Optimal Redistribution: Rising Inequality vs. Rising Living Standards

Axelle Ferriere, PSE & CNRS

Philipp Grübener, Goethe University

Dominik Sachs, University of St. Gallen*

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Abstract

Over the last decades, the U.S. has experienced a large increase in both income inequality and the standard of living. The workhorse models of optimal income taxation call for a more redistributive welfare state as inequality rises. By contrast, the standard of living plays no role for optimal taxes in these homothetic environments. To address this shortcoming, this paper incorporates non-homothetic preferences into the optimal income tax problem. In a Mirrlees setup, we characterize how the rising standard of living alters both sides of the equity-efficiency trade-off. As an economy becomes richer, non-homotheticities imply a fall in the dispersion of marginal utilities which weakens equity concerns but has ambiguous effects on efficiency concerns. In a dynamic incomplete market setup calibrated to the U.S. in 1950 and 2010, we quantify this new channel. We find that the rising standard of living dampens by at least 25% the desired increase in redistribution due to rising inequality.

Keywords: Fiscal Policy, Growth, Non-Homothetic Preferences, Redistribution

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*axelle.ferriere@psemail.eu, gruebener@econ.uni-frankfurt.de, dominik.sachs@unisg.ch.

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1 Introduction

Income inequality has been rising in the United States over the last decades, as documented in Piketty and Saez (2003), among others. As a result, fiscal redistribution has become a central topic in the policy debate, with popular calls for higher taxes and larger transfers. The literature on optimal income taxation characterizes the optimal tax-and-transfer ($t\&T$) system as a trade-off between equity and efficiency concerns. In the workhorse models, higher inequality indeed demands a more redistributive $t\&T$ system, as argued in Mankiw, Weinzierl, and Yagan (2009) and Diamond and Saez (2011).

Yet, in parallel to the rising income inequality, the United States has also experienced a very substantial increase in the standard of living. Mean income per capita has more than tripled since the 1950s, and the share of household expenditures spent on food has shrunk from more than 20% to less than 10%. Standard models of optimal taxation feature homothetic preferences and cannot generate the observed heterogeneity in consumption baskets, both in the cross-section and over time. Loosely speaking, they cannot capture how being poor in the 1950s differs from being poor in the 2010s. Therefore, these models shed no light on how rising living standards affect efficiency and distribution concerns, and thus the optimal $t\&T$ system.

This paper incorporates into the optimal taxation problem non-homothetic preferences, that is, preferences featuring heterogeneous income elasticities of demand across multiple goods. First, we analytically show how changes in standards of living affect the equity-efficiency trade-off in a static Mirrlees (1971) setup with fully flexible nonlinear taxes. Second, we quantify the relative effects of rising living standards and rising inequality from 1950 to 2010 using two complementary approaches: the Mirrlees framework and a rich dynamic incomplete market setup with flexible yet parametric nonlinear taxes. We consistently find that rising living standards reduce the desired increase in redistribution due to rising inequality by at least 25%, as measured by the difference in average income tax rates between the top and bottom income deciles.

Economic mechanisms. We mainly focus on the two recent state-of-the-art non-homothetic preference specifications in the structural change literature, namely Comin, Lashkari, and Mestieri (2021) and Alder, Boppart, and Müller (2022). These preferences imply heterogeneous income elasticities across goods, such that the marginal spending composition of an additional dollar depends on the level of income. As the standard of living rises, heterogenous income elasticities across goods typically have two implications: the dispersion in marginal utilities across households falls, and income effects weaken. Thus, the equity-efficiency trade-off is affected in two ways. First, lower dispersion in marginal utilities reduces the gains from redistributing resources from rich to poor households. That is, the rising standard of living weakens equity concerns. Second, lower wealth effects increase the efficiency costs of raising revenues but decrease the efficiency costs of paying out transfers. That is, the rising standard of living has ambiguous effects on efficiency concerns. These dynamics arise as heterogeneous income elasticities typically imply decreasing relative risk aversion (DRRA), starting from a constant relative risk aversion (CRRA) for the homothetic counterpart of the utility function. Intuitively, poorer households consume a larger share of necessities, so that taking income risks is costlier. This property is also consistent with empirical micro evidence beyond the structural change literature.[1]

Two complementary approaches. The just described mechanisms are first formalized in a Mirrleesian setup. In particular, we consider fully nonlinear taxes in a static environment. Following the representation of Heathcote and Tsujiyama (2021), we decompose how standards of living affect efficiency costs and equity gains of raising marginal tax rates along the income distribution. This analytical representation of nonlinear taxes allows for a clean quantitative decomposition of the different channels through which living standards affect optimal taxes.

Second, we consider a quantitative dynamic incomplete market setup in the tradition of Imrohoroğlu (1989), Huggett (1993), and Aiyagari (1994). In this richer setup, we follow a Ramsey approach and restrict the $t\&T$ system to belong to a flexible parametric class. While the Mirrleesian setup is powerful because it imposes no restrictions on the $t\&T$ system, the dynamic environment allows to discipline preferences from intra- and intertemporal choices, with a meaningful notion of risk aversion. We then build on the quantitative dynamic setup to also discipline the calibration of the Mirrleesian setup.

We first calibrate the model to the U.S. economy in 1950. We then derive inverse optimum Pareto weights, which make the calibrated 1950 $t\&T$ system optimal. Keeping those weights constant, we then compute the optimal $t\&T$ system for two cases. First, we only account for the rise in inequality until 2010, as a benchmark comparable to the literature. Second, we compute the optimal $t\&T$ system when also accounting for rising living standards. We interpret the difference in the optimal $t\&T$ systems as the standard-of-livings channel. We now describe our calibration of the model and preview our quantitative results.

Quantification. We calibrate the dynamic model to be consistent with key micro- and macro-level developments of the U.S. economy from 1950 to 2010, with the non-homothetic CES preferences of Comin, Lashkari, and Mestieri (2021) as our benchmark preference specification. Key for distribution concerns, the model is consistent with the dynamics of inequality. Additionally, we use consumption and labor supply patterns in

[1] See Section 3.3.3 for a description of the empirical literature on risk aversion and intertemporal rate of substitution over time and in the cross-section.

the cross-section and the time series to discipline preference parameters, which eventually govern the degree of DRRA in the calibrated economy. Furthermore, we derive an analytical relation between the degree of DRRA, wealth effects, and marginal propensities to consume (MPCs), and check consistency of model-implied wealth effects and MPCs with recent evidence. The implied degree of DRRA is modest, well within the range of plausible estimates from fields as diverse as portfolio choice, consumption Euler equation estimation, and development.

We then evaluate the effect of rising living standards on the optimal $t\&T$ system relative to the effect of rising inequality, using both approaches. In isolation, the large rise in inequality calls for a more redistributive $t\&T$ system, with the optimal transfer-to-output ratio going up by more than three percentage points in the dynamic Ramsey approach and more than six percentage points in the static Mirrlees framework. Accounting for the rise in the standards of living dampens the increase by 30% and 40% respectively. The desired increase in the difference of top 10% and bottom 10% average tax rates is decreased by about 25% in both frameworks. We further use the Mirrlees setup to validate this result under the alternative preference specification of Alder, Boppart, and Müller (2022). Finally, the Mirrlees quantification allows us to infer whether rising living standards mainly affect distribution or efficiency concerns. We find that almost the whole effect stems from distribution concerns.

Summing up, both approaches to answer the question at hand give comparable results: the rising standard of living dampens by at least 25% the desired increase in redistribution due to rising inequality.

Related literature Our work is related to a large literature in public economics that studies optimal nonlinear income taxation (Diamond 1998; Heathcote and Tsujiyama 2021; Saez 2001). Further, we relate to the macroeconomic literature that studies similar questions, but in richer models and with restricted tax instruments (Conesa and Krueger 2006; Heathcote, Storesletten, and Violante 2017; Holter, Krueger, and Stepanchuk 2019). Our contribution is to connect these approaches with the notion of standards of living by incorporating state of the art non-homothetic preferences into the analysis (Alder, Boppart, and Müller 2022; Comin, Lashkari, and Mestieri 2021).

Our paper complements other papers that have addressed to what extent the rise in inequality in the U.S. justifies an increase in tax progressivity. Heathcote, Storesletten, and Violante (2020) consider the U.S. between 1980 and 2016 find that the inequality channel is basically neutralized by changed incentive costs of tax progressivity: skill-biased technical change increases returns to human capital investment and this increases efficiency cost of taxation. Relatedly, Brinca, Duarte, Holter, and Oliveira (2022) focus on the occupation margin as opposed to the skill margin. They find that optimal tax progressivity between 1980 and 2015 should even decrease since the distortions on occupational choice have increased as consequence of technical change. Our paper emphasizes an additional force to challenge the standard view that redistribution should increase over time in the last decades in the United States.

A recent methodologically-related project is Jaravel and Olivi (2022), who study the impact of changes in relative prices due to market size effects with increasing returns to scale for optimal taxes in a setup with heterogeneous goods and non-homothetic preferences. Finally, two preliminary projects explore optimal taxation as an economy develops, abstracting from heterogeneous income elasticities across goods. de Magalhaes, Martorell, and Santaeulalia-Llopis (2022) show that, when considering both private and public transfers, risk-sharing tends to be larger in developing economies than in rich countries, and further discuss optimality of this finding in a one-good model with Stone-Geary preferences. Tsujiyama (2022) considers how subsistence self-employment, which is more prevalent in developing economies, affects the equity-redistribution trade-off, also in a one-good environment.

