going alter our main results.

In contrast, the analysis of the optimal capital income tax is likely to be substantially affected by the transition because it requires a 69% increase in the capital stock from the current US benchmark. This requires substantial saving and reduction in consumption during the transition, lowering the welfare gains.

8 Discussions and conclusions

Many countries currently have or have had wealth taxes: France, Spain, Norway, Switzerland, Italy, Denmark, Germany, Finland, Sweden, among others. However, the rationale for such taxes are often vague—fairness, reducing inequality—and not studied formally. Here, we propose a case for wealth taxes based on efficiency and distributional benefits and quantitatively evaluate its impact. In particular, we analyze the quantitative implications of wealth taxation (tax on the stock of wealth) as opposed to capital income taxation (tax on the income flow from capital) in an overlapping-generations incomplete-markets model with rate of return heterogeneity across individuals. With such heterogeneity, capital income and wealth taxes have opposite implications for efficiency and some key distributional outcomes.

Under capital income taxation, entrepreneurs who are more productive, and therefore generate more income, pay higher taxes. Under wealth taxation, on the other hand, entrepreneurs who have similar wealth levels pay similar taxes regardless of their productivity, which expands the base and shifts the tax burden toward unproductive entrepreneurs. This reallocation increases aggregate productivity and output. In the simulated model calibrated to the U.S. data, a revenue-neutral tax reform that replaces capital income tax with a wealth tax raises welfare by about 8% in consumption-equivalent terms. Moving on to optimal taxation, the optimal wealth tax is positive, yields even larger welfare gains than the tax reform, and is preferable to optimal capital income taxes. Interestingly, optimal wealth taxes result in more even consumption and leisure distributions (despite the wealth distribution becoming more dispersed), which is the opposite of what optimal capital income taxes imply. Consequently, wealth taxes can yield both efficiency and distributional gains.

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ONLINE APPENDIX

A Appendix: Additional Tables

Table A.1 – Forbes Self-made Index

	Description	Fraction 2015
1	Inherited fortune but not working to increase it	7.00
2	Inherited fortune and has a role managing it	4.75
3	Inherited fortune and helping to increase it marginally	5.50
4	Inherited fortune and increasing it in a meaningful way	5.25
5	Inherited small or medium-size business and made it into a ten-digit fortune	8.50
6	Hired or hands-off investor who didn't create the business	2.25
7	Self-made who got a head start from wealthy parents and moneyed background	10.00
8	**Self-made who came from a middle- or upper-middle-class background**	**32.00**
9	**Self-made who came from a largely working-class background; rose from little to nothing**	**14.50**
10	**Self-made who not only grew up poor but also overcame significant obstacles**	**7.75**
	Our definition of "Self-made:" Groups 8 to 10	**54.25**

B Appendix: Misallocation in the Benchmark Economy

Our benchmark economy is distorted due to the existence of financial frictions in the form of borrowing constraints, and we can measure the effects of these distortions on aggregate TFP and output and compare them to those obtained in other studies. A large and growing literature frames the discussion on misallocation in terms of various wedges, such as capital, labor, and output wedges. The analysis in Hsieh and Klenow (2009) is particularly useful since, in a similar model environment, they study the degree of misallocation and its effect on TFP in manufacturing in China, India, and the United States. Hsieh and Klenow use detailed firm-level data from the U.S. Census of Manufacturers (1977, 1082, 1987, 1992, and 1997) and find that the TFP gains from removing all distortions (wedges), which equalizes the "Revenue Productivity" (TFPR) within each industry, is 36% in 1977, 31% in 1987, and 43% in 1997.

We will follow the approach in Hsieh and Klenow (2009) and will compute the same measures of misallocation for the U.S. as in their analysis. It is useful to briefly describe their approach as it applies to our framework. The final goods producer behaves competitively and uses an aggregated good, Q, and labor, L, in the production of the final good

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

where Q aggregates the intermediate goods x_i in the following way

$$Q = \left(\int_i x_i^{\mu} di \right)^{1/\mu} .$$

Each intermediate-goods producer i produces a differentiated intermediate good using the production function $x_i = z_i k_i$, where z_i is the individual i's entrepreneurial ability and k_i is the amount of capital.

Instead of modeling and capturing the effect of a particular distortion, or distortions, the approach of Hsieh and Klenow, and the related misallocation literature, is to infer the underlying distortions and wedges in the economy by studying the extent to which the marginal revenue products of capital and labor differ across firms in the economy (or in a particular industry). This is based on the insight that absent any distortions, the marginal revenue products of capital and labor have to be equalized across all firms.[23]

TFP in the Q sector. We will first focus on the Q-sector, the sector that produces the composite intermediate input Q by aggregating all the intermediate goods x_i. Under this alternative capital-wedge approach, the problem of each intermediate-goods producer is

$$\pi_i = \max_{k_i} p\left(z_i k_i\right) z_i k_i - \left(1 + \tau_i^k\right)\left(R + \delta\right) k_i \ ,$$

where τ_i^k is a firm-specific capital wedge. The only input in the production function of the intermediate-goods producer is capital, and as a result only one wedge can be identified in the analysis. We choose to specify that wedge to be the capital wedge, but in principle it should be understood as capturing the effect of an output wedge.

