Aging and the Macroeconomy*

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Abstract

The U.S. population is aging and the age dependency ratio is increasing. We evaluate the implications of this phenomenon for the financing of social welfare programs and its macroeconomic consequences in a model that starts in 1955 and includes the demographic and policy changes experienced until now, and projects the composition of the U.S. population into the future. We show that the negative consequences of aging on the macroeconomy are largely mitigated by the increasing share of highly educated people in the population. In contrast, the increasing price of health provision poses a clear challenge to public finances. We evaluate alternative policies to counter this trend.

Keywords: Medicare, health expenditures, health insurance, overlapping generations.

J.E.L. codes: E21, E62, H51, I13

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1 Introduction

As the U.S. population is aging, the dependency ratio (number of dependents, aged below 15 and over the age of 65 to total population, aged 15 to 64) is increasing as well. The age dependency ratio has increased from 15 percent in 1960 to 21 percent in 2013, and it is projected to increase over the next century. The two major channels, that can lead to an aging population and increase this ratio, are: 1. Increasing survival probabilities and 2. Increasing number of college graduates. Survival probabilities have been increasing for individuals of all age in the U.S. For Example, survival probabilities of individuals of 85 years old and older have increased from 84 percent in 1968 to 87 percent in 2007. These probabilities are projected to increase in the next 100 years as well. This demographic change has a direct impact on the increase of the dependency ratio. Moreover, in the past 50 years, fraction of individuals with a college degree has tripled. Studies have shown college graduates are on average more productive compared to non-college graduate and they tend to live longer. Both of these two demographic changes increase the health expenditure as a result of increasing the life expectancy of individuals. However, rise in the share of college graduates increases the average productivity in the economy as well. If this channel is strong enough the increase in the output due to the higher level of productivity can cancel out the impact of the rise in the health expenditure by creating a lower health expenditure to output ratio. Yet the data shows the increase in the productivity cannot compensate for the increase in the health expenditure. Health expenditure to GDP ratio has increased from 0.06 in 1970 to 0.17 in 2014, Based on ????.

Another factor that plays a significant role in increasing the health expenditure in the U.S. is the rise in the relative price of medical care. SAY SOME FACTS HERE ABOUT IT COMPARE IT TO EU AND SUCH

This paper aims to investigate the implications of these demographic changes and the increase in the price of medical care for the U.S. macroeconomy and U.S. social welfare programs. To do so, we build a general equilibrium OG model with heterogeneous agents that builds on Conesa et al. (2016) and contains social medical programs such as Medicare, Medicaid, and food stamp. Moreover, we incorporate the increasing relative price of medical care in the U.S. since 1960 and consider different hypothetical scenarios for how it might evolve in the next century. Then, we calibrate the model along a transition path that embodies four features of the U.S. economy. We start the model in 1955 with social security and food stamps that includes basic medical relief. In 1965 we introduce Medicare and Medicaid to the model. The model also features increasing relative price of medical care from 1960 to 2009. We consider different paths for how the relative price might evolve in the future. Finally, we increase the survival probability and number of college graduates from 1960 to 2094 and study the effects on output, government financing, health expenditure, and inequality during the transition. The result shows that these demographic changes increase output per capita in the economy due to the increase in the share of productive individuals. However, the aggregate health expenditure, health expenditure per capita, and share of health expenditure in output increase PUT RESULTS HERE compared to the values in 1955. THIS PARTS SHOULD BE REWRITTEN USING THE FINAL RESULTS[The increase in the share of health expenditure in output means the rise in the output is not strong enough to compensate for the increasing health costs. We also predict an increase of 7 percentage points in the share of public health expenditure in output compared to the share in 1955. Moreover, the share of social security payments in output rises as well. Thus, government needs to increase the labor tax rates to finance higher public health expenditures. In the benchmark model, we forecast a 14 percentage points increase in the labor tax rates is sufficient for financing government expenditures. Higher labor tax rates and demographic changes lower the hours worked per capita by 13 percentage points in 2155 from its level in 1955. Finally, out model predicts an increase in the Gini coefficient and coefficient of variation both in labor income and wealth. Both results point to a rise in inequality.] We decompose the macroeconomic effects of the benchmark demographic transition by running two counterfactual experiments. First, we only increase the survival probability and fix the share of college graduates and study its implications. Then, we increase the share of college graduates and keep the survival probabilities fixed and evaluate the impacts on macroeconomic variables. As one might predict, both demographic changes increase the health expenditures since both result in higher dependency ratio. However, the increase in the share of college graduates is less costly since this demographic change is accompanied by an increase in the overall productivity in the economy.

