The evolution of wealth inequality over half a century: the role of skills, taxes and institutions

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Abstract

Over the last 50 years, the US economy saw significant changes in its fiscal structure. Notable among these are the introduction and expansion of social security programs and Medicare, and the transformation of the tax system. These institutional changes took place against a backdrop of developments in the technology of production that increasingly favored skilled workers. In this paper, we analyze how the interplay between these institutional and technological factors might have shaped the distributions of income, wealth, consumption and welfare. We find that while changes in income inequality are mostly attributable to technological factors, the increase in wealth inequality has further been compounded by the expansion of social security and Medicare, which have reduced saving incentives for retirement, in particular for low and middle income groups. As a result, they have substantially increased wealth concentration in US. A simulation of the transition of the U.S. economy from the stationary state associated to institutions in 1960 to the one associated to institutions in 2010 shows that the effect of social security on wealth inequality accounts for about a quarter of the increase in the top 1% wealth share up to 2010 and is concentrated in the 1960s and 1970s. Subsequently, wealth inequality is mostly driven by rising wage dispersion. The transition analysis also shows that top wealth shares converge slowly to their steady state values. As a result, the increase in wage dispersion, which is concentrated between 1970 and 1995, continues to affect wealth inequality for several decades, so that the top 1% wealth share keeps increasing beyond the year 2010.

J.E.L. Codes: E32, J31, J41

Keywords: Wealth Inequality, Income Inequality, Social Security, Medicare, Tax Progressivity, Skill-biased Technical Change, Top 1%, Saving

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1 Introduction

Over the last 50 years, the US economy experienced a notable increase in income and wealth inequality. The discussions regarding the causes and consequences of these trends are at the forefront of academic and public debate. An important element of the debate has been the relative roles of market-based explanations and institutional factors. In this paper, we aim to contribute to this debate by evaluating the impact of changes in the US tax and transfer policy on wealth inequality.

Following a long secular reduction, wealth inequality began to increase during the second half of the 20th century. Using capitalization methods based on extensive data from tax records, Saez and Zucman (2014) report a dramatic increase in wealth concentration since 1970. The share of the wealthiest 1% increased from 27.6% in 1970 to 41.8% in 2012. A similar, but a more nuanced picture appears in the data from Survey of Consumer Finances, where the share of the wealthiest 10% increased from 67% in 1983, the earliest year available, to 75% in 2013.[1]

The US economy went through several institutional and technological changes during this period that could potentially explain the rising wealth dispersion observed in the data. A series of changes in US tax regulations rendered the tax system less progressive over the course of 50 years Piketty and Saez (2007). Kaymak and Poschke (2015) show that reductions in corporate and estate taxes, in particular, have made a modest contribution to the rise in wealth inequality. However, the changes in tax policy have to be analyzed in connection with the corresponding changes in transfer policy. During the same period, the share of transfer payments in GDP increased from 4.1% to 11.9%. The rise in the transfer spending was driven by two major programs: Social Security and Medicare, both of which target senior citizens. By subsidizing income and healthcare expenditures for the elderly, these programs alleviate the incentives to save for retirement, a major source of wealth accumulation over the life-cycle. Furthermore, since both programs are means-tested by design, they have a stronger effect on the savings of low and middle income groups. By contrast, those at the top of the income distribution have little to gain from these programs. We argue that the redistributive nature of transfer payments has been

[1]The two data sources disagree on the exact source of the increase in the concentration ratios: the SCF shows that the increase in wealth inequality was driven primarily by those in 90th to 99th percentile of the wealth distribution, therefore excluding the top 1%, while the tax records attribute the higher wealth inequality to rise in the wealth holdings of top 0.1% of the distribution (See Kopczuk (2015) for a discussion of different methods and data sources). In our quantitative analysis we utilize the figures in Saez and Zucman (2014) to calibrate our model for 1960 as data are not available in the SCF prior to 1983.

instrumental in curbing wealth accumulation for income groups outside the top 10% and, consequently, amplified the wealth concentration ratios in US.

While changes in both taxes and transfers might have increased the share of wealth held by the wealthiest, distinguishing between the two is crucial for understanding the potential implications of rising wealth inequality for welfare. A less progressive tax system raises the dispersion of disposable income, and, hence, consumption, whereas larger transfers redistribute disposable income, reducing consumption inequality. Whether public policy circles should be alarmed by the rising dispersion in wealth holdings therefore depends critically on its underlying causes.

The changes in the US fiscal policy took place against a backdrop of developments in the production technology that increasingly favored skilled workers, resulting in an increased dispersion of wages. It is also plausible that higher wage inequality led to increased inequality in earnings, income and wealth. Nonetheless, the wealth distribution is not a mere translation of the earnings distribution, but is a result of its interaction with tax and transfer policies, which shape savings and labor supply behavior. Our objective is, therefore, to link these developments and provide a quantitative evaluation of the role of institutional and technological factors in the evolution of wealth distribution since 1960. Our second objective is to gauge the implications of these changes for welfare, taking into account the implied transitional dynamics.

We conduct our analysis using a dynamic model of consumption and savings with uninsurable idiosyncratic income risk and endogenous labor supply building on Aiyagari (1994); Bewley (1986); Huggett (1993). We make two modifications to the standard model. First, in the spirit of Castañeda, Díaz-Giménez, and Ríos-Rull (2003), we combine dynastic and life-cycle elements of decision-making at the household level: households in the model go through the life-cycle stages of work, where they face idiosyncratic income risk, and retirement, where they live off their pension income and private wealth. Upon death, they are replaced by their descendents, towards whom they are perfectly altruistic. Second, we introduce a persistent but rarely visited state of nature where an individual has very high productivity. These modifications allows us to generate realistic patterns of income and wealth distributions by combining three fundamental motives for wealth accumulation: a precautionary savings motive to insure against life-cycle income risk, a consumption smoothing motive to save for retirement, and a bequest motive to endow estates for their offsprings. While all households experience all three saving motives, their strength will depend on a household's productivity and wealth.

We augment this setting by detailed modeling of transfers and taxes. While working, households pay progressive income taxes (including payroll taxes) and consumption taxes. The government also levies corporate income taxes. Transfers of estates are subject to estate taxes. We model all of these taxes in a way that closely resembles taxes in place in the United States. Retired households receive a pension that is linked to past earnings with actual social security benefit formulas, and a fixed transfer representing benefits that are common across retirees, such as Medicare. This transfer system is financed by taxes in a pay-as-you-go way. In their labor supply and saving choices, households react to taxes they face, and take into account benefits they will receive in the future.

We calibrate the model to match the life-cycle and intergenerational transitions in earnings as well as the overall income and wealth distributions in the 1960s. We then change the parameters that govern the tax and transfer policies as well as the distribution of labor productivity in line with the observed changes in the US economy since then. In particular, we introduce a rising cross-sectional dispersion of labor efficiency, expand social security, and reduce corporate income taxes, estate taxes, and the top marginal income tax rate. After introducing these changes, we compute both the stationary equilibrium implied by the 2010 parameters, and the transition to this new stationary equilibrium. We find that, with few exceptions, the model closely matches the distributions of income and wealth in the US economy along the transition and in 2010. This is particularly remarkable for the wealth distribution, since no information on its evolution was used in the calibration of the "2010" steady state or the transition path.

To gauge the contribution of each change separately, we return to the 1960 economy and introduce each change individually, simulating counterfactual transition paths for economies where only a single change (reduced taxes, increased benefits, or larger wage dispersion) occurred. This allows us to determine for which fraction of the overall change each element accounts, and allows us to discern potential interactions between changes in institutions and technology.

We find that while changes in income inequality are almost entirely attributable to changes in the return to skill, the increase in wealth inequality has further been compounded by the expansion of social security and Medicare. As conjectured above, expanding social security and introducing Medicare in the model reduces saving incentives of the bottom 90% of the wealth distribution strongly, while the effect on saving rates at the top of the wealth distribution is barely discernible. The reason is that transfers have increased by a large amount relative to incomes of the bottom 90%, with a replacement

rate that increased from around 30% to three quarters, while they have remained very small compared to incomes of the wealthy. Similarly, they account for only a small fraction of income of wealthy retirees. As a result, changes in transfers hardly affect saving of the wealthy. At the same time, reduced saving by the wealth-poor implies that their share of the distribution of private wealth shrinks, and the share of the wealthiest groups grows. As a result, the expansion of transfers can account for a quarter of the increase in the top 1% private wealth share between 1960 and 2010, and for most of its increase generated by the model for the 1960s and 1970s. Since saving reactions within the bottom 90% are much less heterogeneous, other measures of wealth inequality that focus on inequality throughout the distribution, like the Gini coefficient of the wealth distribution, increase much less.[2]

Although increased transfers reduce saving, they nonetheless lower inequality of income between workers and retirees. The reason for this is that transfer receipts more than make up for reduced capital income for retirees. As a consequence, the expansion of transfers is linked to a substantial decline in the Gini coefficient of the income distribution in the entire population, while it hardly affects the Gini coefficient among workers.

Compared to transfers, changes in taxes have a minor effect on top wealth shares. They even reduce the top 1% share. This occurs because observed tax changes stimulate saving by the top 1-10% more than saving by the top 1%. This result is in line with our earlier findings (Kaymak and Poschke, 2014).

Increasing wage inequality, in contrast, accounts for a large portion of the change in wealth concentration, and also for the entirety of changes in the income distribution. When considering the entire population, this last change is almost fully compensated by larger benefits.

The analysis of transition paths allows us to attribute changes in wealth inequality in specific periods to specific causes. In this vein, we find that initial increases in wealth inequality were substantially due to larger transfers, while increasing top wealth shares since 1980 were mostly driven by larger wage dispersion. We also find that the convergence of the wealth distribution to its new stationary state is slow. Even for small changes

[2]The model predicts a slightly increasing top wealth share in the 1960s and 1970s due to the expansion of social security. It thus fails to match the observed decline in the top 1% wealth share in these two decades, the only periods since World War II when this share declined. Arguably, this observed decline may have been driven by a set of unmodelled factors: the oil price shocks, the 1973-74 stock market crash, and high levels of inflation. The model thus suggests that without the expansion of social security, top wealth shares would have declined even more in this period.

in the environment, it takes thirty years to complete eighty percent of the transition, and the entire transition takes longer than fifty years. The transition is even longer for larger changes. Consequently, the model predicts that the effects of increasing wage dispersion from the 1970s through the early 1990s are not yet completely reflected in the 2010 wealth distribution. The top 1% wealth share in the model increases beyond the year 2010, rising by an additional seven percentage points over the next thirty to forty years.

There is a substantial literature on the effect of tax reforms. We highlight a few closely related studies using quantitative macro models. Using a similar setup, Castañeda, Díaz-Giménez, and Ríos-Rull (2003) find that reducing a flat estate tax from 17% to zero results in slight increases of top wealth shares (including the top 1%) and in the capital stock. Their analysis of a hypothetical tax cut does not address the non-linearity of the cut that actually occurred, and does not consider its interaction with the contemporaneous increase in wage inequality. Cagetti and de Nardi (2009) also analyze abolition of the estate tax, and focus on its differential effect on the investment decisions of large and small firms. Domeij and Heathcote (2004) study the welfare implications of reducing the capital income tax from 40% to zero. They do not focus on matching the top of the wealth distribution, nor do they report how it changes with the tax experiment. Several recent papers focus on the taxation of top income earners more specifically: Badel and Huggett (2014), Brüggemann and Yoo (2014), Guner, Lopez Daneri, and Ventura (2014) and Kindermann and Krueger (2014) all explore what the optimal marginal tax rate on income of the top 1% income earners should be. Given their focus on income taxes, they consider neither changes in estate or corporate income taxes, nor the role of changing wage inequality or social security. Finally, on the empirical side, Mertens (2013) finds using U.S. time series data that changes in top marginal income tax rates have substantial effects on top income shares. His analysis does not consider corporate income or estate taxes nor wealth inequality, and is therefore complementary to ours.

The literature on increasing wage inequality is similarly large. Here, we only highlight a small number of papers analyzing the effect of increasing wage inequality on other economic outcomes. Notably, Heathcote, Storesletten, and Violante (2014a) analyze the effect of increasing wage inequality on trends in the inequality of hours worked, earnings, consumption, and welfare, but not on wealth inequality. Heathcote, Storesletten, and Violante (2014b) provide results on how optimal progressivity of income taxes responds to changes in the size of uninsurable idiosyncratic productivity shocks, but analyze neither social security and the taxation of estates and corporate income, nor the effect of taxes on

wealth inequality.

Finally, there also is a substantial literature on social security. Since this literature is too large to do justice to here, we only mention a few studies focusing more specifically on risk and inequality: For instance, Conesa and Krueger (1999) analyze how uncertainty about wages affects the insurance role of social security, Huggett and Ventura (1999) analyze the distributional effects of a proposed social security reform, and Deaton, Gourinchas, and Paxson (2002) analyze how social security affects consumption inequality. All of these studies (except for Conesa and Krueger (1999)) compare stationary equilibria, and none of them focusses on wealth inequality.

In what follows, we first provide a brief discussion of the US tax and transfer system in the post-WW II period. Section 3 presents the model and Section 4 explains the calibration of the model parameters. Section 5 explores how well the model fits the US economy in 1960. [Sections 4 and 5 are in progress and for the moment draw closely on our earlier work (Kaymak and Poschke, 2014).] The main findings are reported in Section 6 and 7. In Section 6, we use counterfactual simulations of stationary equilibria to evaluate the impact of social security, rising wage inequality and tax changes on the economy. Section 7 reports results on the simulated transition dynamics from 1960 to 2010. Section 8 concludes.

2 Changes in transfers to seniors and in the US tax system

This section gives a brief overview over changes in transfers to the elderly (social security and Medicare) and in the tax system in the United States. We pay particular attention to how these changes affected different income and wealth groups differently.