2 Static Model: Theoretical Analysis

We consider a continuum of heterogeneous households with labor productivity θ. Labor productivity is distributed according to pdf $f(\theta)$. Households supply labor n and earn gross income $y = \theta n$. This results in expenditure $e = y - \mathcal{T}(y)$, where $\mathcal{T}$ captures the $t\&T$ system. Households allocate their expenditures to J different goods. We denote as $c = (c_1, \ldots, c_J)$ the basket of consumption goods. We assume that utility is of the form

$$U(c) - Bn^{1+\varphi}/(1+\varphi).$$

The additive separability implies that we can separate the labor supply from the consumption composition choice and can therefore decompose the optimization problem into two steps.[2] The first step concerns the optimal labor supply decision. The second step concerns the optimal allocation of expenditures to different goods:

$$V(\theta; \mathcal{T}(\cdot), p, g) \equiv \max_{e,n} u(e; p, g) - Bn^{1+\varphi}/(1+\varphi) \quad \text{s.t.} \quad e = n\theta - \mathcal{T}(n\theta) \qquad \text{(Step 1)}$$

$$u(e; p, g) \equiv \max_{\{c_j\}_j} U(c) \quad \text{s.t.} \quad \sum_j \frac{p_j}{1+g} c_j = e. \qquad \text{(Step 2)}$$

p denotes the vector of relative prices, which we assume to be fixed; g scales the level of prices and captures the level of development of the economy. Hence, to consider variations in the level of economic development, we consider variations in the price vector—i.e. we

[2] The additive separability also implies that the Atkinson-Stiglitz theorem holds in this environment. Hence, the optimal tax system implies uniform commodity taxes.

model growth as lower prices. Consider a first economy with $g' = 0$ and hence $p' = p$ and a second economy with $g'' = x$ and hence $p'' = p/(1+x)$; the second economy features an output which is x percent higher in real terms.

An important insight of (Step 1) and (Step 2) is that g and p only affect the labor supply decision through their impact on $u_e(e; p, g)$. This is very useful for our optimal income tax analysis in Section 2.2, where we analyze the implications of g on the optimal $t\&T$ system. It implies that given the properties of $u(e; p, g)$ we can focus on (Step 1). As a next step, we first specify properties of $U(c)$ that are consistent with the empirical regularities regarding Engel curves and then show what they imply for $u(e; p, g)$.

2.1 Heterogenous Expenditure Elasticities

Consistent with empirical evidence about Engel curves that elasticities of consumption with respect to after-tax income (or expenditure) are heterogenous, we now state the following formal assumption on $U(c)$:[3]

Assumption 1. *Assume that $U(c)$ is such that expenditure elasticities of goods are heterogeneous in the level of expenditure. Formally, this implies*

$$\frac{\partial \log(c_j)}{\partial \log(e)}|_{e=e'} \neq \frac{\partial \log(c_j)}{\partial \log(e)}|_{e=e''} \text{ where } e' \neq e''.$$

There exist different functional forms for $U(c)$ that are consistent with this assumption. Our main focus will be non-homothetic CES preferences that go back, among others, to Hanoch (1975) and have been introduced into a multi-sector growth model by Comin, Lashkari, and Mestieri (2021).

Example 1. *Non-homothetic CES preferences, defined on the basket of consumption goods c, $U(c) = \mathcal{U}(\mathcal{C})$, where the consumption aggregator $\mathcal{C}(c)$ is implicitly defined by*

$$\sum_j^J \left(\Omega_j (\mathcal{C}(c))^{\varepsilon_j}\right)^{\frac{1}{\sigma}} c_j^{\frac{\sigma-1}{\sigma}} = 1$$

and $\mathcal{U}$ is a monotonically increasing function.

For this utility function, one obtains the following elasticities of consumption w.r.t. to expenditure:

$$\frac{\partial \log(c_j)}{\partial \log(e)} = \sigma + (1-\sigma)\frac{\varepsilon_j}{\bar{\varepsilon}},$$

[3]We refrain from using the term income elasticities since after-tax incomes are relevant in a setting with income taxes. In the static model, after-tax income and expenditure are equivalent. For the dynamic version of the model, this is no longer the case. This is why we always refer to elasticities w.r.t. expenditure in the following.

where $\bar{\varepsilon} = \sum_{j=1}^{J} \omega_j \varepsilon_j$ and ω_j are the expenditure shares of the different goods. Hence, those goods j with $\varepsilon_j < \bar{\varepsilon}$ are characterized by expenditure elasticities less than one. As opposed to Stone-Geary preferences, non-homotheticities do not vanish. I.e. the differences in $\frac{\partial \log(c_j)}{\partial \log(e)}$ also prevail as e keeps growing.

An alternative set of preferences that has been recently introduced by Alder, Boppart, and Müller (2022) are intertemporally aggregable (IA) preferences. Note that these preferences are directly defined over expenditure.

Example 2. *IA preferences, defined on expenditure, $u(e; p, g)$:*

$$u(e; p, g) = \frac{1-\varepsilon}{\varepsilon} \frac{1}{\mathbf{B}(p^*)^{\varepsilon}} \left(e - \underbrace{\sum_j \frac{p_j}{1+g} \bar{c}_j}_{\bar{\mathbf{A}}(p^*)} \right)^{\varepsilon} - \mathbf{D}(p^*)$$

where $p^* = \frac{p}{1+g}$, $\mathbf{B}(\frac{p}{1+g}) = \left(\sum_j \Omega_j \left(\frac{p_j}{1+g} \right)^{1-\sigma} \right)^{1/(1-\sigma)}$ is linearly homogenous in prices and $\bar{\mathbf{A}}(p^*)$ and $\mathbf{D}(p^*)$ are homogenous of degree zero.

Alder, Boppart, and Müller (2022) show that this is the most general form of preference that allow for intertemporal aggregation. Importantly, they nest both generalized Stone-Geary (Herrendorf, Rogerson, and Valentinyi 2014) and price independent generalized linearity (PIGL) preferences (Boppart 2014).[4]

We now point out a relationship between heterogenous expenditure elasticities and relative risk aversion. This relation will clarify the role of heterogeneous expenditure elasticities for the design of optimal income taxes.

Lemma 1. *Preferences $u(e; p, g)$ satisfy decreasing relative risk aversion (DRRA) w.r.t. to expenditure e if*

- *Non-homothetic CES case with $J = 2$, $\varepsilon_1 < \varepsilon_2 \equiv 1$ and $\mathcal{U}(\mathcal{C}) = \mathcal{C}^{1-\gamma}/(1-\gamma)$: $\gamma > \varepsilon_1$ (necessary condition), and $\gamma > 2 - \varepsilon_1$ (sufficient condition);*
- *IA case: $\bar{\mathbf{A}} \left(\frac{p}{1+g} \right) > 0$ (necessary and sufficient condition).*

Proof. See Appendix A. □

For the non-homothetic CES case, we analytically show for $J = 2$ that the curvature γ being high enough is sufficient to guarantee DRRA. In Section 3.3, we use $J = 3$ and quantitatively show that the DRRA property generally holds, even for moderate levels

[4] One functional form in terms of primitives, with which we also work in the quantitative exercise below, is given by $B(p) = \left(\sum_{j \in J} \omega_j p_j^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$, $A(p) = B(p)^{-1} \sum_{j \in J} p_j \tilde{c}_j$ where $\sigma > 0, \sum_{j \in J} \omega_j = 1$, and $\omega_j \geq 0$, and $D(p_t) = \frac{(1-\varepsilon)^{\nu}}{\kappa\gamma} \left([B(p_t)^{-1} \tilde{D}(p_t)]^{\gamma} - 1 \right)$, where $\tilde{D}(p) = \left(\sum_{j \in J} \theta_j p_j^{1-\varphi} \right)^{\frac{1}{1-\varphi}}$ where $\nu \geq 0, \varphi > 0, \sum_{j \in J} \theta_j = 1$, and $\theta_j \geq 0$.

of γ. For the IA case, the DRRA property emerges as long as some non-homotheticity arises from subsistence. Typical calibrations with an agriculture, a manufacturing, and service sector do imply $\bar{\mathbf{A}}(\frac{p}{1+g}) > 0$, as we discuss in Section 4.3. We now move to the standard optimal income tax analysis.

2.2 Optimal Incomes Taxes

We consider a social planner that assigns Pareto weights $w(\theta)$ to households of type θ. The planner optimally chooses a flexible $t\&T$ system $\mathcal{T}$. The government's problem is given by

$$\max_{\mathcal{T}(\cdot)} \int_{\underline{\theta}}^{\bar{\theta}} V(\theta; \mathcal{T}(\cdot), p, g) w(\theta) f(\theta) d\theta \quad \text{s.t.} \quad \int_{\underline{\theta}}^{\bar{\theta}} \mathcal{T}(n(\theta; \mathcal{T}(\cdot), p, g)\theta) f(\theta) d\theta \geq G,$$

where G is exogenous spending and subject to optimal household behavior given the tax function

$$n(\theta; \mathcal{T}(\cdot), p, g) \equiv \arg\max_{e,n} u(e; p, g) - Bn^{1+\varphi}/(1+\varphi) \quad \text{s.t.} \quad e = n\theta - \mathcal{T}(n\theta),$$

and where $V(\theta; \mathcal{T}(\cdot), p, g)$ is defined in (Step 1).

As we show in Appendix A, the optimal tax schedule can be characterized as follows, where we suppress the dependence of u_e, y, and η on p and g for readability:

Lemma 2. *For each type θ^*, the optimal marginal tax rate $T'(y(\theta^*))$ is governed by the following equation:*

$$\underbrace{1 - \frac{1 - \frac{\mathcal{T}'(y(\theta^*))}{1-\mathcal{T}'(y(\theta^*))} \frac{1}{1+\varphi} \frac{\theta^* f(\theta^*)}{1-F(\theta^*)} + \int_{\theta^*}^{\bar{\theta}} \mathcal{T}'(y(x)) \eta(x) \frac{dF(x)}{1-F(\theta^*)}}{1 + \int_{\underline{\theta}}^{\bar{\theta}} \mathcal{T}'(y(x)) \eta(x) dF(x)}}_{E(g)} = \underbrace{1 - \frac{\int_{\theta^*}^{\bar{\theta}} u_e(x) \frac{w(x)}{f(x)} \frac{dF(x)}{1-F(\theta^*)}}{\int_{\underline{\theta}}^{\bar{\theta}} u_e(x) \frac{w(x)}{f(x)} dF(x)}}_{D(g)}$$

where $\eta(\theta) \equiv dy(\theta)/d\mathcal{T}(0)$ denotes the income effect of type-θ worker.

This derivation is a standard exercise. The representation of the optimal tax schedule as equalizing gains from redistribution $D(g)$ to the efficiency costs $E(g)$ follows Heathcote and Tsujiyama (2021). We now explain the intuition behind both sides and present our formal results how they are altered by changes in the economic development.