In the benchmark model, we assume the relative price of medical care does not increase after 2009, which is the last year that we have data for it. Yet, this assumption might not be realistic SINCE??? (give some evidence or talk about some studies that try to predict this price). Thus, we evaluate the same model with an increasing trend for the relative price of medical care in the upcoming years. We use the data from 1980 to 2009 and extrapolate the trend until 2099. Under the increasing relative price, total health expenditure, health expenditure per capita, and share of health expenditure in output rise 340, 300, and 22 percentage points above their levels in 2055 in a century. The increase in these variables compared to the benchmark model is striking. The share of the public health expenditure in output increase to 16 percentage points above the share in 1955 which results in labor tax rates 28 percentage points higher than the rates in 1955. The increase in the relative price of medical care not only increases the health expenditure but also it discourages individuals from saving for their medical expenses. Thus, more individuals in costly health expenditure states opt into government programs such as Medicaid and food stamp. These individuals are less willing to work, which combined with lower capital per capita dampens output.

This modified version of the model illustrates the main source of increase in the health expenditure is the rise in the relative price of health care. Although demographic changes impact the aggregate variables noticeably, the magnitude of the impacts generated by the increase in the relative price of medical care is much higher.

Recently, several papers have documented a phenomenon that shows not only survival rate has been increasing in the past decades but also the quality of lives of elderlies has increased as well. Equivalently, they document that individuals in older ages tend to be more productive and healthy. This phenomenon is also known as "100 is the new 90". We incorporate this phenomenon in the model to investigate whether this increase in health and productivity can dampen the impacts of aging and the increase in the relative price of the medical care considerably or not. We increase the probability of survival for elderlies, reduce the probability of transitioning to costly health state, increase the probability of moving to less costly health states, and increase the age efficiency of individuals older than 65 years old. The results show that although 100 is the new 90 assumption increases the output per capita and reduces health expenditure and labor tax rates, the impacts are not strong enough to cancel out the effects of increase in the relative price of medical care.

Finally, we investigate the two alternative government policies that might remedy the impacts increase in the dependency ratio and price of medical care. First, we study the effects of increasing the share of college graduates in the next century. More specifically, we answer the question of by how much should the share of college graduates increase to dampen the increase in the health expenditure. (DO THIS EXPERNIMENT AND FIGURE OUT IF THIS EVEN HAPPENS.)

Second, we study the impacts of reducing the dependency ratio by increasing the share of working age individuals. The policy that generates this kind of behavior in the economy is the immigration policy. We ask by how much US. government should loosen the immigration rules to reverse the impacts of increase in the cost of medical care? Allowing more immigrants in the country reduces the age dependency ratio and addresses the aging problem. However, whether this force is strong enough to compensate for the increasing medical care expenses or not needs further investigation.

This paper is organized as follows. The next section relates our contribution to the literature. In section 3, we set up the environment of our economy and a quantitative life-cycle model. After calibrating the model in section 4, we turn attention to the result of the model. Section 5 studies the results of the benchmark model with two counterfactual experiments. Moreover, we extend the model and study two alternative policies in this section as well. Lastly, section 6 concludes and gives directions for future research.

2 Literature Review

This paper is related to three different strands of literature. Our framework builds on Conesa et al. (2016), which studies the roles of Medicare in the macroeconomy. It develops a general equilibrium overlapping generations model with incomplete markets and heterogeneous agents to measure the impact of an unexpected elimination of Medicare. Conesa et al. (2016) sheds light on the large costs of transitioning to a new steady state without Medicare. We use a similar framework and extend it by introducing demographic changes along the transition path into the model.

Finkelstein (2007) and Finkelstein and McKnight (2008) study the impact of the introduction of Medicare in the US on insurance coverage and health care expenditure. They find that the introduction of Medicare increased the share of elderly with insurance coverage by 75 percentage points.