2.1 Transfers to the elderly: Social Security and Medicare

Over the period 1960 to 2010, there have been two major developments in policies that are targeted at senior citizens: the expansion of the social security system, and the introduction and expansion of Medicare. We argue that these programs have discouraged wealth accumulation by low and middle income groups. Figure 1 shows the share of each component relative to GDP since 1940. The foundations of the current social security system were legislated by the Congress in 1935. The Social Security Administration started collecting payroll taxes to establish its funds in 1937, and first regular benefit payments

began in 1940. The following couple of decades saw several amendments to the law that expanded the coverage of workers under the program. By 1960, close to 90% of the civilian workforce was covered under the social security program, and about 75% of seniors collected benefits in some form. Therefore, the rise in benefits payments relative to GDP between 1940 and 1960 is largely attributable to the expansion of coverage.

During the 1970s, the program went through a second phase of expansion not in coverage of persons but in terms of generosity of benefits. The 1972 legislation introduced automatic adjustments based on wage and price inflation and introduced the supplemental security plan for seniors who had little or no source of income (largely because they worked outside the social security system). These changes led to a sharp increase in transfer payments relative to the GDP until the 1980s, when amendments to automatic adjustment policies stabilized the benefit payments relative to output.

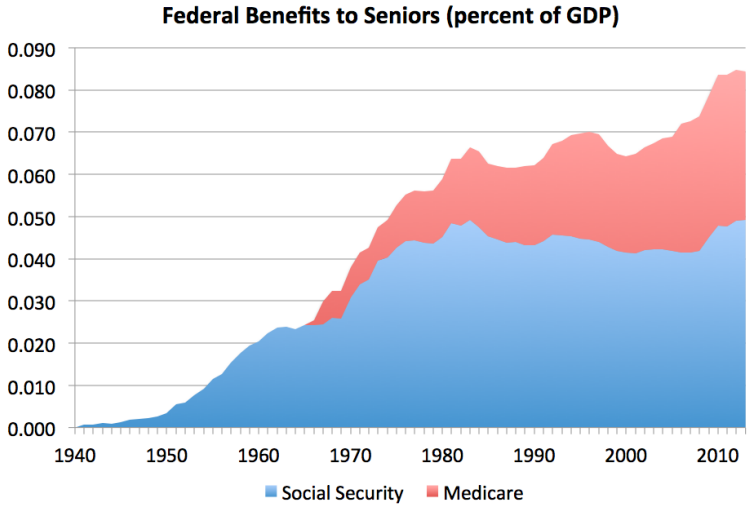


Figure 1: Federal benefits to seniors (percent of GDP)
Source: NIPA.

While the share of seniors in the total population has been steadily rising in the US, the rise in social payouts is not explained by demographic changes. Figure 2 shows the real average payout per beneficiary since 1950 under the two major programs. So-called insurance payments, which constitute the bulk of total payouts, have increased three-fold over the course of 60 years. The increases early on after the inception of the program are driven partly by larger entitlements as workers retired having contributed into the system for a longer period and partly due to sporadic raises in benefit amounts legislated by Congress. A third factor that contributed to the rise in real benefits was real average

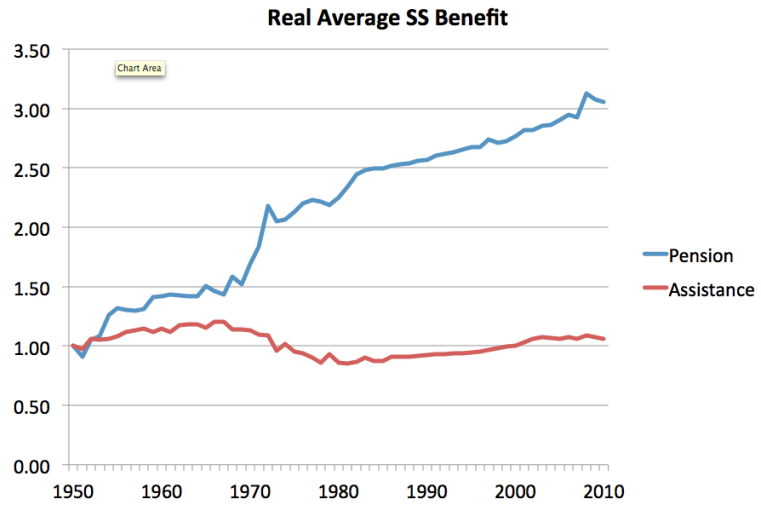
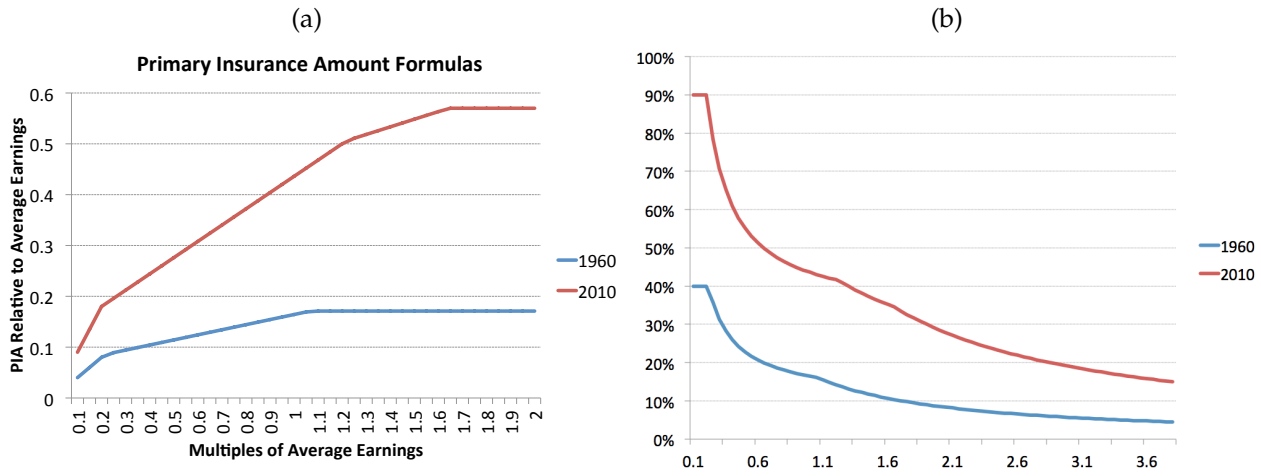


Figure 2: Real average social security benefit (1950=1)
Source: SSA.

growth after the Second World War that lasted until the early 1970s. Even though real wages were stable during the following years, the impact on real benefits lingered for several decades since benefit amounts are calculated based on a worker's entire earnings history and, therefore, workers who contributed to the social security fund during the 1950s and 1960s retired with increasingly higher benefits.

In addition to the growth in the size of the social security program, the formulas that link social insurance benefits to one's earnings history have traditionally been redistributive, and have evolved to be more progressive over the years. Figure 3a compares the initial Simplified Old Start Formula that was used until 1958 with the current formula adopted by the SSA. Each formula determines the monthly benefit amount as a function of average (allowable) earnings during a worker's career. Both variables are expressed relative to average earnings to maintain comparability. Both formulas yield piecewise linear functions with a cap on benefits for those with higher earnings. Figure 3b shows the implied replacement rates (obtained by dividing the value on the vertical axis by the value on the horizontal axis). The fact that the replacement rate is a decreasing function of income shows the redistributive nature of the formulas. From 1960 to 2010, the replacement rate for a worker with average earnings has increased from 16% to 44%. However, the increase in the replacement rate has been asymmetric across the earnings distribution. While the replacement rate for the lowest earnings groups increased from 40% to 90%, that for a worker with three times average earnings only increased from 6% to 19%.

Figure 3: Benefit Calculation Formulas



Source: Authors' calculations based on the Social Security Handbook and the 2013 Bulletin of the SSA.

In 1960, such a worker would have been at the 90th percentile of the earnings distribution. For comparison, in 2010, a worker at the 90th percentile of the earnings distribution has four times average earnings.

The second largest program that primarily targets senior citizens is Medicare, which is a national health insurance program.[3] It was started in 1966, and expanded greatly both in coverage and benefits since then. Currently, federal expenditures on Medicare stand at around 4.3% of GDP.

Both the heterogeneous changes in replacement rates and the fixed nature of benefits from other expanding programs such as Medicare imply that changes in transfers affect the saving incentives of workers with different levels of income and wealth differently. Clearly, the expansion of the social security replacement rate to 90% for a very low-income worker will strongly affect that worker's saving incentive; much more so than the moderate expansion seen for high-income workers. As a consequence, the expansion of transfers can lead to shifts in the wealth distribution. Next, we briefly describe changes in the tax system over the last 50 years.

[3]Medicare also contains a disability insurance component starting in 1973, which currently constitutes 19% of all beneficiaries.

2.2 The US Tax System

The US tax system went through several changes in the last 50 years that particularly benefited the top income groups. The two major components of this transformation are reductions in taxes imposed on corporations and on the transfer of large estates. Figure 4 shows that from 1960 to 2010, total revenue from each of these taxes expressed as a share of GDP declined by about half. In the case of corporate taxes, the decline resulted both from more generous allowances for depreciation expenses and from lower marginal tax rates. The statutory tax rate on corporate income declined from 52% in 1960 to 35% in 2010. A similar pattern is seen in the effective marginal taxes on corporate income, which take into account tax exemptions and allowances and therefore are usually lower than the statutory rate. Gravelle (2004) and Gravelle (2014) report that the average effective marginal tax rate on corporate profits declined from 42.0% in 1960 to 23.6% in 2010.

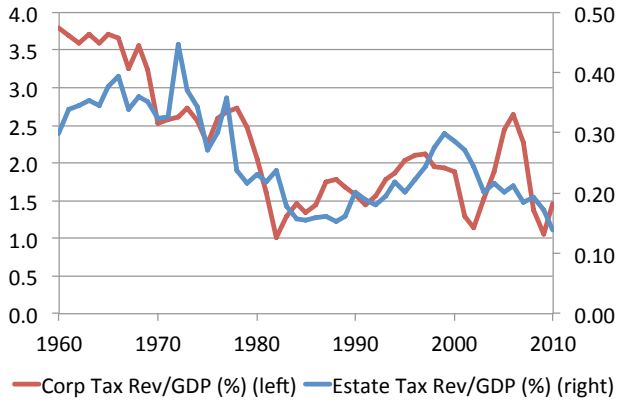
For estate taxes, the decline in revenues stems from a combination of an increase in the exemption level and lower top marginal tax rates. The exemption level in 1960 was 60 thousand dollars, or approximately 1.7 times average wealth then, whereas in 2010, the exemption level was as high as 5 million dollars, or approximately 10 times average wealth. As shown in Figure 5, marginal rates also declined, with the top marginal rate declining from 77% in 1960 to 35% in 2010. As a consequence, marginal estate tax rates dropped by about 30 percentage points for estates corresponding to percentiles 10 to 0.6 of the wealth distribution, and by a variable but large amount at the very top of the distribution. In the analysis below, we will use the estate tax schedules exactly as depicted in Figure 5.

Since ownership of corporate assets and wealth is highly concentrated in the hands of the top income groups, this change benefited them the most. In their survey of tax records, Piketty and Saez (2007) find such redistributional effects of corporate and estate tax cuts across different income groups. Figure 6 shows the average effective tax rates by income for 1970 and 2004 as reported in their paper.[4] The average tax rate for all taxpayers was 23.4% in 1970 and 23.3% in 2004. The average tax rate remained similar for the bottom 99% of the income distribution, while it decreased substantially for all groups in the top 1% category. The magnitude of the drop in average tax rates varies between 4.8 percentage points for those between 99th and 99.5th percentiles and 39.9 percentage points for the top 0.01 percent.

[4]Note that corporate and estate taxes paid do not appear on individual income tax returns. Therefore,

Figure 4: Corporate and Estate Taxes: 1960 - 2010

(a) Tax Revenue / GDP



(b) Tax Rates and Exemption Levels

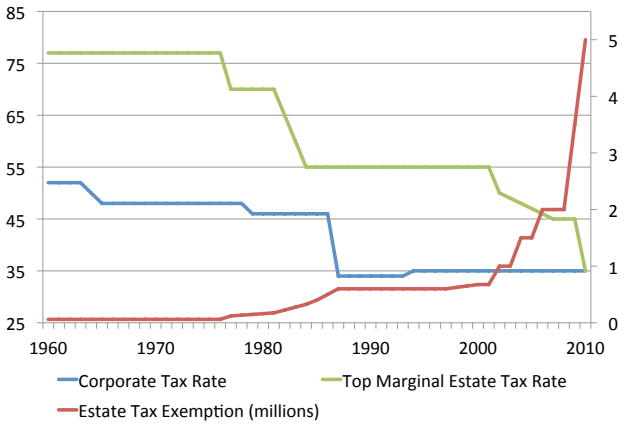
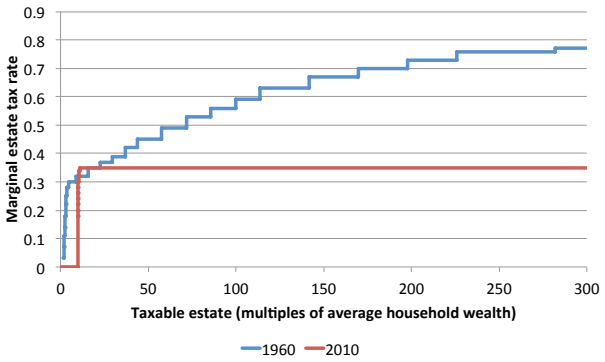