Equity gains from redistribution $D(g)$. $D(g)$ captures the redistribution gains from increasing the marginal tax at income $y(\theta^*)$, that is, from raising more revenues from all workers with income above $y(\theta^*)$ and redistributing them lump-sum. When all workers are identical and Pareto weights are equalized, there is no gain from redistributing, and

$D(g) = 0$. Instead, when workers are heterogeneous, the average marginal utility of workers above θ^*, in the numerator of the fraction in $D(g)$, is typically lower than the average marginal utility across the entire distribution, in the denominator of the fraction. This implies positive gains from redistributing, as $D(g) > 0$. The term $D(g)$ is larger, the larger are the Pareto weights on those individuals of type $\theta < \theta^*$ and the larger the dispersion of marginal utilities u_e.

When $u(e; p, g)$ satisfies CRRA, it is easy to show that $D'(g) = 0$. This is the (implicit) standard in the literature, which implies that gains from redistribution only depend on the distribution of Pareto weights that the social planner assigns as well as the distribution of relative abilities. The latter fully determines the ratios of marginal utility of expenditure. If, however, $u(e; p, g)$ satisfies the DRRA property, Proposition 1 states that $D'(g) < 0$. As the economy grows, dispersion in marginal utilities decreases, and thus the gains from redistributing resources from the rich to the poor weaken, for a given distribution of abilities and a given set of Pareto weights. As we show in Appendix A, the following formal result holds

$$\frac{\partial \frac{u_e(e';p,g)}{u_e(e'';p,g)}}{\partial g} < 0 \text{ if } e' < e'',$$

i.e. the ratio of marginal utilities of low- and high-expenditure households is decreasing in the level of economic development g. We formally summarize this in the following proposition:

Proposition 1. *Assume that preferences $u(e; p, g)$ satisfy the DRRA property, then an increase in g lowers the gains from redistribution: $D'(g) < 0$.*

This proposition demonstrates that with DRRA preferences, the severity of a given level of inequality decreases as income levels increase.

Efficiency costs from redistribution: $E(g)$. The efficiency cost can be decomposed into two parts. First, the efficiency cost from raising revenue which is given by the numerator of the fraction in $E(g)$.

The first term in the numerator captures the fiscal externality that arises from lower labor supply of type θ individuals as a response to higher marginal tax rates. This term is independent of the level and only depends on the elasticity parameter φ as well as the distribution of types.[5] The second term captures the fiscal externalities that arise due to income effects. Taxing more those with type $\theta > \theta^*$ makes them poorer and therefore makes them work more. This lowers the efficiency cost of raising revenue. The denominator of the fraction in $E(g)$ captures the fiscal externalities from income effects

[5] As we show in Appendix A, if we express this formula in terms of the income distribution as opposed to the distribution of types, then as opposed to φ, the compensated labor supply elasticity shows up in the formula. And it is endogenous w.r.t. to g. However, the density of income is also endogenous w.r.t. to g and the two effects cancel out exactly.

that arise from increasing the lump-sum transfer. The stronger the income effects, the more costly it is to increase the lump-sum transfer as workers reduce labor supply in response to the transfer.

As we show in the appendix , the income effect parameters decrease with growth:

$$\frac{\partial \eta(x; p, g)}{\partial g} < 0. \tag{1}$$

This implies that the efficiency cost of raising revenue increases with economic growth, but also that the efficiency cost of paying out transfers decreases with growth. These results are summarized in the following proposition

Proposition 2. *Assume that preferences $u(e; p, g)$ satisfy the DRRA property, then an increase in g implies that*

- *the efficiency costs of raising tax revenue increase,*
- *the efficiency costs of distributing a lump sum decrease.*

As a consequence, the effect on $E(g)$ is ambiguous.

To sum up, from a theoretical perspective, an increase in the standards of living ceteris paribus lowers the gains from redistribution if preferences satisfy DRRA. The effect of the standards of living on the efficiency cost on the other hand is ambiguous. In the following section, we quantitatively explore the effects of the standards of living on optimal taxes using a rich dynamic incomplete markets version of the model in the tradition of Imrohoroğlu (1989), Huggett (1993), and Aiyagari (1994).

Cardinalization. A dynamic model offers two main advantages to quantify the effects of the rising standard of living.

First, it endogenously generates a distribution of expenditure given the observed distribution of income. This allows to quantify well efficiency concerns, for which the income distribution is crucial, as well as distribution concerns, for which the distribution of expenditures is key. Further, for 1950 there is no data available for the distribution of expenditure, so we need the model structure to infer an expenditure distribution from the observed income distribution.

Second, it allows to discipline the DRRA property arising from non-homothetic preferences. Indeed, non-homotheticicities are governed by the dynamics of sectoral expenditures observed in the United States. Non-homotheticicities also imply labor supply patterns that we compare to the data, both in the cross-section and over time. Yet, in principle, one cannot rule out cardinalizations which would leave these static spending allocation and labor supply decisions unchanged but would alter gains from redistribution $D(g)$. Static decisions across different goods for a given level of expenditures may not allow to infer preferences over risk if we consider cardinalizations of the form

$$v\left(u(e;p,g) - Bn^{1+\varphi}/(1+\varphi)\right).$$

Such a cardinalization would have no effect on static choices, but the functional form of $v(\cdot)$ would affect the curvature of the marginal utility function and therefore the gains from redistribution $D(g)$. In a model with risk and intertemporal decisions, however, the functional form $v(\cdot)$ does affect dynamic policies. A model with dynamic saving decisions thus allows to check the implicit identity cardinalization of Lemma 1, by comparing model-implied dynamic moments such as MPCs and wealth effects to their empirical counterparts.

These two advantages come at a cost: A dynamic model requires to use a parameterized function for taxes. We use the flexible functional form introduced in Ferriere, Grübener, Navarro, and Vardishvili (2023). We also quantitatively explore the optimal non-linear taxes in the static model using a calibration based on the dynamic model, to verify that our key results are robust to the functional forms used in the quantitative model. The calibrated static model further allows to decompose the relative importance of efficiency and distribution gains in the formula described above.

3 Dynamic Model: Setup and Quantification

We now proceed with quantifying the effects of rising inequality and rising living standards on the optimal $t\&T$ system. We start by introducing a dynamic incomplete market model with private saving. We describe the calibration and check the model implications of non-homotheticities on static decisions, that is, consumption and labor patterns. We also report the model fit for dynamic decisions. This section ends with a comparison of the implied level of DRRA in the model to empirical estimates provided in the literature.

3.1 Model Setup

The dynamic model is a standard incomplete market setup in the tradition of Imrohoroğlu (1989), Huggett (1993), and Aiyagari (1994). Households are characterized by their productivity θ and holdings of a risk-free bond a. The household problem reads as follows:

$$\begin{aligned} V\left(a,\theta\right) &= \max_{e,a',n}\left\{u(e;p) - B\frac{n^{1+\varphi}}{1+\varphi} + \beta\mathbb{E}_{\theta'}\left[V\left(a',\theta'\right)|\theta\right]\right\} \\ \text{s.t.}\quad & e + a' \leq \theta n + (1+r)a - \mathcal{T}\left(\theta n\right), \quad a' \geq 0. \end{aligned} \tag{2}$$

Productivity θ follows a stochastic process and the $t\&T$ system $\mathcal{T}(\cdot)$ belongs to a parametric class, which we discuss in the calibration section. Households discount the future with discount factor β and face a no-borrowing constraint. The problem is cast in partial equilibrium, with the interest r and the vector of prices taken as exogenous.

3.2 Calibration

We calibrate the model to the U.S. economy in 1950 and 2010. Following the large structural change literature, we consider three sectors: agriculture/food, manufacturing/goods, and services. All parameter values are summarized in Table 1.

3.2.1 Growth and Relative Prices

We fix the interest rate at 2% for both years. For the quantification of prices p we account both for aggregate growth and changes in relative prices. Growth in GDP per capita from 1950 to 2010 and changing relative prices of agriculture and services to goods give us three moments to pin down three prices, which is sufficient since we can normalize all prices in one period.

We compute aggregate growth in GDP per capita from 1950 to 2010 from National Income and Product Accounts (NIPA) to be 3.3. For relative prices we use the estimates of Herrendorf, Rogerson, and Valentinyi (2013) following their final expenditure rather than value added approach since we are modeling household expenditure behavior rather than production. From 1950 to 2010, with the final expenditure approach the relative price of agriculture (food) rises by a factor of 1.87 relative to goods, and the relative price of services rises by a factor of 3.16. These targets translate into falling prices for all commodities from 1950 to 2010, with the largest fall in goods and the smallest fall in services. The data moments discussed here and in what follows as well as their model counterparts are reported Table 2. We match most targeted moments exactly.

3.2.2 Inequality Dynamics

We assume that household productivity follows an AR(1) process in logs. To this process, we append a Pareto tail, with time-varying Pareto tail parameter α, set to 2.2 in 1950 and 1.65 in 2010 (Aoki and Nirei 2017). Across years we fix the persistence of the productivity process ρ to 0.9. We set the standard deviation of the innovation to match the variance of log income in 1950 (0.57) and 2010 (0.78), with the data counterpart from the extended Survey of Consumer Finances (SCF+) of Kuhn, Schularick, and Steins (2020).[6]

The variance of log income is targeted explicitly, but the model provides a good fit for income inequality along the entire income distribution. Table 3 shows income shares

[6] See Appendix B.1 for details on the SCF+ data.

Table 1: Parameter Values

Parameter	Interpretation	Value
Preferences		
β	Discount factor	0.957
γ	Curvature utility	0.750
$1/\varphi$	Frisch elasticity	0.500
B	Labor disutility	8.340
σ	Non-homothetic CES parameter	0.300
ε_A	Non-homothetic CES parameter	0.100
ε_G	Non-homothetic CES parameter	1.000
ε_S	Non-homothetic CES parameter	1.800
Ω_A	Non-homothetic CES parameter	0.057
Ω_G	Non-homothetic CES parameter	1.000
Ω_S	Non-homothetic CES parameter	10.303
Prices		
p_A^{1950}	Price agriculture 1950	3.032
p_G^{1950}	Price goods 1950	5.669
p_S^{1950}	Price services 1950	1.794
p_A^{2010}	Price agriculture 2010	1.000
p_G^{2010}	Price goods 2010	1.000
p_S^{2010}	Price services 2010	1.000
r	Interest rate	0.020
Inequality		
$\rho_\theta^1 950$	Persistence productivity	0.900
σ_θ^{1950}	Std. dev. productivity innovation 1950	0.273
σ_θ^{2010}	Std. dev. productivity innovation 2010	0.302
α_θ^{1950}	Pareto tail parameter 1950	2.200
α_θ^{2010}	Pareto tail parameter 2010	1.650
Government		
λ^{1950}	Tax function level 1950	0.146
τ^{1950}	Tax function progressivity 1950	0.134
T^{1950}	Transfer 1950	0.005
G^{1950}	Government spending 1950	0.070
λ^{2010}	Tax function level 2010	0.172
τ^{2010}	Tax function progressivity 2010	0.073
T^{2010}	Transfer 2010	0.020
G^{2010}	Government spending 2010	0.078

Notes: Table 1 summarizes the parameter values.