This paper contributes to a literature that studies the impacts of an aging population on the macroeconomy. Attanasio et al. (2010) studies the impacts of aging on cost of Medicare program in a general equilibrium model with overlapping generations and finds that labor tax rates need to increase from 23 percent to 36 percent to balance the budget in the long run. Attanasio et al. (2010) suggests three policies to let the government alleviate the fiscal pressure from Medicare. A rise in Medicare premium, a reduction in the Medicare coverage rate, or a rise in the retirement age. Our paper obtains similar quantitative results in terms of needed increase in labor tax rates. However, we explore three factors that ease the future fiscal burden of rising medical costs and aging population: increase the share of college graduates, compression of morbidity, and increase the number of working age immigrants.

Our paper is also related to the literature on saving by the elderly. Palumbo (1999) explains the slow rate of dissaving among elderly Americans using a dynamic structural model of household consumption decision with uncertain health. In this model, older families choose their consumption level considering the effects of uncertain future medical expenses. Empirical evidence reveals that elderly Americans spend their financial assets during retirement much more slowly than is optimal under a life-cycle model that includes only uncertain lifespans. Palumbo (1999) shows that health uncertainty provides another important precautionary motive for consumption and saving decisions. De Nardi, French, and Jones (2015) provides two reasons for the slow rate of asset decumulation among retired U.S. households. First, elderly face the risk of uncertain lifespan and uncertain medical spending. Therefore, they hold on to their assets to cover medical expenses at very old ages. Moreover, individuals might have bequest motives. This paper builds a life cycle saving model of retirees with the two above features to explain the low dissaving rate among elderly.

Macroeconomics and aging: Jung and Tran (2016a) quantifies the effects of Affordable Care Act by developing a stochastic dynamic general equilibrium overlapping generations model with endogenous health capital accumulation. It finds that the introduction of ACA increases the insurance take-up rate of workers but it decreases the capital accumulation, labor supply, and aggregate output.

Macroeconomic effects of health: Pashchenko and Porapakkarm (2013) provides a quantitative analysis of welfare effects of ACA by constructing a general equilibrium life-cycle model that incorporates medical expenses and labor income risks. It finds that ACA decreases the number of uninsured more than twice and generates sizable welfare gains. Welfare gains are due to redistributive measures that are part of the ACA reform.

Jung and Tran (2016b) provides an analytical framework of an ?!!!!!

3 Model

In this section, we present the benchmark model. We consider a discrete time overlapping generations model in which the economy is populated by a continuum of ex-ante heterogeneous consumers. Consumers differ in age, assets, labor productivity, educational level, health status, and health insurance status.

3.1 Consumers

The economy is populated by a continuum of overlapping generations of individuals who live to a maximum of J periods. Consumers are indexed by type $s = (j, e, h, \eta_e, a, i)$, where j indicates age, e denotes educational level, h is health status, η is labor productivity, a represents assets, and i is the consumer's health insurance status. $\Phi(s)$ denotes the measure of agents of type s. In our model, educational level is permanent during agents' lifetime and can obtain two values of college and non-college. Individuals' health level is stochastic and varies with their age, education, and current health status. Health status is governed by a finite-state Markov process with stationary transitions over time:

$$Q_{j,e}(h, H) = Prob\left(h' \in H \,:\, (j,\, e,\, h)\right)$$

Labor productivity of agents follows a stationary finite-state Markov process:

$$Q(\eta, E) = Prob\left(\eta' \in E \,:\, \eta\right)$$

Health insurance status of each consumer specifies whether she has private health insurance, has employer provided health insurance, is self-insured, or is covered by government in the form of Medicare. Medical expenses, m_{jh}, depend on individual's age and health status and health insurance is used to pay for portions of these expenses.

From the age of jr onward, consumers recieve health insurance from the government in the form of Medicare and Social Security benefits SS_e that depends on their education. In every period, individuals face an exogenous survival probability of ψ_{jeh} which depends on their age, education, and health status. The assets of deceased agents are redistributed equally among all agents through lump-sum transfers, B.