Figure 5: The Estate Tax Schedule, 1960 and 2010

(a) Marginal Estate Tax Rate by Size of Estate



(b) Closeup of Rates for Bottom 99.9% of Wealth

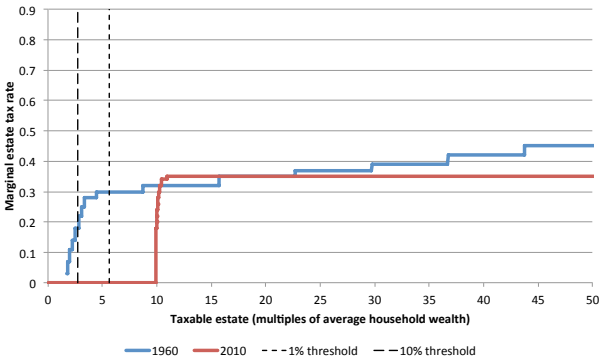
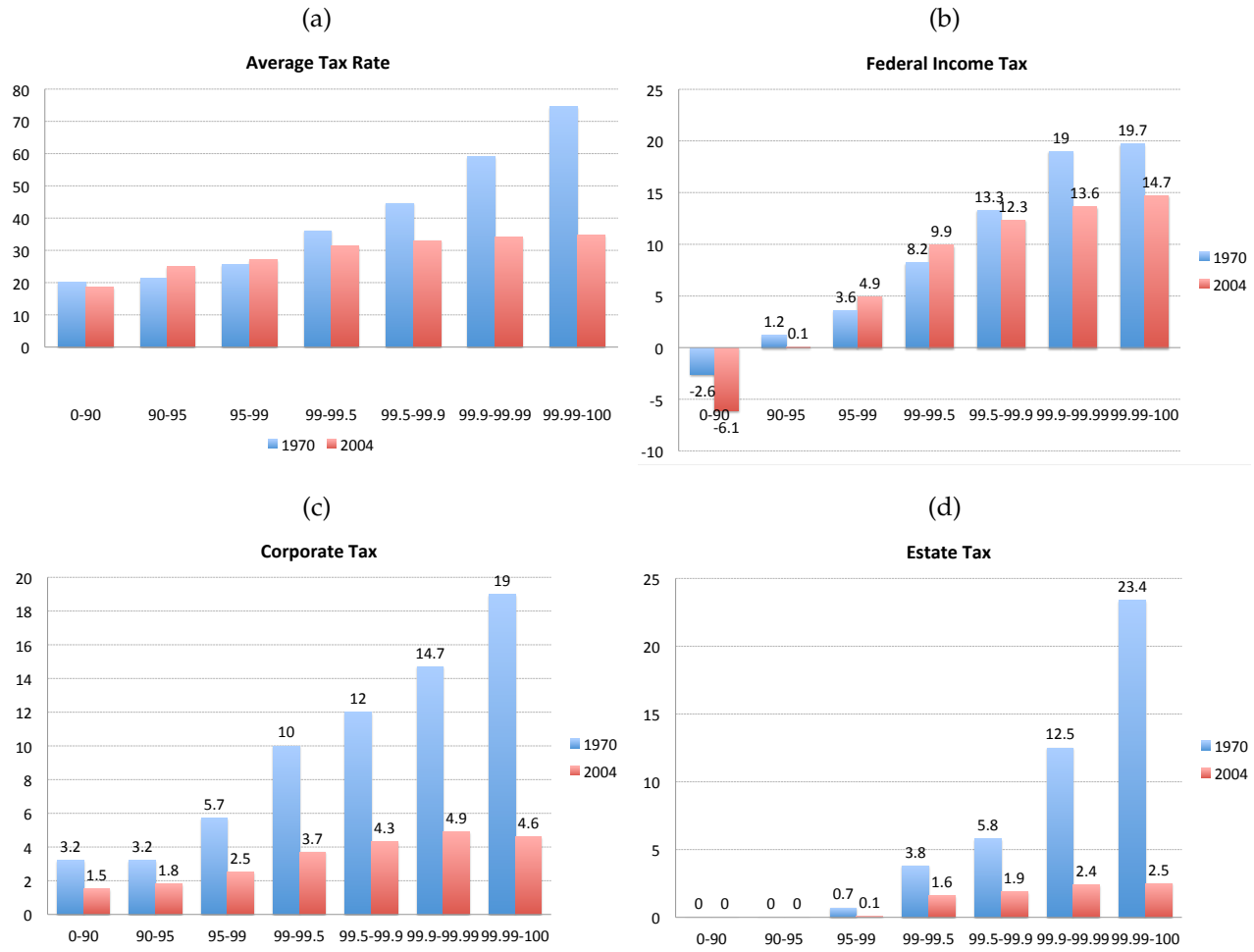


Figure 6: Average Federal Tax Rates by Income Groups



Note: The data for tax rates come from Piketty and Saez (2007).

The main source of the reduction came from lower taxes on corporate income and transfer of estates. The reductions from these two sources add up to a 8.5 percent decline in the average tax rate applied to incomes between 99th and 99.5th percentiles and a 35.3 percent decline for the top 0.01 percent. Despite the remarkable decline in the statutory marginal tax rates applied to highest income earners, changes in the personal income tax code contributed little to the decline of the tax progressivity. This is because the very high rates, such as the 90% top statutory marginal tax rate, were paid by only a handful of households. Panel (b) in Figure 6 shows that the decline in the individual income tax on top groups was much more modest, and concerned only the top 0.5% of the income distribution.

3 Model

Our analysis requires a model featuring income and wealth heterogeneity and retirement. We therefore employ a modified version of the neoclassical dynamic stochastic general equilibrium model with uninsurable idiosyncratic income risk (Aiyagari, 1994; Bewley, 1986; Huggett, 1993), combined with a demographic structure that closely resembles Castañeda, Díaz-Giménez, and Ríos-Rull (2003). In this economy, we include a broad set of taxes and social security, modeled to closely reflect how these institutions operate in practice.

The economy consists of a continuum of heterogeneous households, a representative firm, and a government. Households form dynasties: each one is replaced by a descendant upon death. New entrants to the economy inherit an estate from their parents and start their working life. While working, they face a constant probability of retirement μ_r. Once retired, they still make consumption and savings choices, but cannot work anymore. Retirees die with a constant probability μ_d. Upon death, they are replaced by a descendant who inherits their estate. Let the proportion of retirees in the economy be M_1, and let $\mathcal{R}$ be one for retirees and zero for workers.

At any point in time, a continuum of agents of measure 1 is alive, each endowed with individual-specific capital k and labor skill z. With these endowments, agents can generate a pre-tax income of $y = zwh + rk$, where w is the market wage per skill unit, $h \in [0, 1]$ is hours worked and r is the interest rate net of depreciation. Retirees do not work and receive a fixed social security benefit $\omega(z, \mathcal{R})$, described in detail below, which

Piketty and Saez (2007) impute these taxes to different income groups.

depends on their pre-retirement labor skill.

Private income from labor, savings and social security, corporate income and estates are subject to a detailed tax system, outlined below. Consumption is subject to a proportional sales tax. The government uses tax revenue to finance an exogenous stream of expenditure G. Let the disposable income of an agent net of all types of income taxes be y^d. This depends both on total income and on capital holdings, due to the different tax components. Agents can allocate their resources between consumption and investment in capital. This capital stock constitutes savings for an individual, and becomes the estate that is passed on to a descendant in case of death. To rule out negative bequests, agents cannot borrow. Let x denote an agent's beginning-of-period capital holdings, before paying potential estate taxes due on an inheritance, and k the capital holdings after paying any estate tax. Capital depreciates at a rate δ between periods.

A worker's labor skill z follows a first-order Markov process $F_0(z'|z)$. A descendant enters the economy with her/his own labor skill, which is drawn from a *cdf* $F_1(z'|z)$. The distribution of skill upon labor market entry thus depends on parents' pre-retirement skill.

Agents value consumption, and they dislike work. They care about their welfare as well as about their offspring's, discounting future utility using a constant discount factor $\beta \in (0,1)$. The problem of an agent then is to choose labor hours, consumption and capital investment to maximize expected discounted utility of the entire dynasty. In doing so, agents take the wage rate, the interest rate and the aggregate distribution of agents over wealth and productivity, denoted by Γ, as given. Let Γ_0 be the distribution for workers, Γ_1 that for retirees, and let $\Gamma' = H(\Gamma)$ describe the evolution of the distribution over time. The Bellman equation for a consumer's problem then is

$$V(k,z,\mathcal{R};\Gamma) = \max_{c,x\geq 0,\ h\in[0,1]} \left\{ \frac{c^{1-\sigma}}{1-\sigma} - \theta\frac{h^{1+\epsilon}}{1+\epsilon} + \beta\mathbb{E}[V(k',z',\mathcal{R}';\Gamma')|z] \right\} \tag{1}$$

subject to

$$\begin{aligned} c(1+\tau_s) + x &= y^d(wzh, rk, \omega(z,\mathcal{R})) + k, \\ k' &= x - E(x,\mathcal{R},\mathcal{R}'), \\ \Gamma' &= H(\Gamma), \end{aligned}$$

where the expectation is taken over retirement and survival risk and skill transition risk,

for both survivors and entrants. $E(x, \mathcal{R}, \mathcal{R}')$ denotes the estate tax liability, where x is the estate. The estate tax is zero except for entrants, i.e. unless $\mathcal{R} = 1$ and $\mathcal{R}' = 0$. For retirees, the labor supply choice is fixed at zero. Only retirees receive social security benefits $\omega(z, \mathcal{R})$.

The representative firm produces output Y using aggregate capital K and effective labor N. Its technology takes the Cobb-Douglas form $F(K, N) = AK^{\alpha}N^{1-\alpha}$. Factor markets are competitive, and firms are profit maximizers.

A *competitive equilibrium* of the model economy consists of a value function, $V(k, z, \mathcal{R}; \Gamma)$, policy functions for saving and labor supply, $x(k, z, \mathcal{R}; \Gamma)$ and $h(k, z, \mathcal{R}; \Gamma)$, a wage rate, $w(\Gamma)$, an interest rate $r(\Gamma)$, and an evolution function $H(\Gamma)$ such that:

1. Given $w(\Gamma)$, $r(\Gamma)$ and $H(\Gamma)$, $V(k, z, \mathcal{R}; \Gamma)$ solves the consumer's problem defined by (1) with the associated policy functions $x(k, z, \mathcal{R}; \Gamma)$ and $h(k, z, \mathcal{R}; \Gamma)$.

2. Factor demands are given by the following inverse equations:

$$\begin{aligned} r(\Gamma) &= \alpha A(K/N)^{\alpha-1} - \delta \\ w(\Gamma) &= (1-\alpha)A(K/N)^{1-\alpha} \end{aligned}$$

3. Markets clear:

$$\begin{aligned} K' &= (1 - M_1) \int x(k, z, 0; \Gamma) d\Gamma_0(k, z) + M_1 \int [x(k, z, 1; \Gamma) - \mu_d E(x, 1, 0)] d\Gamma_1(k, z) \\ N &= \int z h(k, z, \mathcal{R}; \Gamma) d\Gamma(k, z). \end{aligned}$$

4. $H(\Gamma)$ is consistent with $F_0(z'|z)$, $F_1(z'|z)$, μ_r, μ_d, the savings policy $x(k, z, \mathcal{R}; \Gamma)$ and the estate tax system.

5. The government budget is balanced:

$$\begin{aligned} G + M_1 \int \omega(z, \mathcal{R}) d\Gamma_1(k, z) = &\int [y - y^d(\cdot)] d\Gamma(k, z) + \mu_d M_1 \int E(x, 1, 0) d\Gamma_1(x, z) \\ &+ \tau_s \int [y^d(\cdot) + k - x(\cdot)] d\Gamma(k, z). \end{aligned}$$

A *steady-state* of the economy is a competitive equilibrium where the distribution of agents is stationary, i.e. $\Gamma^{ss} = H(\Gamma^{ss})$.

4 Calibration

The economy is calibrated in two steps. First, we choose a set of parameters based on information that is exogenous to the model. Then, we calibrate the remaining parameters so that the model economy is consistent with a set of relevant aggregate statistics of the U.S. economy and the empirical distributions of income and wealth in 1960. We then introduce changes in the tax system, in social security, and in the distribution of labor productivity observed in the U.S. since 1960 to analyze the relative role of tax cuts in understanding rising economic inequality. In doing so, we treat both 1960 and 2010 as stationary states.

The calibration of the 1960 economy is broadly consistent with the standard for quantitative models with idiosyncratic labor income risk. However, we make two modifications in the spirit of Castañeda, Díaz-Giménez, and Ríos-Rull (2003) so that the model economy features realistic income and wealth distributions with high concentrations at the top. First, we augment the standard stochastic processes for labor productivity estimated from survey data by allowing households a small chance of reaching an extraordinarily high labor productivity level. Second, we introduce a stochastic life cycle, where households retire and die probabilistically, and allow for a correlation in labor productivity levels across generations.

4.1 Technology

The level of the production technology, A, is normalized to 1. Capital's share in income, α, is set to 0.36. Given the calibration target for the annual interest rate of 4.1%, the annual depreciation rate is set to 7.9%, which ensures that the ratio of capital stock to aggregate income in 1960 is 3.

4.2 Demographics and Income Process

The demographics and the income process are jointly governed by the transition matrices described below:

$$\Pi = \left[\begin{array}{c|cc} & z_W & z_R \\ \hline z_W & \Pi_{WW} & \Pi_{WR} \\ z_R & \Pi_{RW} & \Pi_{RR} \end{array}\right]$$

where z_W is a vector of labor productivity levels for a working household. The idiosyncratic labor income risk during employment is governed by the matrix Π_{WW}. The transitions from work to retirement is governed by Π_{WR}. We assume that, each period, all workers face a fixed probability of retirement, μ_r. As a result Π_{WR} is a diagonal matrix with μ_r along the diagonal. We set $\mu_R = 1/45$ to obtain an average career length of 45 years. Once retired, households face a constant death probability μ_d. Consequently, Π_{RR} is a diagonal matrix with $1 - \mu_d$ along the diagonal. We set $\mu_d = 1/15$ to obtain an average retirement duration of 15 years. When a household dies, it is replaced by a working age descendant. The intergenerational transition in labor productivity is governed by Π_{RW}.