Table 2: Data and Model Moments

Moment	Source	Data	Model
Moments related to Preferences			
Wealth-to-income ratio 2010	Piketty et al. (2014)	4	4
Avg. RRA in 2010	Standard value (log utility)	1.00	0.99
Avg. labor supply 2010	Normalization	-	0.3
Agg. agriculture share 2010	Herrendorf et al. (2013)	7.5%	7.5%
Agg. goods share 2010	Herrendorf et al. (2013)	25.6%	25.6%
Agg. services share 2010	Herrendorf et al. (2013)	66.9%	66.9%
Moments related to Prices			
Change rel. price A to G	Herrendorf et al. (2013)	1.87	1.87
Change rel. price S to G	Herrendorf et al. (2013)	3.16	3.16
GDP per capita growth	NIPA	3.34	3.34
Moments related to Inequality			
Variance log income 1950	SCF+	0.57	0.55
Variance log income 2010	SCF+	0.78	0.78
Moments related to Government			
T/Y 1950	OMB	1.1%	1.1%
G/Y 1950	OMB / const. spending	14.0%	14.0%
AMTR difference 1950	Mertens et al. (2018)	12.86%	12.86%
T/Y 2010	OMB	3.6%	3.6%
G/Y 2010	OMB / const. spending	14.0%	14.0%
AMTR difference 2010	Mertens et al. (2018)	8.67%	8.67%
Untargeted Moments			
Wealth-to-income ratio 1950	Piketty et al. (2014)	3.5	3.0
Agg. agriculture share 1950	Herrendorf et al. (2013)	21.5%	16.7%
Agg. goods share 1950	Herrendorf et al. (2013)	39.2%	49.1%
Agg. services share 1950	Herrendorf et al. (2013)	39.2%	34.2%

Notes: Table 2 summarizes data moments and their model counterparts.

Table 3: Income, Expenditure, and Wealth Distributions

1950	**Income** Share by Quintile				
Model	6%	11%	13%	21%	49%
Data (SCF+)	6%	11%	15%	21%	48%
2010	**Income** Share by Quintile				
Model	4%	9%	11%	19%	56%
Data (SCF+)	4%	9%	13%	21%	53%
1950	**Expenditure** Share by Quintile				
Model	8%	13%	17%	23%	39%
Data	-	-	-	-	-
2010	**Expenditure** Share by Quintile				
Model	7%	11%	16%	21%	45%
Data (CEX)	9%	14%	18%	23%	35%
1950	**Wealth** Share by Quintile				
Model	0%	2%	6%	17%	76%
Data (SCF+)	0%	1%	4%	11%	84%
2010	**Wealth** Share by Quintile				
Model	0%	1%	5%	13%	81%
Data (SCF+)	-1%	1%	3%	10%	87%

Notes: Table 3 compares income, expenditure, and wealth shares by quintile of the respective distribution in model and data. Data for income and wealth are from the SCF+ and for expenditure from the CEX.

by quintile. In particular, the model reproduces that the income share of the bottom quintile falls by a third, and that the share of income going to the top quintile strongly increases.

As in the data, income inequality translates into an even more unequal asset distribution. With assets available to smooth consumption, expenditure inequality is smaller than income inequality. The variance of log expenditure in the model is 0.46 in 2010, relative to 0.42 in Consumer Expenditure Survey (CEX) data.[7] The model somewhat overestimates the concentration of consumption in the top quintile. Note, however, that with the Pareto tail we capture well the income distribution up to the top, which may not be well represented in the CEX. For 1950, lower income inequality relative to 2010

[7]We compute and statistics of the expenditure distribution (and cross-sectional consumption patterns below) from the CEX, based on the data preparation of Aguiar and Bils (2015). See Appendix B.3 for details.

translates into lower expenditure inequality, for which we do not have a data counterpart and therefore need the model with endogenous private insurance to infer the degree of expenditure inequality.

3.2.3 Preferences

Non-homothetic CES. As the benchmark preference specification, we use the non-homothetic CES preferences. For the parameters ε_j, governing the expenditure elasticities of demand, and σ, governing the substitutability of the different commodities, we rely on the estimates of Comin, Lashkari, and Mestieri (2021) based on micro data from the CEX. We set $\sigma = 0.3$, $\varepsilon_A = 0.1, \varepsilon_G = 1.0,$ and $\varepsilon_S = 1.8$. Hence, agricultural products are the necessities, with a low expenditure elasticity of demand, whereas services are the luxury, with a high expenditure elasticity of demand. We set the parameters Ω_j of the non-homothetic CES to match exactly aggregate sector shares in 2010, based on data from Herrendorf, Rogerson, and Valentinyi (2013). The agriculture share is 8%, the goods share is 26%, and the services share is 67%. We do not explicitly target the aggregate sector shares in 1950, but the model captures the structural change out of agriculture towards services well, with an agricultural sector share of 17% (data: 22%), goods share of 49% (39%), and services share of 34% (39%). We also report the cross-sectional expenditure distribution across goods, comparing model and data, in Table C.1 in the appendix.

Other preference parameters. For the remaining preference parameters, we set the discount factor β to match a wealth-to-income ratio of 4 in 2010 (Piketty and Zucman 2014). We do not explicitly target the wealth-to-income ratio in 1950, but the model matches it reasonably well (model 3; data 3.5). We fix the Frisch elasticity at a standard value with $1/\varphi = 0.5$ and the labor disutility parameter B such that average labor supply in 2010 is 0.3. We choose the consumption curvature $\gamma = 0.75$ to achieve an average relative risk aversion in 2010 of 1, a standard value in the literature that often relies on log utility (Guner, Kaygusuz, and Ventura 2023; Heathcote, Storesletten, and Violante 2017; Saez 2001)

3.2.4 Government

Tax and transfer function. For the dynamic model, we restrict ourselves to a parametric but flexible functional form, following Ferriere, Grübener, Navarro, and Vardishvili (2023). The tax payment is given by

$$\mathcal{T}(y) = \exp\left[\log(\lambda)\left(y^{-2\tau}\right)\right] y - T \tag{3}$$

The first part of the equation describes a two-parameter tax function, with parameter λ governing the level of taxes and parameter τ governing the progressivity. For most income levels this functional form can be parameterized to give similar marginal tax rates as the widely used loglinear tax function popularized by Feldstein (1969), Benabou (2002), and Heathcote, Storesletten, and Violante (2017). We choose this alternative functional form because it restricts marginal tax rates to be positive for all income levels and we model transfers separately with a lump-sum component T. While the log-linear tax function captures tax rates very well for large parts of the income distribution (Heathcote, Storesletten, and Violante 2017), allowing for a lump-sum transfer on top of a progressive tax function also improves the fit to the data in particular at the bottom and the top of the income distribution (Ferriere, Grübener, Navarro, and Vardishvili 2023).

Calibration of the t&T system. We set the parameters T, exogenous spending G, and τ for the years 1950 and 2010 to match the transfer-to-output ratio, the spending-to-output ratio, and the difference in average marginal tax rates (AMTRs) between the top 10% and the bottom 90% of the income distribution. For transfers and other spending we use data from the White House Office of Management & Budget (OMB). We include in transfers T general retirement and disability insurance (excluding social security), federal employee retirement and disability, unemployment compensation, housing assistance, food and nutrition assistance, and other income security. These programs amount to 1.1% of GDP in 1950 and 3.6% of GDP in 2010. For other spending, we purposefully pick exogenous spending G to match a constant spending-to-output ratio of 14%. In the data, spending has risen over time, but this increase has been largely deficit financed, which we do not model. We keep the spending-to-output constant, as changing spending requirements would introduce further dynamics in the optimal level of tax progressivity.[8] We compute the difference in AMTRs along the income distribution, closely linked to tax progressivity τ, using data from Mertens and Montiel Olea (2018). The difference between the top 10% AMTR and the bottom 90% AMTR is 13% in 1950 and 9% in 2010. The final parameter of the tax function λ is determined by the restriction that the government budget has to clear period by period.

The flexible functional form with transfers modeled separately from progessive taxes allows to capture two key developments of the U.S. $t\&T$ system over the last decades. First, marginal tax rates have become less progressive, reflected in a lower progressivity parameter in 2010 than in 1950 (Ferriere and Navarro 2023). Second, transfers have risen significantly over this time period, such that average $t\&T$ rates have become more progressive (Heathcote, Storesletten, and Violante 2020; Splinter 2020).

[8]See Heathcote and Tsujiyama (2021) and Ayaz, Fricke, Fuest, and Sachs (2023) for discussions of how "fiscal pressure" influences optimal tax progressivity.

3.3 Model Validation

We now validate the calibration of preference parameters and the implied degree of DRRA in the model. We proceed in three ways. First, we investigate the model consistency with prominent labor supply patterns over time and in the cross-section. Second, we exploit the dynamic structure of the model to link DRRA to the better measurable concepts of wealth effects and MPCs. Third, we compare the implied degree of DRRA to estimates from various literatures.