Consumers are endowed with one unit of time in every period that can be used for work and leisure. Retirement age is endogeneously chosen by agents. This assumption is motivated by the observation that nearly 20 percent of individuals aged 65 and older still participate in the workforce. Labor supply, ℓ, is indivisible and can take on one of four values: $\ell \in \{0, \ell_p, l_f, l_e\}$, where p, f, and e refer to part time, full time, and extra time, respectively. Individuals derive utility from consumption, c and leisure, $1-\ell$ in the following form:

$$u(c,\ell) = \frac{\left[c^{\gamma}(1-\ell)^{1-\gamma}\right]^{1-\sigma}}{1-\sigma}$$

3.1.1 Firms

Firms hire labor at wage w and rent capital at rate r from the households to maximize profits. We assume that the aggregate technology can be represented by a constant returns to scale Cobb-Douglas production function:

$$Y = \theta K^{\alpha} N^{1-\alpha}$$

where θ denotes total factor productivity, K is the aggregate capital stock, N denotes aggregate labor supply (measured in efficiency units), and α is capital's share of income. Output is used for consumption, C, investment, $I = K' - (1-\delta)K$, and to cover medical expenses, M:

$$C + M + K' = \theta K^{\alpha} N^{1-\alpha} + (1-\delta)K$$

where δ is the rate of depreciation.

3.1.2 Health insurance and government welfare programs

This section presents the different types of health insurance that are available in the economy. As noted earlier, health insurance is available in the form of private insurance, employer-provided insurance, and Medicare. Health insurance is also provided by the government in the form of Medicaid and a combined food stamps and basic medical relief program (for brevity, referred to as food stamps below). The agent's insurance status determines what fraction of her medical expenses must be paid out-of-pocket, m_{op}. Throughout, we let χ_P, χ_E, χ_{CARE}, and χ_{CAID} denote the copayment parameter for private health insurance, employer-provided health insurance, Medicare, and Medicaid, respectively.

Private health insurance Agents can purchase health insurance for the following period from private insurance companies. We let private insurance companies price-discriminate based on age, education, and health. We assume that the price is actuarially fair for each insurance pool (j, e, h), i.e., the firm breaks even on each insurance pool. This gives the following expression for the insurance premium:

$$\pi_{jeh} = \begin{cases} \frac{\psi_{jeh}(1-\chi_P)\int m_{j'h'} Q_{j,e}\left(h, dh'\right)}{(1+r')} & \text{if } j < jr-1 \\ \\ \frac{\psi_{jeh}(1-\chi_P)\chi_{CARE}\int m_{j'h'} Q_{j,e}\left(h, dh'\right)}{(1+r')} & \text{if } j \geq jr-1 \end{cases}$$

We assume that Medicare is the primary payer for all elderly households, i.e., in the event that a household is covered by both Medicare and private insurance, Medicare pays first. This is captured in the second line of the formula by the Medicare copayment parameter.

Employer-provided health insurance We assume that a fraction of workers have health insurance provided by their employer. The employer pools the medical expenses of all their employees that do not choose to go on food stamps. These costs are then split evenly between all employees that currently work positive hours. That is, we model employer-provided health insurance as a pay-as-you-go system where current contributors pay for the health expenditures of current receivers. The premium is thus given by:

$$\bar{\pi}_E = \frac{(1-\chi_E)\int \mathbb{I}_{F=0} m_{jh} \Phi\left(\{1,\ldots,j_r-1\} \times de \times dh \times d\eta_e \times da \times \left\{i^E\right\}\right)}{\int \mathbb{I}_{\ell>0} \Phi\left(\{1,\ldots,j_r-1\} \times de \times dh \times d\eta_e \times da \times \{i^E\}\right)}$$

where the indicator function $\mathbb{I}_{F=0}$ in the numerator equals one for all agents that do not choose to go on food stamps. We assume that agents cannot have both employer-provided and private health insurance, and that agents cannot opt out of employer-provided insurance.[1] In addition, for computational tractability, we assume that agents aged jr and older are not eligible for employer-provided health insurance. That is, agents that continue to work in old age can only work for employers that do not provide health insurance. Since agents aged jr and older are not eligible for employer-provided health insurance, we let agents of age $jr-1$ with employer-provided insurance purchase private insurance for the following period.

Medicaid Medicaid is a means-tested program that provides health insurance to low income households. There are two ways to qualify for Medicaid. First, an agent is eligible for Medicaid if the sum of her gross income and interest earnings is below a threshold y^{cat}. Second, agents also qualify for Medicaid if the sum of their gross income and interest earnings net of out-of-pocket medical expenses is below a threshold y^{mn} and their assets are less than a^{mn}. Following Pashchenko and Porapakkarm (2013), we call the two eligibility criteria "categorical eligibility" and "eligibility based on medical need," respectively.