We assume that the vector $z_W = [z_j]$ contains 6 distinct values in increasing order of which $\{z_1, .., z_4\}$ are ordinary states and $\{z_5, z_6\}$ are extraordinary states reserved for exceptionally high earnings levels that are commonly censored in the survey data. The ordinary levels of productivity consist in combinations of two components: a permanent component, $f \in \{f_H, f_L\}$, that is fixed over a household's lifespan, and a random component, $a \in \{a_L, a_H\}$. Let $F = [F_{ij}]$ and $A = [A_{ij}]$ with $i, j \in \{L, H\}$ be 2-by-2 transition matrices associated with the two components f and a. With this formulation, idiosyncratic fluctuations in labor income risk along the life cycle are captured by A, and those across generations by F. The following matrices summarize the stochastic labor productivity process over the life cycle and across generations.

$$\Pi_{WW} = \left(\begin{array}{c|cccccc} & f_L + a_L & f_L + a_H & f_H + a_L & f_H + a_H & z_5 & z_6 \\ \hline f_L + a_L & A_{11} & A_{12} & 0 & 0 & \lambda_{in} & 0 \\ f_L + a_H & A_{21} & A_{22} & 0 & 0 & \lambda_{in} & 0 \\ f_H + a_L & 0 & 0 & A_{11} & A_{12} & \lambda_{in} & 0 \\ f_H + a_H & 0 & 0 & A_{21} & A_{22} & \lambda_{in} & 0 \\ z_{awe_l} & \lambda_{out} & \lambda_{out} & \lambda_{out} & \lambda_{out} & \lambda_{ll} & \lambda_{lh} \\ z_{awe_h} & 0 & 0 & 0 & 0 & \lambda_{hl} & \lambda_{hh} \end{array}\right)$$

$$\Pi_{RW} = \left(\begin{array}{c|cccccc} & f_L + a_L & f_L + a_H & f_H + a_L & f_H + a_H & z_5 & z_6 \\ \hline f_L + a_L & F_{11} & 0 & F_{12} & 0 & 0 & 0 \\ f_L + a_H & F_{11} & 0 & F_{12} & 0 & 0 & 0 \\ f_H + a_L & F_{21} & 0 & F_{22} & 0 & 0 & 0 \\ f_H + a_H & F_{21} & 0 & F_{22} & 0 & 0 & 0 \\ z_{awe_l} & F_{21} & 0 & F_{22} & 0 & 0 & 0 \\ z_{awe_h} & F_{21} & 0 & F_{22} & 0 & 0 & 0 \end{array}\right)$$

The following additional assumptions are explicit in the formulation of the matrices. The probability of reaching an extraordinary status within lifetime, λ_{in}, is independent of one's current state. Likewise, if a household loses their extraordinary status, then it is equally likely to transition to any ordinary state.[5] The descendant households start their career at a_L. This helps generate wage growth over the life cycle. It is also consistent with a higher variance of wages for older workers. The probability of having a low or high permanent component for a descendant of a household at the extraordinary state is the same as of a household with a high permanent productivity component. The chances that the descendant of an extraordinarily productive household will also be as productive is zero. Relaxing these restrictions leads to negligible improvements in the performance of the model.

Our working assumption is that the values for ordinary states and the transitions within are directly observed in the data, whereas the transitions to, from and within extraordinary states are not. We jointly calibrate the levels of ordinary states, $\{z_1, .., z_4\}$, and the elements of the transition matrices A and F in order to match the average wage growth of 0.305 log-points observed in the data, the annual autocorrelation of 0.985, as estimated by Krueger and Ludwig (2013), the variance of earnings for working age households, which is reported as 0.52 by Heathcote, Perri, and Violante (2010) and the intergenerational elasticity of wages of 0.30 as reported by Solon (1999). This leaves the transitional probabilities $(\lambda_{in}, \lambda_{out}, \lambda_{ll}, \lambda_{lh}, \lambda_{hl}, \lambda_{hh})$ and the extraordinary productivity levels z_5, z_6. We choose the values for these parameters to replicate the observed distributions of income and wealth in 1960. In particular we target the top 0.5 and 1 percent concentration ratios and the Gini coefficients of inequality for income and wealth.

4.3 Tax System

The tax system consists of personal income taxes levied on capital and labor earnings, sales taxes, corporate income taxes, and taxes on estate income. The tax receipts are used to support exogenous government expenditures and transfers to households.

Corporate taxes are modeled as a flat rate, τ_c, levied on a portion of capital income before households receive their income.[6] We set $\tau_c = 52\%$, which is the average marginal

[5]The formulation of the transition matrix allows for the possibility of transitioning between different values of the permanent component f by passing through an extraordinary state. However, given the calibrated values for λ_{in} and λ_{out} below, the probability of such an event is extremely small.

[6]As a result, corporate income taxes reduce the tax base for personal income tax.

tax rate on corporate profits in 1960 as reported by Gravelle (2004) based on tax records. To reflect the fact that for most households, positive net worth takes the form of real estate and thus is not subject to corporate income taxes, we assume that corporate taxes only apply to capital income above a threshold d_c.[7] We then choose d_c such that the share of corporate tax revenue in GDP is 3.8% as measured in the data for 1960.

To obtain the federal income tax base, or adjusted gross income (AGI), we take personal income net of corporate income, subtract employer contributions to social security, and add social security benefits. Social security contributions are levied at a payroll tax rate τ_p, apply to earnings up to a cap of p, and are borne to equal parts by the employee and the employer. Therefore, adjusted gross income y_{agi} is given by

$$y_{agi} = wzh - \min\{wzh, p\}\tau_p/2 + \min(rk, d_c) + \omega(z, \mathcal{R}).$$

[Note: in the current version of the quantitative results, payroll taxes are embedded in the general income tax.]

Personal income taxes apply to adjusted gross income. They are modeled after the current U.S. income tax system, which can be approximated by a log-linear form for after-tax income. In addition, we assume that the top marginal tax rate is bounded at $\tau_{\max}$, as in the actual tax system. Let the level of income up to which the log-linear system applies be $y_b(\tau_{\max})$. Beyond that, the top rate of $\tau_{\max}$ applies. For 2010, we set $\tau_{\max}$ to 0.35. For 1960, we set it to 0.92, which turns out not to be binding in our simulations.

Personal income taxes are then given by

$$y_{agi} - \lambda[\min(y_{agi}, y_b)]^{1-\tau_l} - (1 - \tau_{\max}) \max(y_{agi} - y_b, 0).$$

The power parameter $\tau_l \leq 1$ controls the degree of progressivity of the tax system, while λ adjusts to meet the government's budget requirement. $\tau_l = 0$ implies a proportional (or flat) tax system. When $\tau_l = 1$, all income is pooled, and redistributed equally among agents. For values of τ_l between zero and one, the tax system is progressive.[8] See Guner, Kaygusuz, and Ventura (2014), Heathcote, Storesletten, and Violante (2014a) and Bakis, Kaymak, and Poschke (forthcoming) for evidence on the fit of this function. Here, we set the progressivity of the personal income tax system in 1960, τ_l, to 0.08. We choose λ to

[7] Only about 20% of U.S. households hold stocks or mutual funds directly (Heaton and Lucas 2000, Bover 2010).

[8] For income below y_b, the average income tax rate is $1 - \lambda y^{-\tau_l}$, which increases in y if $\tau_l > 0$.

balance the government's budget.[9]

Combining all these components, disposable income is the sum of after-tax personal income and corporate income, minus payroll taxes paid by employees, plus transfers:

$$\begin{aligned} y^d =& \lambda[\min(y_{agi}, y_b)]^{1-\tau_l} + (1-\tau_{\max})\max(y_{agi} - y_b, 0) \\ &+ (1-\tau_c)\max(rk - d_c, 0) - \min(wzh, p)\tau_p/2 + T. \end{aligned} \tag{2}$$

The symmetric treatment of capital and labor income in (2) is in line with the U.S. tax code. Also note that retirees are still subject to federal income taxes on their pension payments and capital income.

Finally, estates are subject to tax when they are transferred to the next generation. The estate tax code in the U.S. consists of a deductible and a progressive schedule applied to the remaining portion of the estate. We represent the marginal estate tax schedule by the step function depicted in Figure 5. We do so using statutory estate tax rates and the corresponding brackets reported by the IRS. To obtain comparability across years when changing this function in the following analysis, we normalize the thresholds for estate brackets by average wealth in each year.

The government uses the tax revenue to finance exogenous expenditures and transfers. The expenditures are set to yield a sum of expenditure and transfers of 17% of GDP, as observed in the data. In the data, transfers to persons in 1960 represent 4.5% of GDP, of which 2.5% is destined to the elderly in the form of pension payments and 2% is destined to the general public in the form of disability benefits, veterans benefits etc. We set the transfers in the model, T, accordingly, to match receipts per person. Social security benefits are described next.

4.4 Social security

We model transfer payments to retirees as consisting of two components: one component that is related to past income and represents the "primary insurance amount" of social security, and another component that is common across retirees and represents assistance payments (common in 1960) and Medicare. We obtain the former by multiplying

[9] One benefit of this formulation for the income tax system is that it also allows for negative taxes. Income transfers are, however, non-monotonic in income. When taxes are progressive, transfers are first increasing, and then decreasing in income. This feature allows addressing features of the real tax system like the earned income tax credit and welfare-to-work programs, which imply transfers that vary with income.

an individual-specific replacement rate with the average hourly wage. The replacement rate is a function of past earnings (see Figure 3a). It consists in a piecewise linear schedule with up to two kinks, labelled b_1 and b_2, and a cap $\bar{\omega}$. We take information on the cap, the kinks, and on the replacement rates applying between them, ψ_1 to ψ_3, from the Social Security Administration. The measure of past earnings used by the Social Security Administration is "Average Indexed Monthly Earnings" (AIME); a weighted average of salaries of the past 35 years. For reasons of tractability, we compute a retiree's replacement rate using earnings of a comparable worker, i.e. somebody with equal productivity and wealth.

The common component is modeled as a common amount T_R that accrues to all retirees. We obtain it by matching the sum of assistance payments and Medicare expenditure per retiree. In the data, this amounts to 1% of GDP in 1960 (only assistance, no Medicare), and to 3.5% (mostly Medicare) in 2010.

4.5 Preferences

Preferences are described by a discount rate, β, the elasticity of intertemporal substitution, σ, the Frisch elasticity of labor supply, ϵ, and the disutility of work, θ. We choose β such that the equilibrium interest rate is 4.1%. We set $\epsilon = 1.67$, which implies a Frisch elasticity of 0.6. Blundell, Pistaferri, and Saporta-Eksten (2012) report an estimate of 0.4 for males and 0.8 for females. Thus a value of 0.6 for a model of households seems broadly plausible. We choose θ so that at the equilibrium an average household allocates 34% of their time endowment to work.

The elasticity of intertemporal substitution is an important element of our analysis since a higher elasticity lead to a stronger savings response to tax cuts. We report our results for $\sigma = 1.1$, which implies an EIS of 0.9. As most estimates of the EIS are closer to zero, we consider our choice to be an upper bound.

Table 1 summarizes the calibration of the model for the 1960 economy.

5 Calibration Results for the 1960 economy

In this section we overview the characteristics of the 1960 economy implied by our calibration of the model and compare them with the available statistics in the data. The elements of the matrix within ordinary labor productivity states were already calibrated to match

Table 1: Calibration of the model parameters for 1960

Parameter	Value	Data Target and Value	
		Preset Parameters	
σ	1.1	Risk Aversion	
α	0.36	Capital Income Share	
δ	0.079	$K/Y = 3.0$	
μ_r	0.022	Average Career Length of 45 yrs.	
μ_d	0.067	Average Retirement Length of 15 yrs.	
		Taxes	
τ_l	0.08	Author's Estimates	
$\tau_{\max}$		not binding in 1960	
τ_c	0.49	Marginal Corporate Tax Rate, Gravelle (2004)	
τ_e		Actual Estate Tax Schedule	
γ	0.108	$G/Y = 0.17$	
T/Y	0.02	NIPA	
		Social Security	
b_1	0	Social Security Administration	
b_2	0.214		
ψ_1	1		
ψ_2	0.4		
ψ_3	0.1		
$\bar{\omega}$	0.171		
		Productivity Process	
ρ_{lc}	0.985	Kindermann and Krueger (2014)	
ρ_{ig}	0.30	Solon (1992)	
σ_a	0.5×0.38	household earnings variance	0.71
σ_f	0.5×0.62	share of fixed effects	0.62
		Jointly Calibrated Parameters	
β	0.958	Interest Rate	0.041
θ	12	mean hours	0.34
ϵ	1.67	Frisch elasticity	0.6
T_R	0.07	(Pension assistance+Medicare)/GDP	1%
d_c/r	$0.47\times K$	Corporate tax revenue/GDP	3.8%

panel data on wages. Therefore we focus our discussion on the implied transition probabilities for the extraordinary states. The probability of reaching an extraordinary state at any given year is 0.2 percent, and the probability of going back to an ordinary state is 13.6%.[10] These figures imply a considerable degree of persistence of having a high earner status. There is, however, little information on the transitions to, from and within extraordinary states in the data. Using micro-level data from the Social Security Administration, Kopczuk, Saez, and Song (2010) estimate the probability of staying in the top 1% of earners from one year to the next to be around 75%. The probability is fairly stable over the years fluctuating between 70 to 80%. The corresponding probability implied by our calibration is 80%.

The extraordinary states are essential to the model's ability to generate a realistic wealth distribution. At these states (z_5 and z_6), which represent the most productive 1.3% of the labor force combined, labor productivity is 6 times the average. The top state z_6 alone corresponds to 0.08% of the workforce, with a productivity level that is 57 times the average. When households reach these states, they also work about 20% longer hours than an average household to take advantage of the higher wages and build up a substantial amount of wealth against the risk of losing their highly productive status either by retirement or by returning to an ordinary state. The resulting wealth distribution is highly concentrated as observed in the data.