3.3.1 Labor Supply

Recent literature has documented key patterns of labor supply over time, across countries, and in the cross-section within a country. Boppart and Krusell (2020) find as a robust pattern of labor supply over time across countries a steady fall in hours worked by roughly 0.5% per year. For the postwar U.S., McGrattan and Rogerson (2004) and Ramey and Francis (2009) find a fall in hours per worker of 4-6%.[9] Boppart and Krusell (2020) argue that this evidence requires preferences such that the income effect of steady productivity growth outweighs the substitution effect. Cross-country evidence on hours worked reveals an important nonlinearity, in that hours fall more strongly from low- to middle-income countries than from middle- to high-income countries, suggesting a role for non-homotheticicities in generating income effects dominating substitution effects (Bick, Fuchs-Schündeln, and Lagakos 2018).[10]

Non-homothetic preferences also have the potential to account for changing cross-sectional patterns of labor supply over time. Before the 1970s, low-wage workers worked more hours than high-wage workers, a pattern which has reversed since then. (Costa 2000; Heathcote, Perri, and Violante 2010; Mantovani 2023).

To obtain a consistent set of numbers, we use data from the Census and American Community Survey (ACS) to compute measures of hours worked over time and in the 1950 and 2010 cross-sections.[11] We find a fall in hours worked over time of 3%, on the low end of available measures. In the 1950 cross-section, we find a fall of hours in wages, which is strongest from the 1st to the 2nd wage quintile. In the 2010 cross-section, the correlation between hours and wages turns positive.

The calibrated model is broadly consistent with these patterns. The fall in labor supply over time is 7%, somewhat higher than what we find in the data, but well within the range of reasonable values. Hours are increasing in wages in 2010. The model cannot

[9]In terms of total hours this is compensated by rising female labor force participation, a pattern we abstract from in the model.

[10]Restuccia and Vandenbroucke (2013) argue that a subsistence requirement consistent with the size of final expenditures on food relative to GDP accounts very well for the fall in hours in the U.S. from 1870 to 1970. Analyzing labor supply in OECD countries from 1956–2004, Ohanian, Raffo, and Rogerson (2008) find a role for a modest subsistence requirement in accounting for the observed patterns.

[11]See Appendix B.2 for details on the Census/ACS data.

deliver the full reversal of the wage-hours relation in 1950, but does deliver a fall in 1950 labor supply from the first to the second quintile.[12]

3.3.2 Wealth Effects and MPCs

As a second step to validate the calibration of preferences and the implied degree of DRRA, we exploit the dynamic dimension in the model and link DRRA to concepts that are better measurable in the data. In particular, we derive the following expression

$$\eta\left(\varphi\frac{e}{\theta n}+\frac{e\mathcal{T}''\left(\theta n\right)}{\mathcal{T}'\left(\theta n\right)}\right)=\text{MPC}\times\text{RRA},$$

which links relative risk aversion to wealth effects η and MPCs. We compute MPCs and wealth effects in the calibrated model to verify that the cardinalization we choose is consistent with these well-measured concepts.

In 2010, the calibrated model produces MPCs and wealth effects well in line with available evidence. For MPCs, we compute the expenditure response to a $500 increase in wealth. On average, the model produces an MPC of 18%. While this is relatively low compared to most of the available evidence (Fagereng, Holm, and Natvik 2021; Johnson, Parker, and Souleles 2006; Kaplan and Violante 2022), we consider it a success in a model with just one asset calibrated to the entire stock of wealth. For wealth effects, we compare the model response to a one-time unanticipated wealth shock to the evidence provided by Golosov, Graber, Mogstad, and Novgorodsky (2023), who measure the earnings response to lottery winnings using the universe of U.S. taxpayers. The model captures very well that earnings fall by $2.3 in response to a $100 wealth shock.

3.3.3 DRRA: Relation to the Litarature

Finally, we directly compare the model implied degree of DRRA to available evidence from the literature, attained using a vast variety of different approaches. The calibrated model implies a modest degree of DRRA. From 1950 to 2010, average relative risk aversion falls from 1.07 to 0.99. Also cross-sectional dispersion in risk aversion is small, as shown in Figure 1.

In this section, we argue that this degree of DRRA is small relative to the available evidence. We start with approaches that directly aim to estimate DRRA or varying intertemporal elasticity of intertemporal substituttion (IES), and then turn to theoretical models, in which DRRA is a necessary feature to make the model consistent with the data.

Atkeson and Ogaki (1996) estimate the IES both using Indian panel data and in the aggregate time series for India and the U.S. They find an IES of the richest households

[12] Model and data are compared in Table C.2 in the appendix.

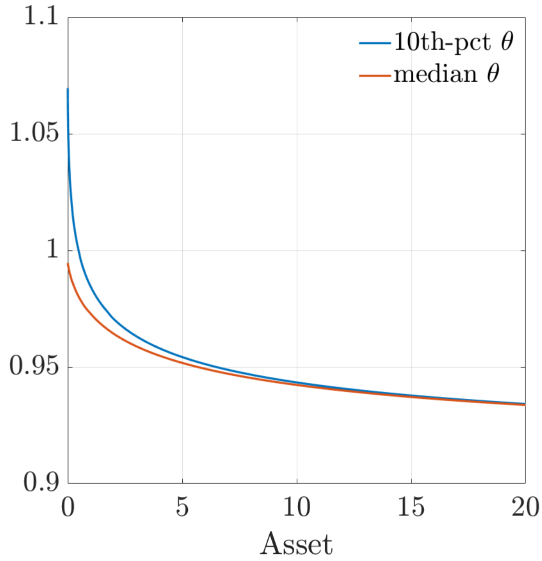

Figure 1: Relative Risk Aversion

Notes: Figure 1 shows dispersion in relative risk aversion in the calibrated model for 2010.

in India that is 60% higher than that of the poorest households. The ratio of the IES between the U.S. and India is roughly 1.5. In the U.S. time series they estimate an increase in the IES from 0.38 to 0.41 from 1929 to 1988. Blundell, Browning, and Meghir (1994) and Attanasio and Browning (1995) also estimate that the IES in increasing in consumption using UK data. Blundell, Browning, and Meghir (1994) report variation in the IES from the 10th to the 90th percentile ranging from 0.66 to 1.10 or 0.96 to 2.8, depending on the specification.[13] Relative to this evidence, the variation in our model is modest.

Ogaki and Zhang (2001) and Zhang and Ogaki (2004) allow for DRRA when testing for risk sharing using consumption data from Pakistani and Indian villages. Their empirical specifications reject the hypothesis of CRRA in favor of DRRA.

In addition to these direct estimates, DRRA is an important feature in making theory consistent with data in a variety of fields. In consumption theory, Straub (2019) employs non-homothetic preferences that imply risk aversion decreasing in income and wealth to account for consumption responses to permanent income changes. In finance, DRRA typically helps in matching portfolios across the wealth distribution (Cioffi 2021; Meeuwis 2022; Wachter and Yogo 2010) and in mitigating the equity premium puzzle (Ait-Sahalia, Parker, and Yogo 2004). More closely related to us, in the development literature, Donovan (2021) argues that the heterogenous income elasticities coming from

[13]From a theoretical perspective, the literature has established that the shape of Engel curves in the data is inconsistent with a constant IES. (Crossley and Low 2011; Hanoch 1977; Stiglitz 1969). The logic that “luxuries are easier to postpone” (Browning and Crossley 2000) implies an increasing IES.

non-homothetic preferences also imply DRRA and that this is important in accounting for aggregate productivity differences across countries.[14]

4 Optimal Policies

We now turn to the analysis of optimal policies. We first do a Ramsey analysis of optimal restricted tax instruments in the dynamic model. Then, we use the calibration of the dynamic model to parameterize the Mirrlees environment and compute the optimal unrestricted nonlinear income tax schedule in that environment. We also use the static model to decompose the equity and efficiency effects of growth in combination with non-homothetic preferences, and conduct various robustness exercises.

4.1 Ramsey Analysis in Dynamic Model

We start with the Ramsey analysis in the dynamic model to quantify the effect of rising living standards relative to the effect of rising inequality. We proceed in three steps. First, we find inverse optimum Pareto weights that make the observed $t\&T$ system in 1950 optimal. Second, we add the change in inequality from 1950 to 2010. Third, in addition to the rising inequality, we account for rising levels of income with growth.

Pareto weights. The point of departure is the 1950 calibrated tax system. As a first step, we follow an inverse optimum approach and find the welfare weights under which the 1950 $t\&T$ system is optimal. We then assume social preferences fixed over time and use them to evaluate the optimal $t\&T$ system in 2010.[15]

In static Mirrlees models, it is natural to make welfare weights a function of productivity. In the dynamic model, heterogeneity is two-dimensional, with households differing both in productivity and wealth. A one-dimensional measure, capturing how well-off a household is, is expenditure.[16]

The $t\&T$ system in 1950 is characterized by two parameters, T and τ. Hence, we use a two-parameter function for the Pareto weights, which we assume of the following form:

$$\omega\left(p_i\right) = \mu + p_i(e_i)^{\nu},$$

[14] The mechanism is that lower intermediate input usage in agriculture in developing countries is driven by the combination of idiosyncratic shocks, incomplete markets, and subsistence requirements, where the latter imply DRRA, because lower intermediate input usage limits exposure to uninsurable shocks.

[15] In Section 4.3, we also present robustness with a Utilitarian social welfare function.

[16] Chang, Chang, and Kim (2018) also use an inverse optimum approach conditioning Pareto weights on expenditures. As a robustness, we have also made weights a function of productivity only, with similar results as those reported here.