Medicare The government also provides health insurance in the form of Medicare. Unlike Medicaid, Medicare is not a means-tested program, but provides equal health insurance to all elderly households. Since Medicare does not cover all out-of-pocket medical expenses, elderly households can purchase private insurance as a complimentary insurance.

Food stamps and basic medical relief Finally, the government provides health insurance in the form of a combined food stamps and basic medical relief program. The program combines institutional features of food stamps, disability insurance, and basic medical relief programs for the poor. In order to qualify for this program in the model, agents have to forfeit all assets and work zero hours. In return, the government pays for all out-of-pocket medical expenses and guarantees a minimum consumption level, $\underline{c}$.

3.1.3 Government

The government finances its costs of providing health insurance, food stamps, and Social Security by means of payroll taxes. Let b_e denote the Social Security replacement rate conditional on the agent's educational level. Social Security benefits SS_e then satisfy:

$$SS_e = \frac{b_e w N}{\int \Phi\left(\{1,\ldots,j_r-1\} \times de \times dh \times d\eta_e \times da \times di\right)}$$

For simplicity, we assume that the government balances its budget period-by-period. Let gov denote total government expenditure on health insurance and food stamps. Taxes on labor income, τ, then have to satisfy:

$$\tau w N = SS_e \int \Phi\left(\{j_r,\ldots,J\} \times de \times dh \times d\eta_e \times da \times di\right) + gov$$

[1]We abstract from tax deductions for employer-provided health insurance premia, which have been shown to discourage healthy agents to opt out of group insurance in favor of private insurance (Jeske and Kitao, 2009). The assumption that households cannot opt out of employer-provided insurance is thus needed to alleviate the adverse selection problems associated with group insurance plans.

3.2 Household problem

Before we present the household problem, let us describe the timing of events. At the beginning of the period, agents observe the realization of their idiosyncratic labor productivity shock and their health status, the latter of which also determines the value of their medical expenditure shock. They also receive transfers from accidental bequests. Then, households supply labor and capital to the firm, after which production takes place, households receive factor income, workers pay taxes, and old agents receive Social Security benefits. Next, households receive health transfers from the government if they are on Medicare or Medicaid, from their employer if they have employer-provided insurance, or from private insurance companies if they purchased insurance in the preceding period. Then, agents pay out-of-pocket medical expenses and make their intertemporal decisions, i.e., they make their consumption-savings choice and decide whether or not to purchase private health insurance for the following period. The present discounted value of these choices are compared to the value of going on food stamps. If the value is higher under food stamps, the government seizes the agent's assets, pays all of her out-of-pocket medical expenses, and provides her with consumption $\underline{c}$. Finally, the uncertainty about early death is revealed.

The agent's choice set depends on her current age and insurance status. Thoughout, we use the word young to denote agents of age less than jr and old to denote agents that are at least jr years old. We start by presenting the problem of a young agent with employer-provided health insurance. This subsection also defines the value of going on food stamps. Next, we set up the problem faced by young households without employer-provided health insurance. Lastly, we discuss the problem of old agents.

3.2.1 Young households with employer-provided health insurance and the value of food stamps

Recall that an agent's type is given by $s = (j, e, h, \eta_e, a, i)$, where j denotes age, e is educational level, h denotes health status, η_e is labor productivity conditional on education, a denotes assets, and i is the household's health insurance status. Let $V^E(s)$ denote the value of being on employer-provided health insurance. Similarly, let $V^F(s)$ denote the value of food stamps. Then the problem of a young household with employer-provided insurance is given by:

$$V(s) = \max \left\{ V^E(s), V^F(s) \right\}$$

where $V^E(s)$ is given by:

$$\begin{aligned}
V^E(s) &= \max_{c,a',\ell} \; u(c,\ell) + \beta\psi_{jeh} \iint V(s') Q_e(\eta, d\eta') \, Q_{j,e}(h, dh') \\
s.t. &\quad c + a' + m_{op} + \mathbb{I}_{\ell>0}(\bar{\pi}_E) = w(1-\tau)\,\epsilon_{je}\eta\xi(h)\,\ell \\
&\qquad\qquad + (1+r)(a+B) + \mathbb{I}_{Med}(s,\ell)(1-\chi_{CAID})\, m_{op} \\
&\quad m_{op} = \chi_E m_{jh} \\
&\quad \ell \in \begin{cases} 0, \ell_p, \ell_f, \ell_e & \text{if sick} \\ \ell_p, \ell_f, \ell_e & \text{if healthy} \end{cases} \\
&\quad c, a' \geq 0 \\
&\quad i' = i_E
\end{aligned}$$