Table 2 shows the distributions of total income, wealth and labor income for the 1960 economy. The calibration targets are reported in bold. The data on the wealth distribution comes from two different sources. Top 0.5, 1 and 10 percent concentration ratios are taken from Saez and Zucman (2014), who infer the wealth distribution from the reported capital income in tax records and observed returns by asset type in the US economy. They do not report distributional measures for lower wealth levels. The remaining shares and the Gini coefficient are therefore taken from Keister and Moller (2000) and are based on 1962 Survey of the Financial Characteristics of Consumers (SFCC). The model closely approximates the distributions of income and wealth. While the earnings distribution implied by the model is slightly more concentrated at the top than in the data, the Gini coefficient of earnings in the model is very close to that reported by Heathcote, Perri, and Violante (2010). The main reason for this discrepancy is that the data figures come from Piketty and Saez (2003), who report concentration ratios for wage income shares only. The relevant statistic that corresponds to the model is total labor income, including a

[10]The full set of calibrated values for the transition matrices are reported in the appendix.

Table 2: Distribution of Income and Wealth in 1960

	Top Percentile							
	0.5%	1%	5%	10%	20%	40%	60%	Gini
Wealth Share (Data)	**0.21**	**0.28**	n/a	0.71	0.81	0.95	1.00	**0.80**
Wealth Share (Model)	**0.24**	**0.29**	0.46	0.64	0.80	0.92	0.98	**0.75**
Income Share (Data)	**0.07**	**0.10**	0.23	0.33	0.49	0.73	0.89	**0.34**
Income Share (Model)	**0.09**	**0.11**	0.24	0.41	0.54	0.75	0.89	**0.33**
Earnings Share (Data)	0.05	0.07	0.20	0.33				0.34
Earnings Share (Model)	0.08	0.10	0.22	0.33				0.32

Note.– The data values are taken from Saez and Zucman (2014) and Keister and Moller (2000) for the wealth distribution, and from Piketty and Saez (2003) for the income and earnings shares. Wealth shares are for a wealth ordering of the population, and income and earnings shares for an ordering by income. The income and earnings Ginis are from Heathcote, Perri, and Violante (2010) and refer to 1967, the earliest year for which they report results. The income Gini in both model and data refers to working-age households. See text for details.

portion of entrepreneurial income, which is excluded by Piketty and Saez (2003). Since the share of entrepreneurial income in total income is substantial for the top income/earnings groups, excluding it biases the concentration ratios downward.[11] In line with this, the model slightly overstates the share of labor income in the top 1% incomes, at 71% versus 60% in the data (Piketty and Saez, 2003), but is accurate for the top 10%, at 80%, and below.

A critical element of the analysis is the distribution of the tax burden across income groups. Since our modeling of the corporate and estate tax systems does not explicitly target income groups, the model's ability to shed light on the distributional consequences of changing tax schedules depends on how well it captures the tax liabilities of different income groups in 1960. In their survey of tax records, Piketty and Saez (2007) report the average tax rates for different tax categories for top income groups. In Table 3, we compare the reported values with the model-implied rates for the top 1% and the bottom 99% of the income distribution. The model matches the aggregate revenue from corporate taxes by design. [Still need to adjust d_c.] At the same time, it reflects that the top 1% pay much more corporate taxes as a fraction of their income, given their higher capital income

[11] Income from entrepreneurial activities constitutes 30% of total income for the top 1% of incomes, and 17% of total income for the top 10% in 1960.

Table 3: Average Tax Rates by Income Group in 1960

	Corporate Tax			Estate Tax			Income Tax		
	1%	99%	R/Y	1%	99%	R/Y	1%	99%	R/Y
Data	14.4	5.1	3.8	6.0	0.0	0.3	24.0	13.8	10.6
Model	14.4	4.6	4.6	3.1	0.1	0.3	22.6	10.6	9.6

Note.– R/Y stands for revenue as a fraction of GDP. These figures are from NIPA and from Joulfaian (2013). The top 1% and 99% data values are from Piketty and Saez (2007).

share. Aggregate estate tax revenue in the model is also close to that in the data, although this is not a calibration target. The model matches the fact that the 99% pay essentially no estate taxes, but understates the estate tax paid by the top 1% of the income distribution. We think that the difference might stem from the way estate taxes are imputed to income groups in Piketty and Saez (2007), which likely overshoots the actual figure in the data.[12] The fact that the model does not overstate top estate tax rates and provides a good approximation of aggregate revenue indicates that the use of the statutory tax schedule provides a good representation of the estate tax system, even if it abstracts from certain deductions, deferrals and methods of tax avoidance. Finally, the progressivity of the personal income tax system chosen for the calibration closely reflects the distribution of the income tax burden.

Overall, the calibration of the parameters seems reasonable, as the model does a good job of capturing the salient features of the 1960 economy. In particular, the distributions of income, wealth and the tax burden among households is consistent with the empirical facts of the time. We find this encouraging as it indicates that the model provides an appropriate framework to study the macroeconomic implications of the changes in the tax system, which we turn to next.

[12]Since estate taxes are filed separately, relating them to income tax records is not straightforward. The working assumption in Piketty and Saez (2007) is a perfect rank correlation between the size of the estate and the income of the decedents, which represents an upper bound for the estate tax paid by top income groups.

6 Institutions, Technology and the Evolution of the Wealth Distribution – Steady State Analysis

In this section, we analyze the effect of changes in the tax policy, in social security, and the distribution of labor productivity on economic inequality. We change all tax schemes in line with the data, and expand social security. We also increase the variance of labor productivity, mimicking skill-biased technical change over the period 1960 to 2010.

We modify the tax system as follows in order to reflect the situation in 2010. First, we decrease the corporate income tax rate from 52% to 35%, which is the average marginal tax rate on corporations reported by Gravelle (2014) for 2010. Secondly, we change the estate tax schedule to represent the 2010 statutory rates and brackets relative to average wealth in 2010. Thirdly, we reduce the top marginal income tax rate to 35%. This is close to statutory top marginal federal income tax rates reported by Guner, Kaygusuz, and Ventura (2014). Figures for effective top rates reported by the same authors are a bit lower at 25 to 30%. Yet, it should be noted that these rates exclude state income taxes. In the main analysis, we do not change the progressivity of the tax system. We conduct robustness checks where we raise τ_l to 0.166, as estimated by Bakis, Kaymak, and Poschke (forthcoming). Recall that average tax rates adjust to balance the government's budget.

The expansion of transfers had two important components: more generous pensions, and the introduction and expansion of Medicare. The former is reflected in an increase in replacement rates, and a large increase in the cap from 0.17 to 0.57 times average wages. (See Table 4 for details.) This expansion was financed with an increase in payroll taxes. [In the current version of our results, which still does not have payroll taxes, it is financed with an increase in λ, i.e. an across the board increase in average personal income taxes.] The increase in generosity is clearly visible in Figure 3, which depicts replacement rates as a function of earnings for 1960 and 2010. The increase in transfers unrelated to income, such as Medicare, is captured by an increase in T_R from 0.07 to 0.18. This results in payments to retirees in line with aggregate expenditure on this component of 3.5% of GDP in 2010. Taken together, payments to retirees are consistent with aggregate expenditure on pensions and medicare of 8% of GDP.

The third important change that occurred over the period under consideration are changes in technology, and notably in the return to skill. We capture the technological changes that lead to a higher wage inequality by raising the variance of the labor productivity process to match the rise in the household earnings variance in equilibrium.

Table 4: The tax system and social security, 1960 and 2010

	1960	2010
	Taxes	
τ_l	0.08	0.08
$\tau_{\max}$	0.92	0.35
τ_c	0.49	0.236
τ_e	see Figure 5	
	Social Security	
b_1	0	0.2
b_2	0.214	1.22
ψ_1	1	0.9
ψ_2	0.4	0.32
ψ_3	0.1	0.15
$\bar{\omega}$	0.171	0.57
T_R	0.07	0.18

In doing so, we maintain a constant average labor productivity. This requires a 21.3% increase in the standard deviation of the process and a 0.187 log-points decline in the median.

Table 5 reports the distributions of earnings, income and wealth associated with the steady-state of the new economy. We compare these numbers with the corresponding figures in 2010. The income and earnings distributions implied by the model closely replicate the observed values in 2010. The level of wealth concentration predicted by the model, however, substantially overshoots that observed in 2010. We will see in the next section that this arises from comparing a stationary equilibrium of the model with data for the year 2010, which still lies on the transition path. We therefore label the new stationary equilibrium "2010", to stress that in some dimensions, it cannot be directly compared to data for 2010.

In the results just presented, social security, taxes and wage inequality were all different from 1960. Together, these changes in institutions and technology do a good job of accounting for changes in inequality observed over the 50 years from 1960 to 2010. Next, we ask how much of the change can be attributed to each individual feature. To answer this question, we take the 1960 model economy, and change each element individually,

Table 5: Income and Wealth Inequality in 2010

	Top Percentile							
	0.5%	1%	5%	10%	20%	40%	60%	Gini
Wealth Share (Data)	0.31	0.40	n/a	0.74	0.83	0.95	0.99	0.82
Wealth Share (Model)	0.48	0.58	n/a	0.86	0.98	1.00	1.00	0.92
Income Share (Data)	0.16	0.20	0.35	0.46	0.62	0.82	0.94	0.43
Income Share (Model)	0.17	0.19	0.31	0.48	0.54	0.75	0.87	0.42
Earnings Share (Data)	0.12	0.16	0.33	0.47				0.42
Earnings Share (Model)	0.16	0.18	0.30	0.44				0.40

one by one.[13] Table 6 shows how inequality in the model changes as a function of each feature of the model economy that changes between 1960 and 2010.

6.1 Transfers, saving behavior, and inequality

First, we consider inequality in an economy where only social security and Medicare changed, and wage dispersion and taxes remained the same. It is clear that both changes in the social security system reduce income inequality below the top 1%, as evidenced by a decline in the top 10% income share and in the Gini coefficient of the income distribution. This change is driven by an increase in the relative income of retirees, whose income share increases from 7.5% to 15.5% due to more generous social security. (Not shown in the table.) The wealth share of retirees also increases. Income inequality among workers, in contrast, does not change much. Like the distribution of income, the distributions of disposable income and of consumption both become less dispersed.

Although the top 1% income share is unchanged and the top 10% income share declines, the top 1% and 10% wealth shares both increase. While the top income and wealth groups are not exactly identical, this pattern suggests that the changes in the wealth distribution are driven not so much by changes in the distribution of income, but rather by changes in saving rates, to which we turn next.

Table 7 shows saving propensities and a measure of the generosity of social security

[13] An alternative approach would be to take the 2010 economy, and undo each change individually, one by one. This approach yields qualitatively very similar results. Below, we comment on some differences.

Table 6: The effects of changing institutions and wage inequality on the distribution of income and wealth

	Wealth distribution			Income distribution				c	y^d	Retiree
	Top 1% share	Top 10% share	Gini	Top 1% share	Top 10% share	Gini (all)	Gini (workers)	Gini	Gini	wealth share
benchmark (1960)	0.262	0.610	0.727	0.112	0.412	0.501	0.333	0.402	0.440	0.151
difference to benchmark (percentage points):										
more generous social security										
... only benefit component	3.9	4.0	2.6	0.1	-1.3	-3.9	0.6	-3.0	-4.1	2.1
... only fixed component T_R	2.6	3.5	3.7	0.1	-0.7	-2.9	0.6	-2.3	-3.1	1.0
... both components	4.4	3.4	1.6	-0.2	-2.4	-6.1	0.7	-4.7	-6.1	3.8
lower taxes										
... lower corporate income taxes	-0.3	2.1	3.6	-0.4	-0.6	-0.2	-0.2	0.7	0.9	0.5
... 2010 estate tax schedule	-0.8	2.3	2.5	-0.2	0.6	0.2	0.2	0.1	0.2	0.3
... lower top marginal tax rate	1.8	0.9	0.9	0.3	0.4	0.2	0.2	0.3	0.3	0.0
higher wage inequality	14.3	10.8	9.1	7.5	5.9	8.0	7.6	6.8	6.7	0.2
all changes (2010)	18.4	20.8	17.5	6.2	5.4	2.3	8.0	3.5	2.5	3.7

Table 7: The effects of changing institutions and wage inequality on saving, by wealth group

	Saving rates by wealth			Transfer replacement rates by wealth group		
	Top 1%	Top 10%	Bottom 90%	Top 1%	Top 10%	Bottom 90%
benchmark (1960)	0.942	0.895	0.705	0.027	0.070	0.291
difference to benchmark (percentage points):						
more generous social security						
... only benefit component	0.1	0.0	-4.5	1.9	8.6	23.5
... only fixed component T_R	0.0	0.2	-3.6	0.8	3.7	22.5
... both components	0.1	0.0	-5.2	3.1	12.8	46.5
lower taxes						
... lower corporate income taxes	0.2	1.0	1.3	0.3	0.0	1.8
... 2010 estate tax schedule	0.1	0.7	-0.7	0.1	0.0	-1.5
... lower top marginal tax rate	0.1	0.2	-0.2	0.3	0.2	0.2
higher wage inequality	0.4	0.9	-2.2	-0.7	-1.4	5.0
all changes (2010)	0.6	2.5	-12.6	6.4	12.7	43.0

for three wealth groups: the top 1%, the top 10%, and the bottom 90%.[14] The saving propensity is the propensity to save out of total after tax resources, defined as $x/(y^d + k)$. (If no estate tax is due in the transition to the next period, this is identical to $k'/(y^d + k)$.) The social security replacement rate is computed, for all workers in a wealth group, as the ratio of total pension benefits due in the next period, should they retire, over total income. Due to the combination of the progressivity of the social security benefit schedule and the positive correlation between income and wealth, the social security replacement rate is much higher for less wealthy households. It is also clear that wealthier households save substantially more. Since on average they have high income, all three savings motives present in the model – life-cycle, precautionary, and bequest – are stronger for them.