The revenue TFP in sector Q for each firm i is

$$TFPR_{Q,i} \equiv \frac{p\left(x_i\right) x_i}{k_i} = \frac{1}{\mu}\left(1 + \tau_i^k\right)\left(R + \delta\right) .$$

The aggregate TFP in sector Q can be expressed as

$$TFP_Q = \left(\int_i \left(z_i \frac{\overline{TFPR_Q}}{TFPR_{Q,i}} \right)^{\frac{\mu}{1-\mu}} di \right)^{\frac{1-\mu}{\mu}} ,$$

[23] This is the case in the monopolistic competition models, such as in Hsieh and Klenow (2009). Alternatively, in environments such as in Lucas (1978) and Restuccia and Rogerson (2008), in which firms feature decreasing returns to scale, but produce the same homogeneous good, in the non-distorted economy the marginal products of capital and labor have to be equalized.

where the average $TFPR_Q$ is given by

$$\overline{TFPR_Q} = \left(\int \frac{1}{TFPR_{Q,i}} \frac{p(x_i)\, x_i}{p_q Q} di \right)^{-1}.$$

In the non-distorted economy, without capital wedges, the level of TFP in the Q sector is

$$TFP_Q^* = \left(\int_i (z_i)^{\frac{\mu}{1-\mu}} \, di \right)^{\frac{1-\mu}{\mu}} \equiv \overline{z}.$$

Therefore, we can measure the improvement in TFP in the Q sector, Ω_Q, as a result of eliminating the capital wedges, or equivalently, as a result of eliminating the borrowing constraints:

$$\Omega_Q = \frac{TFP_Q^*}{TFP_Q} = \left(\int_i \left(\frac{\overline{z}}{z_i} \frac{TFPR_{Q,i}}{\overline{TFPR_Q}} \right)^{\frac{\mu}{1-\mu}} \, di \right)^{\frac{1-\mu}{\mu}}.$$

Table B.2 reports Ω_Q for various economies—the TFP in the Q sector in the non-distorted economy is 58% higher than in the benchmark economy, 51% higher than in the economy with a wealth tax, 54% higher than in the economy with consumption tax, 49% higher than in the economy with an optimal capital income tax, and 47% higher than in the economy with an optimal wealth tax.

Wealth taxes give the higher TFP gains, allowing for better allocation of capital across firms, even without eliminating the borrowing constraints. The tax reform experiment to wealth taxes implies a TFP gain of 4.6% and optimal wealth taxes give a TFP gain of 7.3% with respect to our benchmark economy.

This can also be seen in the dispersion of TFPR of the different models. Recall that absent any constraints on the firms the TFPR would be equated across all of them, so there is higher misallocation in the economy the higher the dispersion of TFPR across firms. Table B.2 reports the standard deviation of TFPR and some of its percentiles.

TABLE B.2 – Hsieh and Klenow (2009) Efficiency Measure - Benchmark Model

	Benchmark	Tax Reform (τ_a)	Opt. Taxes (τ_k)	Opt. Taxes (τ_a)
TFP_Q	1.001	1.047	1.064	1.074
$\frac{TFP_Q^*}{TFP_Q}$	1.582	1.514	1.489	1.475
Mean TFPR	0.145	0.131	0.106	0.145
StD TFPR	0.054	0.048	0.039	0.053
p99.9	0.68	0.61	0.5	0.66
p99	0.35	0.32	0.27	0.35
p90	0.19	0.17	0.14	0.19
p50	0.14	0.12	0.1	0.14
p10	0.1	0.09	0.07	0.1

Comparison with the Hsieh and Klenow (2009) results for the U.S.

In order to compare these results with the results reported in Hsieh and Klenow (2009) for the U.S., we need to note that the improvement in aggregate output, Ω_Y, as a result of eliminating the capital wedges in the economy can be expressed as

$$\Omega_Y = \frac{Y^*}{Y} = \left(\frac{TFP_Q^*}{TFP_Q}\right)^{\alpha} \left(\frac{K^*}{K}\right)^{\alpha} \left(\frac{L^*}{L}\right)^{1-\alpha}.$$

Since the model with capital wedges is static, the effect of the removal of the capital wedges on aggregate capital, K, and labor supply, L cannot be taken into account. The analysis in Hsieh and Klenow (2009), measures the improvement in total output as a result of an improvement in TFP in all industries. In our model, this corresponds to the improvement in TFP in the Q sector. Therefore, removing the capital wedges would increase total output, through its effect on TFP in the Q sector, by 20%.[24]

Two things are important to point out. First, the magnitude of the misallocation in our benchmark economy is substantial, although a bit lower than the one measured in Hsieh and Klenow (2009) using micro data from manufacturing firms: 36% in 1977, 31% in 1987, and 43% in 1997. However it is in line with the level reported in ongoing research by Bils et al. (2017), who take into account measurement error in micro data, they find gains from removing distortions for the U.S. in the range of 20%. In any case, it is worth noting several differences between our framework and that of Hsieh and Klenow (2009). Our benchmark economy is parametrized based on moments from the entire economy, not just the manufacturing sector. Second, our benchmark model is a dynamic model

[24] Note that $\tilde{\Omega}_Y = \Omega_Q^{\alpha} = \Omega_Q^{0.40} = 1.20$.

and any changes in the financial frictions will affect aggregate capital accumulation and aggregate labor supply. The misallocation calculations above do not take those changes into account. It is clear, however, that eliminating the financial friction would increase the aggregate capital stock K and lead a larger increases in total output than measured above. The effect on aggregate labor supply is less obvious.