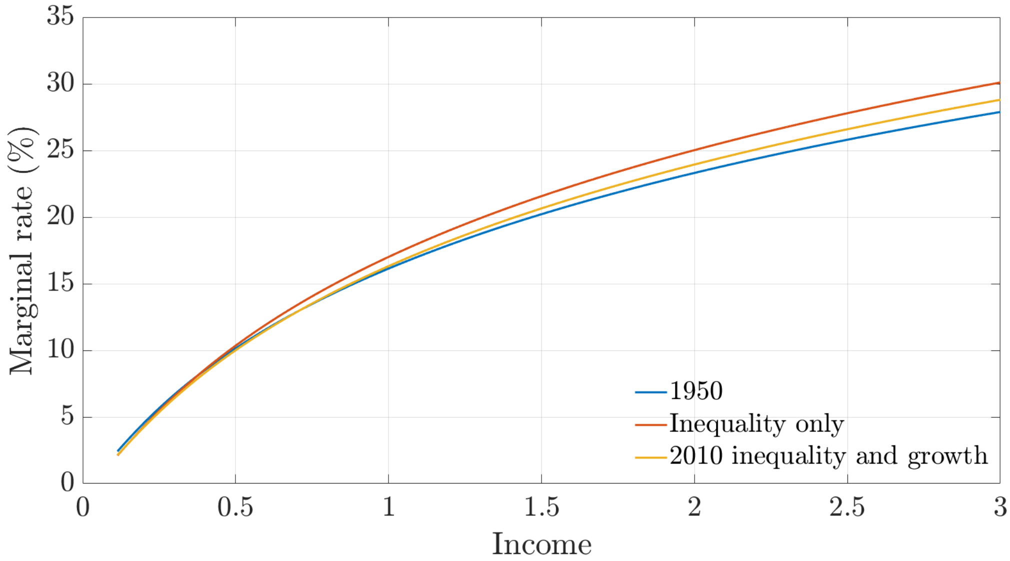

Figure 2: Optimal Marginal Rates in the Dynamic Model

Notes: Figure 2 shows the optimal marginal tax rates schedule in the dynamic model for three cases, the 1950 inverse optimum, a counterfactual economy with only a rise in inequality, and the 2010 economy with rising inequality and growth. 1 corresponds to mean income in 2010.

where the weight ω depends on the percentile p_i of the expenditure distribution and the parameters μ and ν. Though there is no guarantee to match exactly the calibrated system, we loosely think of ν to relate to the progressivity and μ to the lump-sum transfer. Defining Pareto weights as a function of the percentile rather than of the level of expenditure itself avoids to mechanically increase Pareto weights on the rich as inequality increases.

Making the observed system optimal requires putting a high welfare weight on the very high expenditure households relative to the rest of the distribution. With parameters $\mu = 0.05$ and $\nu = 116.4$ we obtain weights that are flat up to the 95th percentile of the expenditure distribution, but then strongly increase in expenditure up to roughly 20 times the weight at the bottom. We come very close to matching the observed tax system, with an optimal progressivity of 0.15 and a transfer-to-output ratio of 0.9%, relative to the calibrated values of 0.13 and 1.1%.

Figure 2 shows the optimal marginal tax rates for 1950 and the two scenarios that we discuss next. Figure 3 shows into which average $t\&T$ rates these optimal marginal rates translate. In 1950, average rates are only very modestly negative at the bottom, given the small transfer.

Rising inequality. Starting from the 1950 economy, we first adjust only inequality to 2010 levels and compute the optimal $t\&T$ system. With only rising inequality, taxes

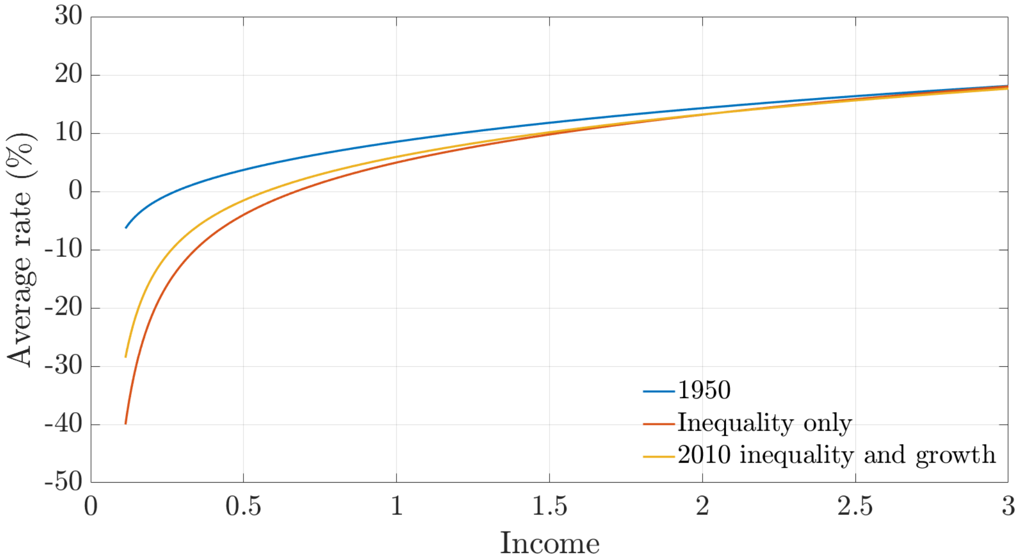

Figure 3: Optimal Average Rates in the Dynamic Model

Notes: Figure 3 shows the optimal average $t\&T$ rates schedule in the dynamic model for three cases, the 1950 inverse optimum, a counterfactual economy with only a rise in inequality, and the 2010 economy with rising inequality and growth. 1 corresponds to mean income in 2010.

become more progressive. Marginal rates rise across most of the income distribution, but especially so at the top. Hence, revenue goes up, and the government can finance larger lump-sum transfers amounting to 4.4% of output. This aligns with the typical finding in the literature that rising inequality calls for more redistribution. The increased redistribution in response to rising inequality manifests itself in average $t\&T$ rates that go as low as -40%.

Rising living standards. The third scenario depicted in the figure accounts for rising living standards in addition to rising inequality. Marginal rates in this case fall between marginal rates of the other two cases. The lump-sum transfer is only 3.3% of output. Hence, by this simple metric of the generosity of the welfare state, rising inequality is the quantitatively dominant force, but rising standards of living reduce the desired increase in the transfer-to-output ratio by 31%. When also accounting for growth, the lowest average $t\&T$ rates only go up to -30%. Growth reduces the increase in top 10% average rates minus bottom 10% average rates by 28%.

4.2 Mirrlees Analysis in Static Model

We now turn to the optimal policy analysis in the static model, allowing for unrestricted nonlinear income taxes in the tradition of Mirrlees. We do this for two reasons. First, we view the approach as complementary to the Ramsey analysis in the dynamic model. The latter is a richer model which allows to disentangle income and expenditure inequality, thus better capturing efficiency and equity concerns, and which has meaningful notions of RA and IES, but we restrict the $t\&T$ system to a flexible yet parametric class. The Mirrlees approach allows to ensure that results are not driven by parametric restrictions on the $t\&T$ system. Second, we can use the optimal tax formula to decompose whether falling redistribution in response to rising living standards is driven purely by equity concerns or also by efficiency concerns, as the latter have a theoretically ambiguous effect.

Parameterization. In contrast to the dynamic model, there is no distinction between after-tax income and expenditure in this environment. For the quantification, we therefore follow a partial insurance approach and calibrate productivities such that the model is consistent with inequalities in expenditures. Specifically, we calibrate the distribution of skills as an exponentially modified Gaussian distribution (EMG), as in Heathcote and Tsujiyama (2021). The Pareto tail of the expenditure distribution is thinner than that of the income distribution. For 2010, we set the tail parameter to 3.3, relative to that for the income distribution of 1.65 (Aoki and Nirei 2017; Toda and Walsh 2015). For 1950 there are no available estimates of the tail parameter for the expenditure distribution, so we assume that the relation to the income distribution stays the same. Based on a tail coefficient for the income distribution of 2.2, we set the parameter to 4.4 for the expenditure distribution. Then, we set the remaining EMG parameter to match the variance of log expenditure in 2010 and 1950, respectively, and arrive at a variance of log expenditure of 0.37 for 2010, well in line with our findings from the CEX and with the literature (Attanasio and Pistaferri 2014; Heathcote, Perri, and Violante 2010), and 0.26 in 1950.[17]

As for the dynamic model, we set government parameters to match transfer-to-output ratios, spending-to-output ratios, and the difference in AMTRs between the top-10% and bottom-90% of the distribution. Prices are set to replicate aggregate growth and changes in relative prices over time. Preference parameters are as in the dynamic model, except for the share parameters of the non-homothetic CES, which we set to match aggregate sector shares. In the static model, we can also validate the calibration with labor supply behavior over time and in the cross-section, with an even slightly better fit than in the dynamic model. Over time, labor supply is falling by 5%, whereas it is monotonically decreasing in productivity in 1950 and monotonically increasing in productivity in 2010.

Optimal policy. For the optimal policy analysis in the static Mirrlees world, we follow the same approach as with the dynamic model. We start with finding inverse optimum weights making the 1950 $t\&T$ system optimal. In this framework, we can find a unique

[17]We show that the expenditure distribution by quintiles is very similar in static and dynamic model; see Table C.3 in the appendix.

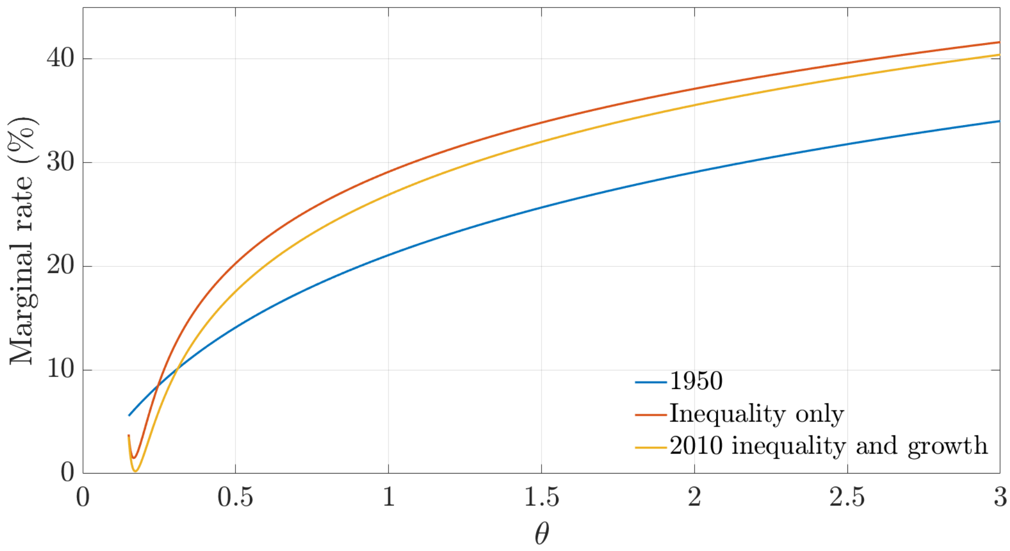

Figure 4: Optimal Marginal Rates in the Static Model

Notes: Figure 4 shows the optimal marginal tax rates schedule in the static model for three cases, the 1950 inverse optimum, a counterfactual economy with only a rise in inequality, and the 2010 economy with rising inequality and growth.

set of Pareto weights as a function of productivity, which in this environment captures inequality in earnings potential (Bourguignon and Spadaro 2012; Hendren 2020; Jacobs, Jongen, and Zoutman 2017; Lockwood and Weinzierl 2016). As before, over time we keep these weights constant for the two following scenarios as functions of the position in the distribution.