The expansion of social security makes benefits more generous for all groups, but particularly so for the bottom 90%. Comparing stationary equilibria, the replacement rate for the top 1% wealthiest workers doubles, but remains small; social security does not even

[14]Note that for conciseness and simplicity, the discussion in the following few paragraphs conflates income and wealth differences to some extent. This is inaccurate to the extent that the correlation between these two variables is high but not perfect. However, all patterns reported in the table and the following two figures are very similar when grouping households by income instead of wealth.

Table 8: The effects of changing institutions and wage inequality on aggregate outcomes

	K	N	Y	r	w	C	average hours	λ
benchmark (1960)	29.9	5.65	10.3	0.045	1.17	7.93	0.344	1.06
relative to benchmark (benchmark = 100):								
more generous social security								
... only benefit component	89.7	99.6	95.9	119.1	96.3	97.8	99.6	94.9
... only fixed component T_R	92.7	99.8	97.2	113.7	97.4	98.5	99.9	96.9
... both components	86.2	99.4	94.4	125.1	95.0	96.9	99.3	91.8
lower taxes								
... lower corporate income taxes	112.8	100.0	104.4	77.3	104.4	101.9	100.0	95.9
... 2010 estate tax schedule	104.1	100.2	101.6	92.9	101.4	100.8	100.1	99.6
... lower top marginal tax rate	101.3	100.2	100.6	98.4	100.4	100.4	100.1	99.7
higher wage inequality	118.9	103.3	108.7	75.2	105.2	105.6	100.2	102.5
all changes (2010)	120.4	103.1	109.0	71.0	105.8	105.6	99.6	90.1

replace 10% of income for this group. For the bottom 90%, in contrast, the replacement rate almost triples, and goes from replacing about one quarter to three quarters of income in that group. The change for the top 10% lies in between. As a consequence of these changes, the retirement saving motive for the bottom 90% is significantly weakened, and the saving propensity of this group declines by five percentage points, while it hardly changes for the top 1% and 10%.

The expansion of transfers goes along with substantial general equilibrium effects, as shown in Table 8. First, since households that can count on larger transfers in retirement reduce their saving, the capital stock declines. This tends to increase the interest rate and to reduce the wage rate by up to 5%. As a consequence, hours and the aggregate labor input decline slightly. Output then contracts mostly as a consequence of the smaller capital stock. As the latter implies that less investment is required, consumption declines less than output, by 3% overall. Finally, the overall burden of income taxes increases, with a reduction in λ of around 8%, as more revenue is required for financing increased transfer expenditure.

These general equilibrium effect attenuate the response of saving to increased transfers, as illustrated in Figure 7. This figure shows a decomposition of changes in the saving rate in response to the expansion of social security into two effects: the change in saving rates in response to more generous social security, keeping prices and the entire tax schedule, including λ, at the benchmark levels (direct effect, solid line), and the change in saving rates induced by price changes generated by the introduction of social security, keeping social security at the benchmark level (general equilibrium effect, broken line). The sum of the two effects approximately equals the entire effect of increasing the generosity of social security in general equilibrium, as the further effect due to changing λ is very small. As a reminder, the figure also shows the change in the replacement rate for each group (line with diamonds, right axis). It is clear that the partial equilibrium effect of expanding social security on saving rates is very large; the saving rate of the bottom 90% drops by almost 20 percentage points, from around 70 to around 50%. The saving propensity of the top 10% declines slightly, while that of the top 1% remains essentially unchanged. In general equilibrium, the reduction in saving leads to an increase in the interest rate, from 4.5 to 5.6%. (See also Table 8 below.) This in turn affects saving incentives, and attenuates the decline of the saving propensity of the bottom 90%. While higher r also affects saving of higher-wealth groups, this effect is smaller for them, as the income effect of the price change is larger for groups that derive more of their income from capital. The total effect of expanding social security on saving of the bottom 90% is strongly negative, as seen in Table 7, since the negative direct effect clearly outweighs the positive general equilibrium effect.

The expansion of transfer payments had two components: a more generous social security benefit schedule, and larger payments that are independent of past income. Figure 8 shows the effect of each component on saving separately, as well as the implied effect of each component on the replacement rate. Again, the figure shows the effects of social security keeping prices fixed at the benchmark level, as well as the effect of the price change resulting from the expansion of social security (both components). It is evident that both components of social security induce a strong decline in saving among the bottom 90%. However, given that the change in the benefit schedule had a larger effect on replacement rates, its effect on saving rates is also larger. In addition to this, since the change in benefits, unlike the fixed component, was skewed towards the poor, its effect varies more across wealth groups.

To summarize, we find that the expansion of social security contributed significantly

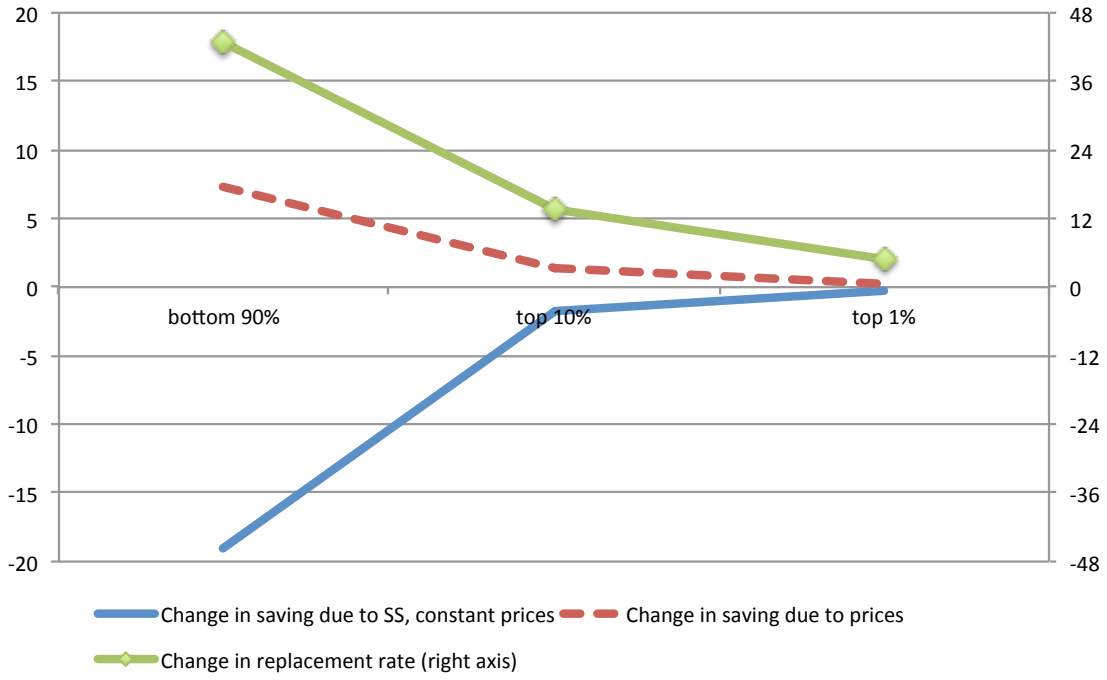


Figure 7: Changes in saving propensities in response to expansion of transfers, by wealth group, in percentage points

to increasing wealth inequality by reducing saving propensities among the bottom 90% of the wealth distribution. Given only small changes in saving at the top of the wealth distribution, this results in a lower wealth share of the bottom 90%. These changes in saving are attributable both to changes in the social security benefit schedule and in the expansion of fixed payments, with a slightly larger role for the former. Finally, the effect of the social security expansion on saving would be even stronger were it not for a counteracting general equilibrium effect.

6.2 Tax changes, wage inequality, and the distribution of wealth

The effect of tax changes and wage inequality on the wealth distribution closely parallels those found in Kaymak and Poschke (2014). We therefore discuss each element briefly.

As shown in Table 6, lower corporate income and estate taxes do not affect the distribution of income. Therefore, they affect the wealth distribution through their effect on saving rates.

Changes in saving are shown in Table 7 and in 9, which display changes in saving rates

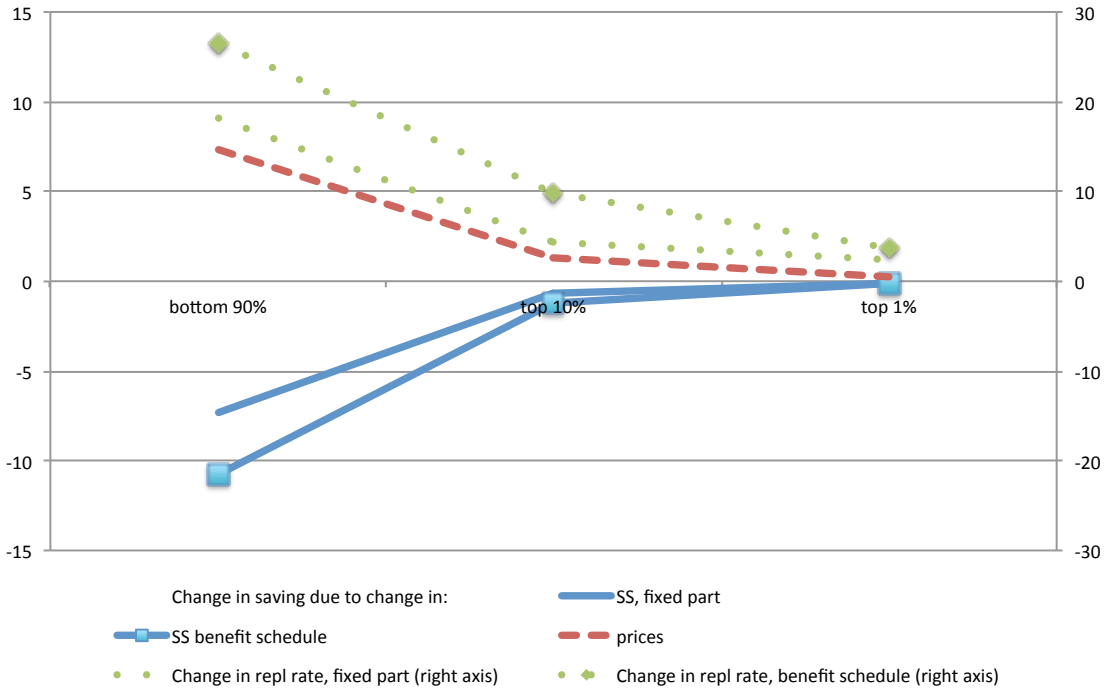
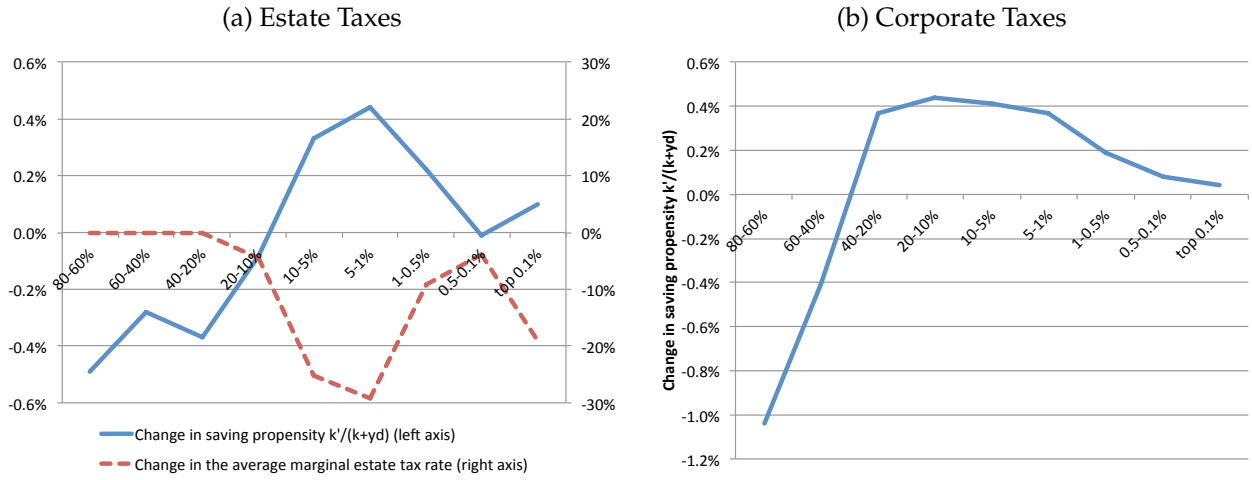


Figure 8: Changes in saving propensities in response to expansion of transfers, by wealth group and type of transfer, in percentage points

and in effective tax rates across the wealth distribution. The figure also shows changes in the effective marginal estate tax rate for different parts of the wealth distribution. Changes in the estate tax system can be captured by two key components: a much larger exemption, and much lower top rates. The larger exemption mostly benefits groups just outside the top 1% of the wealth distribution. Lower top rates benefit very wealthy households, albeit to a moderate extent: while effective estate tax rates decline for the top 0.3% of the wealth distribution, the largest declines are realized for marginal rates on very large estates, which only affect a small fraction of wealth transfers, even for the wealthy. As a consequence, changes in the estate tax system mostly affect saving behavior of the 90-99% group. Their wealth increases for two reasons: first, their wealth transfers are subject to lower taxes, and second, they increase their saving in response to the lower tax rate.

The reduction in corporate income taxes has a similar effect. Changes in saving behavior in response to it is shown in panel (b) of Figure 9. First of all, since low-wealth households are not exposed to this tax, their saving behavior only reacts to the tax cut via general equilibrium effects. For those who are affected, a stronger substitution effect relative to the income effect leads to higher saving propensities. However, as the income

Figure 9: Saving Propensity and Marginal Tax Rates



Note.– The figure represents reactions to changes in the estate tax system and the corporate tax rate for different groups of the wealth distribution (horizontal axis).

effect is larger for households that receive a larger fraction of their income from capital, the saving rate increases most for households in percentiles 70-95 of the wealth distribution, and changes very little in the top 1%. As a consequence, wealth of the top 1-10% of the wealth distribution expands relative to the rest of the distribution, implying that the shares of the top 1% and the bottom 90% decline.

While changes in the wealth distribution in response to changes in corporate income and estate taxes are driven by the saving reaction, the pattern is essentially the reverse for a decline in the top marginal income tax rate. This change leads to a slight increase in top income shares, as high-productivity agents work more. Saving rates change very little. As a consequence, the wealth share of top wealth groups increases in line with the increase in their income shares.

All three tax changes encourage capital accumulation, either by directly increasing incentives to save (reduction in capital income taxation) or by increasing resources available to agents with high propensities to save (lower top marginal tax rate). As a result, all of them lead to lower interest rates and higher wages. The increased capital stock also implies larger output. Since investment also needs to increase to maintain the larger capital stock, aggregate consumption increases less than output, by 0.4 to 2%, depending on the exercise. To evaluate welfare, it would be necessary to evaluate whether this increase

in output is sufficient to compensate for higher consumption inequality. The evaluation would depend on the degree of inequality aversion in the social welfare function. In addition, knowing about steady state outcomes is not sufficient for making this evaluation, as accumulating additional capital has costs along the transition. Bakis, Kaymak, and Poschke (forthcoming) show that for optimal progressivity of income taxes, results may differ substantially depending on the welfare weights of present and future generations.

Finally, changes in wage inequality strongly amplify income differences. They strongly increase the income shares of the top 1%. The share of the top 10% increases, but less than that of the top 1%, indicating that the income share of percentiles 90-99 actually declines slightly. Due to the larger earnings variance throughout the distribution, the Gini coefficient of income among workers increases strongly, in turn driving up the overall income Gini coefficient. Inequality in disposable income and consumption increase slightly less than pre-tax income inequality.

Changes in wage inequality have further small effects on saving behavior. Since overall income dispersion increases, the precautionary saving motive for high-income earners becomes stronger, so that saving propensities at the top of the distribution increase. Since productivities of the least productive households decline with the larger spread in z, saving propensities of the bottom 90% fall slightly. Due to the increase in saving rates, top wealth shares rise by substantially more than corresponding top income shares.

Aggregate variables are also affected. While average hours hardly change, the aggregate labor input increases substantially, as the labor input of high-productivity workers relative to low-productivity ones increases due to the higher productivity spread. A larger labor input increases the marginal product of capital and encourages capital accumulation. The larger productivity spread and a shift of income to households with a high propensity to save imply further increases in saving, implying that overall, the capital stock increases more than the labor input, and the capital-labor ratio increases. Since both inputs increase, output increases, and consumption increases by about 5%.

Comparing the different potential sources of increased wealth inequality, it is clear from Table 6 that, despite the dominant role of changing wage inequality, the expansion of social security also accounts for an important portion. The model generates a doubling in the top 1% wealth share for all channels combined. The expansion in social security accounts for about a sixth of this. Similarly, the model predicts an increase in the top 10% wealth share of 23 percentage points, of which about one sixth can be attributed to social

security.

The expansion of transfers accounts for a smaller share of the increase in the Gini coefficient of wealth. The reason for this is that larger transfers essentially lead to a substitution of claims on the public sector for private wealth accumulation by low-wealth households. This effect is not present for high-wealth households, for whom transfers are very small compared to income, implying a small saving response. The expansion of transfers thus mainly affects wealth differences between high and low wealth households, and less so within the group of low-wealth households. Moreover, this pattern suggests that while the expansion of transfers leads to higher top wealth shares, the distinction between private wealth accumulation and the accumulation of claims on the public sector is important.

7 Institutions, Technology and the Evolution of the Wealth Distribution – from 1960 to 2010 and beyone

Next, we evaluate how well the model can match the evolution of income and wealth inequality over time, and how much different factors contributed at different points in time. To do so, we solve for the transition from the steady state labelled 1960 to the one associated with 2010. Along the transition, we solve the model at an annual frequency. We feed in tax and transfer policies and wage inequality as observed in the data in each year along the transition. Since we do not know in advance how long the transition between steady state will take in the model, we allow for a transition of 100 periods (years). This turns out to be right. [longer transition in progress] In the following, we first briefly present the inputs into this analysis (series of policy parameters and wage dispersion). We then show predicted paths for top shares of wealth and income, and decompose predicted shares at each point in time into components due to the different drivers.

7.1 Taxes, transfers and wage inequality along the transition

For the transition analysis, we allow the tax and transfer system to vary at an annual frequency. The evolution of key model parameters is depicted in Figure 10. For corporate income taxes and the top marginal income tax rate, we use the series of statutory rates depicted in Figure 4b. The statutory corporate income tax rate declines in several steps

from 52% to 35%. The statutory top marginal income tax rate starts at 91%, drops gradually until it reaches 28% in the late 1980s, and is at 35% in 2010. Recall that while the 91% top rate is not binding in the model, lower top rates do bind. Since the progressivity of the tax system τ_l did not change much over the period under consideration, we fix it at 0.08 in all years. The parameter λ, which controls the average income tax rate, adjusts endogenously every period to ensure budget balance.

Social security administration bulletins allow computing replacement rates ψ_1 to ψ_3, bend points b_1 and b_2 and a benefit cap $\bar{\omega}$ for years since 1979. For the years between 1960 and 1979, we proceed as follows. First, given the near constancy of average individual and aggregate real benefits in the 1960s shown in Figures 1 and 2, we assume that the 1960 benefit schedule applied until 1970. Then, given the gradual increase of both average individual and aggregate benefits in the 1970s also shown in these Figures, we set values for parameters of the benefit schedule in the 1970s by linearly interpolating the 1970 and 1979 values. This results in a close to linear increase of the replacement rate for a person with average earnings.

Finally, to model the evolution of wage dispersion over the period 1960 to 2010, let $z_{it} = \exp(\mu_z + \zeta_t \bar{z}_i - \kappa_t)$. We recover μ_z and $\bar{z}_i$ by setting ζ_t to 1 and κ_t to 0 in 1960, and by setting the mean of $\bar{z}_i$ to zero. With this formulation, ζ_t / ζ_{1960} equals the ratio of the standard deviation of log wages in year t to that in 1960. We thus set ζ_t in each period to match a five-year moving average of annual levels of the variance of log equivalized household earnings reported by Heathcote, Perri, and Violante (2010).[15] As that series, which is based on the U.S. Current Population Survey (CPS), begins only in 1967 and ends in 2005, we assume that the wage structure is unchanged before 1969 and after 2003. Just like in the steady state comparison, we adjust mean log productivity in every year by choosing κ_t such that average z does not change over time.

The transition between the 1960 and the "2010" stationary equilibria of the model may well take more than 50 years. As a consequence, we need to take a stand on the institutional and technological environment after 2010. We assume that over the following 50 years, taxes, social security and wage inequality do not change. It will become clear soon

[15] We choose this target because, unlike wages, it is measured at the household level. The disadvantage of this choice is that it ignores that the earnings variance can change not only due to changes in wages but also due to changes in hours. However, Heathcote, Perri, and Violante (2010) also show that changes in household earnings inequality are dominated by changes in wage inequality. Relative hours of different wage groups changed little, with the exception of a decline in hours in the bottom 10% of the earnings distribution between 1967 and the early 1980s. For men, the variance of log annual hours was essentially constant from 1960 to 2005.

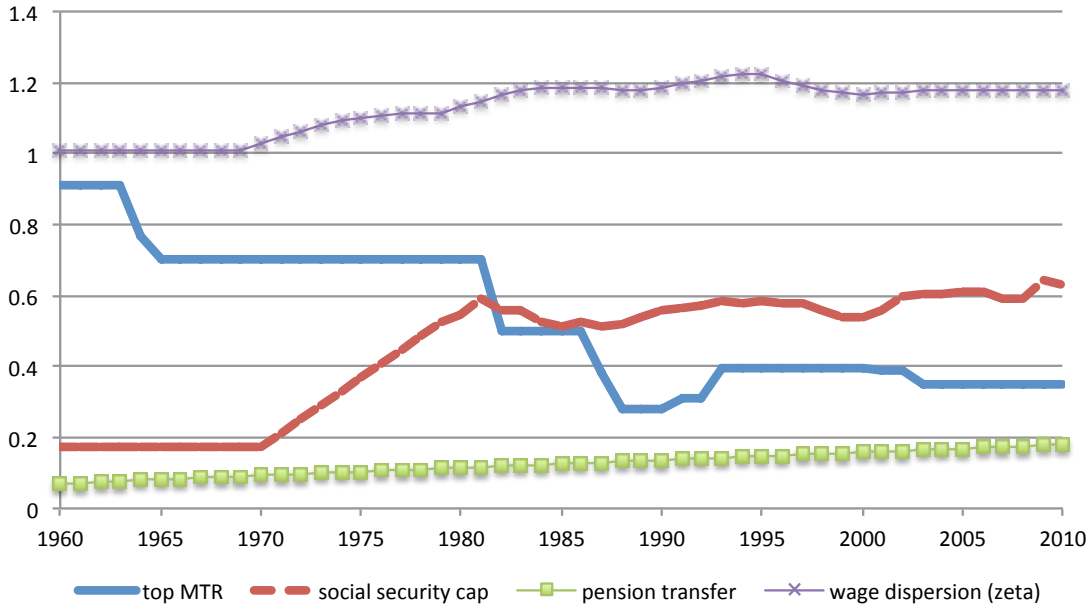


Figure 10: The evolution of key model parameters, 1960-2010

that this is a conservative choice in terms of the model's ability to match increasing inequality: Assuming that past changes will continue into the future would result in an even longer and steeper increase in top wealth shares.

We also need to take a stand on expectations. For computational tractability, we assume at this stage that households in the model have perfect foresight over future changes in institutions and technology. While this implies some unrealistic anticipation effects, these are small relative to other drivers of concentration.

7.2 Results: the evolution of the top 1% wealth share

Figure 11 shows the main result of this section: the evolution of the top 1% wealth share in the model, compared to the data, for different model scenarios. It is clear that apart from the decline in the 1% wealth share in the 1970s, which was associated with circumstances (oil price shock, stock market crash, inflation) which are beyond our model, the evolution of the top 1% wealth share in the model parallels that in the data extremely close. This is also clear in Table 9, which shows changes by decade, and for subperiod. For the period from 1980 to 2010, the top 1% wealth share in the model change by 15 percentage points, almost identical to its change of 14.9 percentage points in the data. This is all the

more remarkable given that no information on changing wealth concentration was used in parameterizing the model.

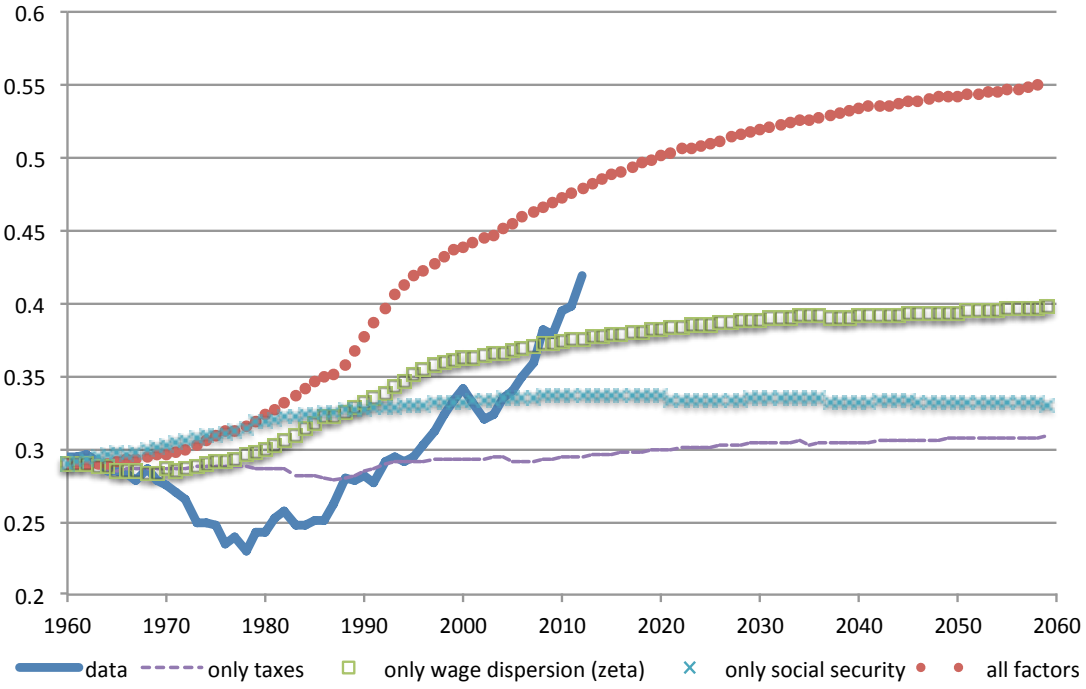


Figure 11: The top 1% wealth share, model and data, 1960-2060

7.2.1 Steady state versus transition analysis

It is clear from the results in the previous section that the stationary state of the model implied by 2010 institutions and wage dispersion features higher wealth concentration than observed in the data. This is also visible in Figure 11, which shows that the top 1% wealth share converges to a number in excess of that observed in the data in recent years. That same figure also shows that the transition analysis is much better are replicating top wealth concentration in 2010. As just remarked, this figure shows that the model replicates the increase in the top 1% wealth share from 1980 to 2010 exactly. However, the model predicts that after 2010, although taxes, social security and wage dispersion are assumed not to change anymore, the top wealth share continues to increase for another thirty years.