Figure 4 shows optimal marginal tax rates in the static model for the three cases: the 1950 inverse optimum, the change in only inequality, and changes in inequality and income levels toward 2010. Results allowing for the unrestricted nonlinear marginal rates are similar to the dynamic model. In 1950 marginal tax rates are monotonically increasing by virtue of the inverse optimum approach. With only the increase in inequality to 2010 levels, marginal tax rates rise across most of the distribution, except at the very bottom. The transfer-to-output ratio rises from 1.2% to 6.7%, which is a slightly bigger increase than in the dynamic model. However, when also accounting for growth, the relative importance of rising living standards compared to rising inequality is of a similar magnitude. With higher inequality and growth, optimal marginal rates are lower than with just higher inequality and the transfer-to-output ratio falls to 4.5%. Hence, by this metric growth reduces the desired increase in the transfer-to-output ratio by 40%.

We relegate the average $t\&T$ rates in this environment to Figure C.1 in Appendix C.2. Similar to the results in the dynamic model, growth reduces the increase in top 10% average rates minus bottom 10% average rates by 28%.

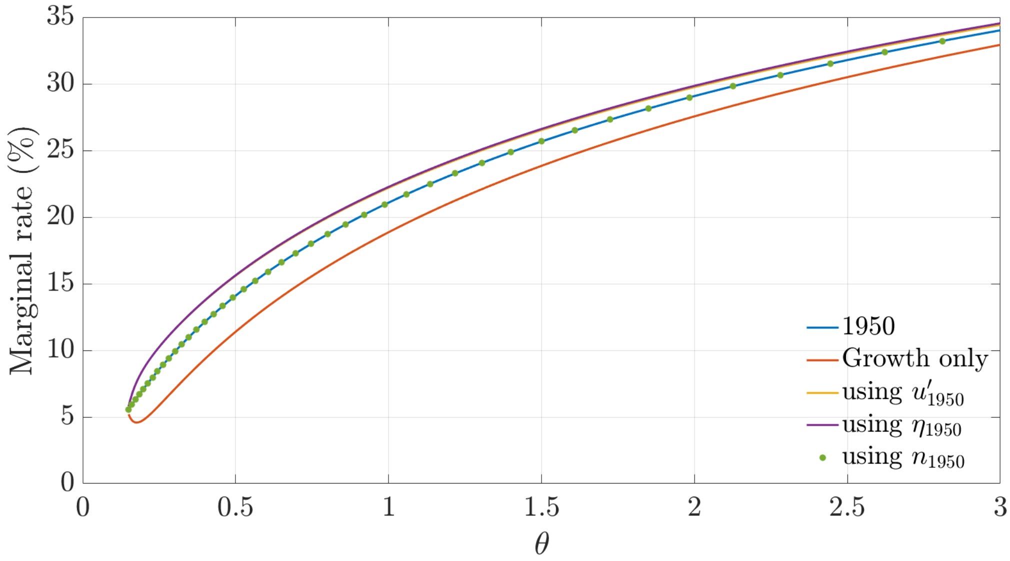

Figure 5: Decomposition of the Effect of Growth in the Static Model

Notes: Figure 5 decomposes the effect of growth in the static model into the effects of changing dispersion of marginal utilities, changing income effects, and the changing distribution of hours worked.

Decomposition of the growth effect. We now use the quantified version of the static model to decompose what drives the effect of growth, guided by the optimal tax formula derived in the theoretical part of the paper. Recall that growth affects the tax formula through three channels: changing marginal utilities, changing income effects, and changing hours worked. Figure 5 shows the decomposition.

Also for the decomposition we start from the 1950 inverse optimum. The first step is to just account for growth, i.e. to evaluate the tax formula using 2010 prices without changing inequality. The figure shows that marginal utilities fall across the board. Hence, fewer revenues are raised and the small lump-sum transfer turns into a lump-sum tax, with the transfer-to-output ratio becoming -0.7%. This illustrates again that rising living standards call for less redistribution. To understand which of the potential channels accounts for this overall effect we change them one-by-one. First, we compute the optimal $t\&T$ system, where marginal utilities are computed using 1950 prices, but still evaluate income effects and hours worked using 2010 prices. This isolates the effect of changing marginal utilities. The figure shows that with only this change redistribution increases strongly, with marginal rates rising above those of the 1950 system. The transfer-to-output ratio rises to 2.4%. Second, we also compute income effects using 1950 prices. Theoretically, this has an ambiguous effect and quantitatively the opposing effects essentially cancel out, with marginal tax rates and the transfer-to-output ratio barely changing relative to the previous scenario. Third, we also compute hours with 1950 prices, which brings marginal rates back exactly to the starting point, the 1950

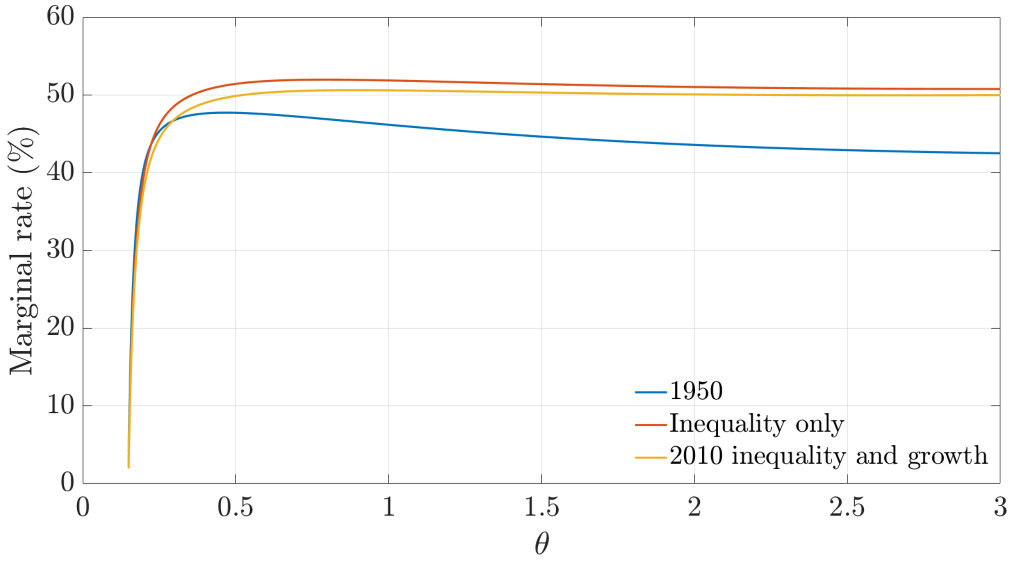

Figure 6: Optimal Marginal Rates in the Static Model - Utilitarian Planner

Notes: Figure 6 shows the optimal marginal tax rates schedule of a utilitarian planner in the static model for three cases, the 1950 economy, a counterfactual economy with only a rise in inequality, and the 2010 economy with rising inequality and growth.

inverse optimum. Hence, this effect lowers redistribution. This is because, given constant skill inequality, income inequality is lower at 1950 than at 2010 prices, as in particular the very poor work much more when living standards are lower.

4.3 Robustness

Utilitarian planner. We use the static model to perform a number of robustness checks. First, we study the problem of a utilitarian planner rather than employing inverse optimum weights. The optimal marginal tax rates are shown in Figure 6. First note that marginal rates are much higher across all scenarios. This is a common finding in the literature when studying the problem of a utilitarian planner (Heathcote and Tsujiyama 2021; Saez 2001). In 1950, the transfer-to-output ratio in the optimal system is 25.2%. With only the rise in inequality, optimal marginal rates rise such that the transfer-to-output ratio inreases to 29.2%. As with inverse optimum weights, when also accounting for growth optimal marginal rates are lower and finance a lower transfer. The transfer-to-output ratio falls to 27.6% such that by this metric growth reduces the desired increase in redistribution by 39%. Using the alternative metric of the difference in average $t\&T$ rates between top-10% and bottom-10%, growth reduces the optimal increase in redistribution by 9%.

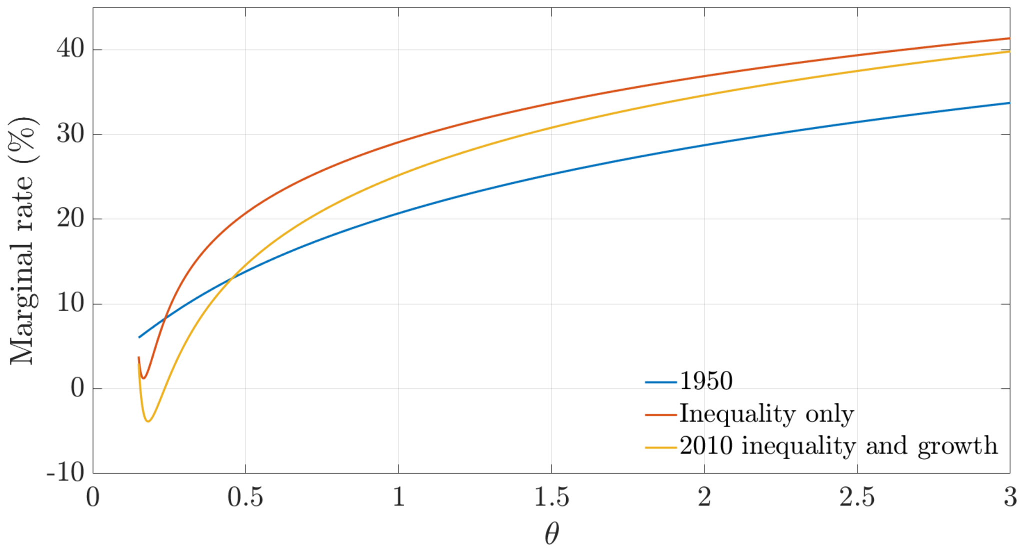

Figure 7: Optimal Marginal Rates in the Static Model - IA Preferences

Notes: Figure 7 shows the optimal marginal tax rates schedule with IA preferences in the static model for three cases, the 1950 economy, a counterfactual economy with only a rise in inequality, and the 2010 economy with rising inequality and growth.