This occurs because, unlike the reaction of top income shares, top wealth shares react slowly to changes in income inequality, and take time to converge to their new stationary

Table 9: Changes in the top 1% wealth share, data and model

	data	model			
		all factors	only taxes	only wage dispersion (ζ)	only social security
Change by decade:					
1960s	-2.0	0.8	-0.2	-0.4	1.1
1970s	-3.0	2.7	0.0	1.5	1.7
1980s	3.6	5.4	-0.2	3.2	0.9
1990s	4.9	6.1	0.9	3.0	0.5
2000s	6.4	3.4	0.1	1.2	0.3
Total change:					
1960-2010	9.9	18.4	0.5	8.4	4.5
1980-2010	14.9	15.0	0.7	7.4	1.7
Contribution of each factor:					
1960-2010			0.02	0.46	0.25
1980-2010			0.05	0.49	0.12

levels. For example, consider an unexpected, permanent increase in ζ from 1 to 1.05 in the initial stationary state, corresponding to an increase in the standard deviation of log earnings by five log points. This results in an instantaneous increase in the top 1% income share by 1.5 percentage points. After this, the top 1% income share remains flat. Top earners react to larger wage dispersion by increasing their savings levels. As a result, wealth levels of top earners rise for some time, until they converge to their new stationary levels. As a consequence, the top 1% wealth share increases slowly and takes 70 years to achieve its entire increase of 2.5 percentage points. It takes 16 years for half the change to be completed. After 30 years, 80% of the change are completed.

In line with this, increasing wage dispersion in the 1970s, 1980s and early 1990s (the peak of ζ occurs in 1995) leads to a protracted rise in the top 1% wealth share. The peak value of ζ of 1.22 implies a change in ζ that is more than four times as large as the one considered in the previous paragraph. As a result, the wealth distribution takes a long time to converge, and the model predicts that wealth inequality continues to increase for a long time beyond 2010.

7.2.2 A decomposition of the path of the top 1% wealth share

To understand which changes in the economy drive the increase in the top wealth share along the transition, we simulate economies where only taxes, only social security, or only wage dispersion change. In addition to the stationary states for these counterfactual economies, which we already considered in the previous section, we can also compute transition paths to these stationary states. These are displayed in Figure 11, with some summary statistics reported in Table 9.

These results confirm the lessons of the analysis of stationary states in section 6. In addition, they allow us to attribute changes in top wealth in different subperiods to different forces.

In the 1960s and 1970s, the expansion of social security is the dominant factor leading to increased inequality of private wealth. While in the 1960s, social security does not actually expand, the anticipation of its expansion still reduces saving by the bottom 80% of the wealth distribution, leading to higher top wealth shares. In the 1970s, social security goes through the bulk of its expansion, resulting in lower saving by the bottom 90% of the wealth distribution, and an increase in the top 1% wealth share by almost 2 percentage points. While social security does not change much after 1980, the effects of past reforms on the wealth distribution continue to be felt, and result in a further increase in the top 1% wealth share in the 1980s by almost one percentage point.

At the same time, the effects of increased wage dispersion become noticeable. More dispersed earnings in the 1970s lead to higher top wealth shares at the end of that decade. Wage dispersion continues to increase over the next 15 years. Over that period, its effect on wealth inequality is even stronger, as it consists in both the direct effect of new changes in ζ, and the lingering effects of past changes. If persistent changes in ζ in the 1970s have substantial effects on changes in wealth inequality for thirty years, a linear increase in ζ can lead top wealth shares to increase at increasing rates for some time, as predicted by the model for the period up to 1995, when the path of ζ flattens, but past changes in wage dispersion continue to exert influence on the wealth distribution.

Changes in taxes throughout have very little effect on top wealth shares. Only in the 1990s is any effect of tax changes on top wealth shares visible. This reflects the reduction in the top marginal tax rate first from 70% to 50% for 1982, and then from 50% to around 30% in 1986-88. Changes in income taxes in the model mostly affect the distribution of after-tax income. From an inequality point of view, a reduction in top tax rates thus has a

similar effect to an increase in top wages. It is also similar in the sense that it takes time for its entire effect on the wealth distribution to be felt. Most of this effect occurs in the 1990s, and a very small portion afterwards.

Overall, it is clear from Figure 11 and Table 9 that almost half of the change in the top 1% wealth share is due to changes in wage dispersion. However, this is not true for all time periods; each taken in isolation, the cumulative effect of less equal wages surpasses that of reduced saving incentives due to social security only in the mid-1980s.

In addition, it is clear from both the Figure and the Table that these two developments interact. The fractions in the last two lines of Table 9 do not add up to one because they ignore these interactions. The main interaction consists in the fact that expanding social security leads to larger increases in top wealth when the wage distribution is more unequal. When wages are very equal, all households react in similar ways to an expansion in social security, and the effect on wealth inequality is small. But if wage inequality is so large that social security benefits are near irrelevant for some high-wage households, expanding social security leads to higher wealth inequality. Therefore, in the 1970s and 1980s, increasing wage inequality and social security expansion feed on each other in terms of promoting higher top wealth shares. As a consequence, the total effect of the two combined over the period 1980 to 2010 is more than 2.5 percentage points larger than the sum of their separate effects (not shown in Table 9).

7.3 Other outcomes

Figure 14 reports the evolution of the top 1% income share over the transition, as well as the contribution of its components. Here, it is very clear that this outcome is only driven by changes in wage dispersion. In addition, the top income share follows ζ closely. Hence, the increase in the top wealth share does not appear to raise the top income share beyond the direct effect of higher wage dispersion; just as when comparing stationary equilibria, price changes neutralize the effect of increased wealth inequality on income inequality.

Figure 13 displays the evolution of aggregate variables over the transition. These clearly reflect changes in policy and wage dispersion. This is particularly clear for λ. Its decline reflects tax reductions and the expansion of social security. The reduction in r and increase in w beginning around year 25 (1985) reflect the increase in K, which is driven by saving at the top. Over the preceding 25 years, in contrast, the effects of increased wage inequality and expanded social security on K compensate each other almost exactly.

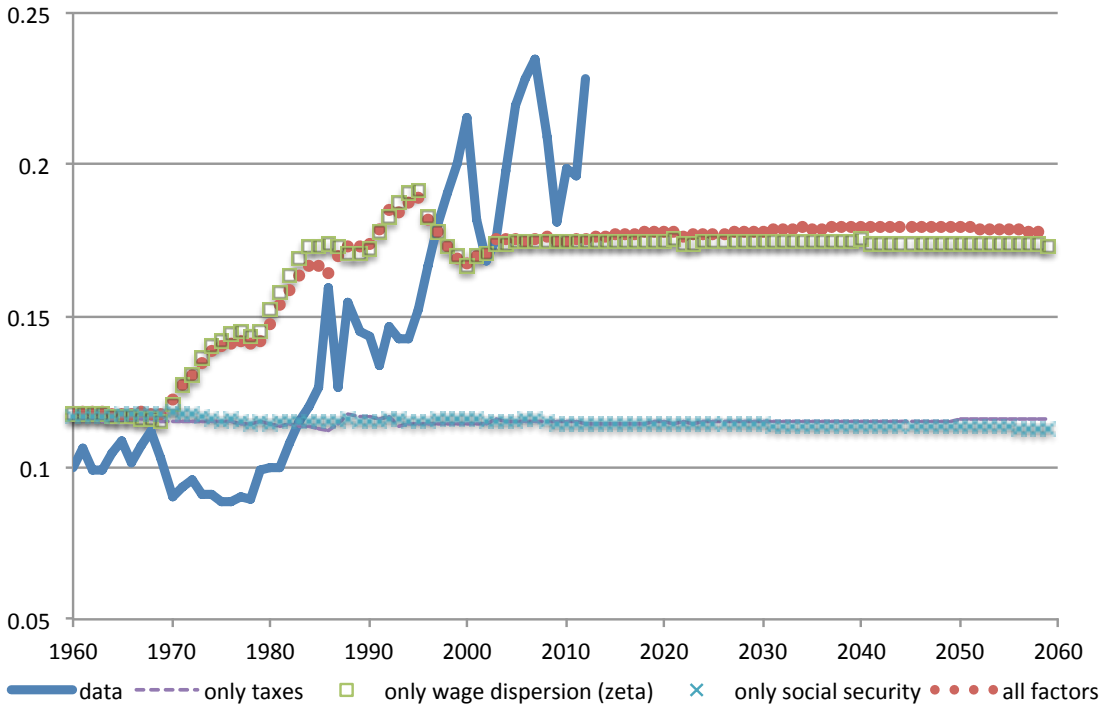


Figure 12: The top 1% income share, model and data, 1960-2060

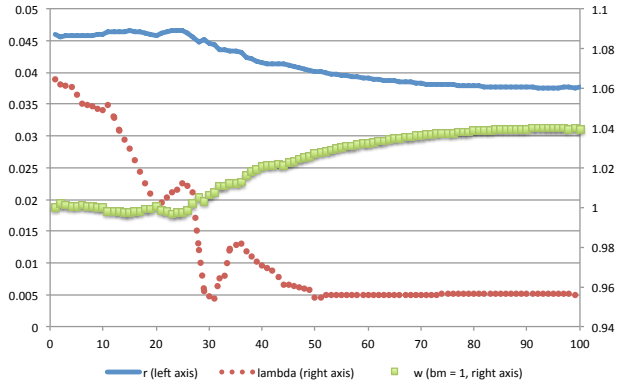
Finally, the model matches the observed evolution of federal expenditure on benefits to seniors very closely. It thus appears that our assumptions on the evolution of social security benefits are reasonable.

8 Conclusion

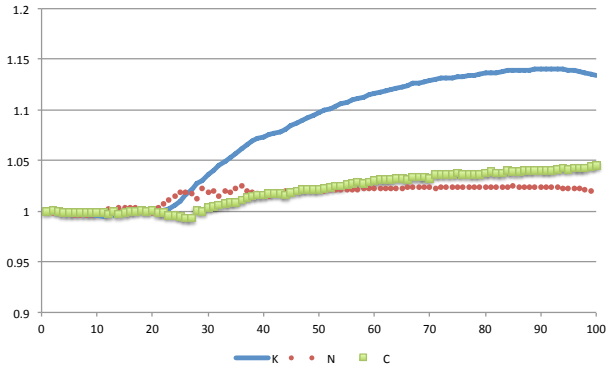
To be concluded...

Figure 13: Evolution of aggregates, prices and taxes over the transition

(a) Prices and taxes



(b) Aggregates (benchmark = 1)



A Additional Tables and Figures

Table 10: The Transition Matrix for The Life-cycle Productivity Process

$z_W \backslash z_W$	**6.7**	**19.2**	**20.5**	**58.4**	**61.4**	**1222**
6.7	0.967	0.009	0	0	0.002	0
19.2	0.006	0.970	0	0	0.002	0
20.5	0	0	0.967	0.009	0.002	0
58.4	0	0	0.006	0.970	0.002	0
61.4	0.034	0.034	0.034	0.034	0.826	0.014
1222	0	0	0	0	0.205	0.773

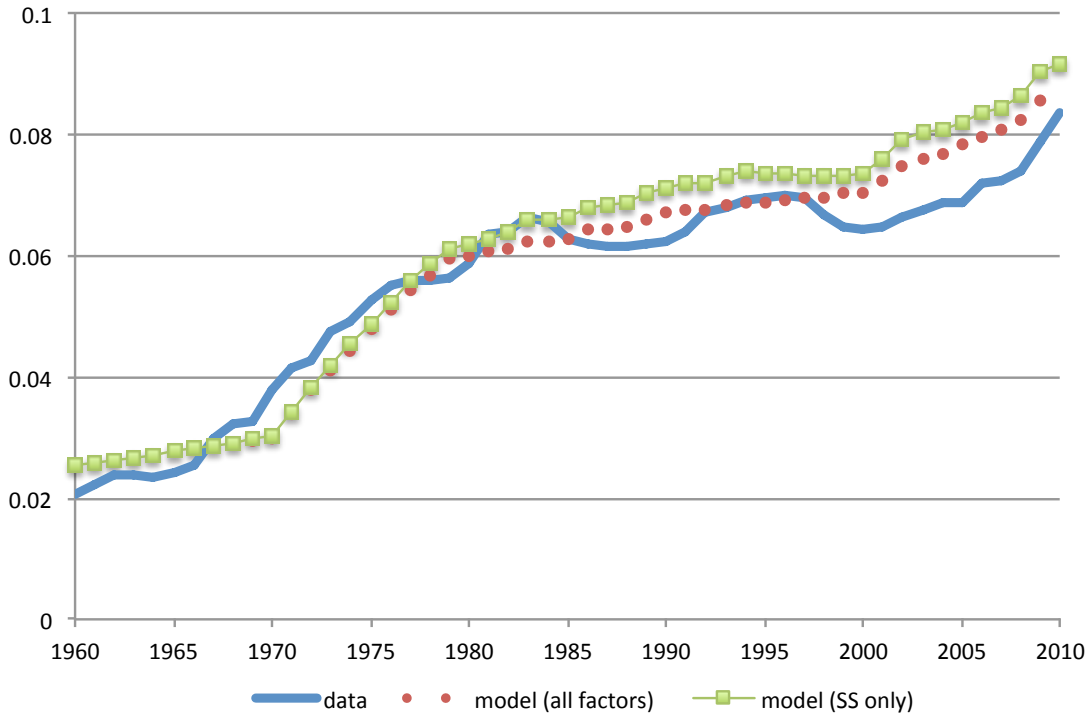


Figure 14: Federal benefits to seniors, model and data, 1960-2060

Note: Over this period, the fraction of seniors in the U.S. population over age 20 increases from 15% to almost 20% (U.S. life tables). Since in the model, no such change occurs, model numbers are adjusted for this figure only.

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