IA preferences. As a second robustness check we perform the analysis replacing the non-homothetic CES preferences with the IA preferences of Alder, Boppart, and Müller (2022), calibrated to match the same targets as with the non-homothetic CES.[18] With IA preferences the effects of growth are larger, so that our results based on non-homothetic CES are conservative. As in all previous cases, marginal rates rise with inequality, but this rise is dampened when accounting for growth. The transfer-to-output ratio moves from 1.1% to 6.1% to 2.4% across cases. Hence, growth reduces the optimal rise in the transfer-to-output ratio by 73%, and it reduces the optimal increase in the difference in average $t\&T$ rates between top-10% and bottom-10% by 44%.

5 Conclusion

In this paper, we studied how the optimal design of the tax-and-transfer system is affected by rising living standards. Relative to a large optimal taxation literature that investigates how the optimal $t\&T$ system is affected by changing inequality, we incorporated a role for rising living standards by using non-homothetic preferences. With these preferences we captured how households consumption baskets switch from necessities to luxuries as they become more affluent and how this affects optimal redistribution.

[18] The parameters for the IA preferences are the following: $\varepsilon = \gamma = 0.1$, $\bar{c}_A = 0.03$, $\bar{c}_G = 0.00$, $\bar{c}_S = 0.005$, $\sigma = 0.001$, $\omega_A = 0.05$, $\omega_G = 0.4$, $\omega_S = 0.55$, $\nu = 15$, $\phi = 2$, $\theta_A = 0.1$, $\theta_G = 0.6$, $\theta_S = 0.3$.

We showed theoretically that a key property of preferences is DRRA. With this property, rising living standards unambiguously reduce the distribution needs in the economy. The effects on efficiency concerns are theoretically ambiguous. Quantitatively, we showed using both a Ramsey approach in a dynamic incomplete market framework and a Mirrlees approach in a static environment that accounting for growth reduces the desired increase in redistribution in the U.S. from 1950 to 2010 due to rising inequality by at least 25%.

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A Theory Appendix

TO BE ADDED

B Data Appendix

In this section, we describe the datasets to compute the data moments described in the main text.

B.1 SCF+

The SCF+ provides long-run data on income and wealth inequality in the U.S. It is compiled by Kuhn, Schularick, and Steins (2020), based on historical waves of the SCF. The covered time period is from 1949 to 2016.

As income components in the data, we use wages and salaries, income from professional practice and self-employment, and business and farm income. We exclude rental income, interest, dividends, and transfers, as we model asset income and transfers separately from the labor income process.

For wealth, we compute net worth as the sum of all assets minus the sum of all debts. Assets include liquid assets (checking, savings, call/money market accounts, certificates of deposit), housing and other real estate, bonds, stocks and business equity, mutual funds, cash value of life insurance, defined-contribution retirement plans, and cars. Debt consists of housing debt (debt on owner-occupied homes, home equity loans and lines of credit) and other debt (car loans, education loans, consumer loans).

We restrict the sample to the working age population, i.e. household heads aged 25 to 60. We impose that minimum household income is \$5,000 in 2010 (in 2016 dollars). In 1950, we choose the cutoff such that the ratio of minimum income to median income is the same as in 2010, which results in a cutoff of \$2,700 (in 2016 dollars).

B.2 Census and ACS

For hours worked, we use data from the 1950 Census 1% Sample and the 2010 American Community Survey (ACS), provided by IPUMS USA (Ruggles, Flood, Goeken, Schouweiler, and Sobek 2022). For 2010 we use usual hours worked per week, while for 1950 only hours worked last week is available. We compute statistics based on hours of the household head.

We impose the same basic sample selection criteria as for the SCF+, restricting the sample to heads between 25 and 60 and a minimum household income of \$2,700 in 1950 and \$5,000 in 2010 (in 2016 dollars). Additionally, we impose some restrictions to eliminate implausible hours values and reduce the effect of outliers. In particular, we focus on households with only one family and not more than one couple. Hours per week have to be between 20 and 80. Hours per year have to be at least 240. Weeks worked per year have to be at least 20. The minimum real wage per hour is $1.

B.3 CEX

For the expenditure distribution, we use data provided by Aguiar and Bils (2015) from the CEX. This data does not go back to 1950, so we only consider 2010. To increase the sample size, we consider years 2008 to 2010, again restricting the sample to household heads aged 25 to 60 and a minimum household income of $5,000 (in 2016 dollars). We scale household expenditure by dividing by the square root of family size.

For cross-sectional consumption patterns, we map 20 expenditure categories into three sectors, following Comin, Lashkari, and Mestieri (2021) whose classification is consistent with Herrendorf, Rogerson, and Valentinyi (2013), from which we take aggregate sector shares. Agriculture includes food at home. Goods include vehicle purchasing, leasing, insurance; alcoholic beverages; all other transportation; men's and women's clothing; shoes and other apparel; furniture and fixtures; appliances, phones, computers with associated services; children's clothing; personal care; tobacco, other smoking. Services include housing; utilities; health expenditures including insurance; food away from home; entertainment equipment and subscription television; entertainment fees, admissions, reading; domestic services and childcare; education; cash contributions (not for alimony/support).

C Model Quantification Appendix

C.1 Dynamic Model: Quantification

Table C.1 compares 2010 expenditure shares on agriculture, goods, and services in the cross-section, reporting sectoral expenditure shares by income quintile. Note that the calibrated model is consistent with aggregate sector shares, which do not line up perfectly with the aggregate sectoral shares implied by the CEX: the aggregate service share is 66% in NIPA but only 60% in the CEX. Thus, the model-implied sectoral expenditure shares on average differ from their data counterparts by a few percentage points. This being said, the distribution of sectoral expenditure shares in the model is broadly aligned with the data. In particular, the model captures well the fall across quintiles in the share of necessities, as captured by agriculture. Instead, the model overstates the increase in the share of services across quintiles. This discrepancy may arise from the fact that the model features a Pareto tail of the income distribution which may not be well measured in the CEX.

Table C.1: Sectoral Expenditures by Income Quintiles

	Model				
	Q1	Q2	Q3	Q4	Q5
Agriculture	11.1%	10.7%	8.6%	7.6%	4.9%
Goods	28.7%	29.1%	27.4%	26.4%	22.4%
Services	60.2%	60.2%	64.1%	66.0%	72.7%
	Data				
	Q1	Q2	Q3	Q4	Q5
Agriculture	14.1%	12.1%	10.9%	10.4%	9.1%
Goods	28.5%	29.8%	30.1%	29.2%	29.1%
Services	57.4%	58.1%	59.0%	60.5%	61.8%

Notes: Table C.1 compares the cross-sectional expenditure shares on different commodities in 2010 across model and data.

Table C.2: Labor Supply by Wage Quintiles

1950	Q1	Q2	Q3	Q4	Q5
Data	0.340	0.317	0.303	0.297	0.287
Model	0.315	0.309	0.315	0.326	0.349
2010	Q1	Q2	Q3	Q4	Q5
Data	0.287	0.298	0.303	0.303	0.309
Model	0.276	0.282	0.293	0.309	0.339

Notes: Table C.2 shows labor supply along the wage distribution. 40 hours are normalized to 0.3.

Table C.2 compares labor supply in model and data across wage quintiles for both 1950 and 2010, using data from the Census and ACS.

C.2 Static Model: Quantification

Table C.3 shows the expenditure distributions in the static and the dynamic model.

Figure C.1 shows the optimal average $t\&T$ rates schedule in the static model for three cases, the 1950 inverse optimum, a counterfactual economy with only a rise in inequality, and the 2010 economy with rising inequality and growth.

Table C.3: Expenditure Distribution in the Dynamic and the Static Model

1950	**Expenditure** Share by Quintile				
Dynamic model	8%	13%	17%	23%	39%
Static model	9%	13%	17%	23%	38%
2010	**Expenditure** Share by Quintile				
Dynamic model	7%	11%	16%	21%	45%
Static model	7%	12%	16%	23%	43%

Notes: Table C.3 compares the expenditure distributions in the static and the dynamic model.

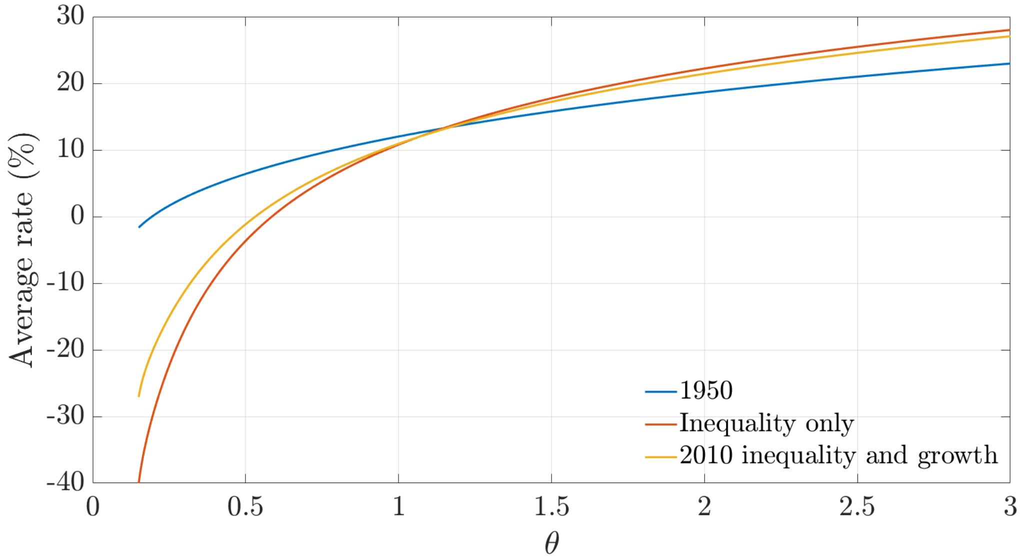

Figure C.1: Optimal Average Rates in the Static Model

Notes: Figure C.1 shows the optimal average $t\&T$ rates schedule in the static model for three cases, the 1950 inverse optimum, a counterfactual economy with only a rise in inequality, and the 2010 economy with rising inequality and growth.