The indicator function on the right-hand side of the budget constraint equals one if the agent qualifies for Medicaid. Medicaid covers a share $1 - \chi_{CAID}$ of out-of-pocket medical expenses, which are given by $\chi_E m_{jh}$ for agents on employer insurance. All agents on employer insurance that work positive hours must pay a premium $\bar{\pi}_E$. We assume that healthy agents on employer insurance have to supply a minimum of $l_P > 0$ hours. Sick households, on the other hand, are free to choose zero hours. In the model, households are considered sick if they have a catastrophic health state.

In order to qualify for food stamps in the model, agents have to forfeit all assets and work zero hours. In return, the government covers all out-of-pocket medical expenses and provides the agent with consumption

$\underline{c}$. The value of food stamps is thus given by:

$$
\begin{aligned}
V^F(s) \quad = \quad & u(\underline{c}, 0) + \beta\psi_{jeh} \iint V(s')Q_\eta(\eta, d\eta') Q_{j,e}(h, dh') \\
& s.t. \quad a' = 0 \\
& \qquad i' = i_E
\end{aligned}
$$

Note that agents that choose to go on food stamps continue to be eligible for employer insurance in the following period.

3.2.2 Young households without employer-provided health insurance

Let $V^I(s)$ denote the value of young agents without employer-provided health insurance. Households without employer insurance that do not choose to go on food stamps may or may not purchase private insurance for the following period. This yields the following problem:

$$
V(s) = \max \left\{V^I(s), V^F(s)\right\}
$$

where $V^I(s)$ is given by:

$$
\begin{aligned}
V^I(s) \quad = \quad & \max_{c,a',\ell,i'} \; u(c, \ell) + \beta\psi_{ehj} \iint V(s')Q_e(\eta, d\eta') Q_{j,e}(h, dh') \\
s.t. \quad & c + a' + m_{op} + \mathbb{I}_P(i')\pi_{jeh} = w(1-\tau)\epsilon_{je}\eta\xi(h)\ell \\
& \qquad + (1+r)(a+B) + \mathbb{I}_{Med}(s,\ell)(1-\chi_{CAID})m_{op} \\
& m_{op} = \mathbb{I}_P(i)\chi_P m_{jh} + (1 - \mathbb{I}_P(i)) m_{jh} \\
& \mathbb{I}_{\mathbb{P}}(i) = \begin{cases} 1 & \text{if } i = i_P \\ 0 & \text{otherwise} \end{cases} \\
& \ell \in \{0, \ell_p, \ell_f, \ell_e\} \\
& c, a' \geq 0 \\
& i' \in \{i_P, i_S\}
\end{aligned}
$$

Here, $i = i_P$ means the household has private health insurance and $i = i_S$ means the household is self-insured. Out-of-pocket medical expenses are given by m_{jh} for self-insured households and $\chi_P m_{jh}$ for agents that purchased private insurance in the preceding period. Finally, the value of going on food stamps is the same as above with the exception that households are self-insured in the following period, i.e., $i' = i_S$.

3.2.3 Old households

Let $V^R(s)$ denote the value of an old agent of type s. Similarly to young households without employer-provided health insurance, old agents that do not choose to go on food stamps may or may not purchase private insurance for the following period. This yields the following problem:

$$
V(s) = \max \left\{V^R(s), V^F(s)\right\}
$$

where $V^R(s)$ is given by:

$$
\begin{aligned}
V^R(s) \quad &= \quad \max_{c,a',\ell,i'} \; u(c,\ell) + \beta\psi_{jeh} \iint V(s')\, Q_e(\eta, d\eta')\, Q_{j,e}(h, dh') \\
& s.t. \quad c + a' + m_{op} + \mathbb{I}_P(i')\,\pi_{jeh} = w(1-\tau)\,\epsilon_{je}\eta\xi(h)\ell \\
& \qquad\qquad + (1+r)(a+B) + SS_e + \mathbb{I}_{Med}(s,\ell)(1-\chi_{CAID})\, m_{op} \\
& \qquad m_{op} = \mathbb{I}_P(i)\chi_P\chi_{CARE} m_{jh} + (1-\mathbb{I}_P(i))\chi_{CARE} m_{jh} \\
& \qquad \mathbb{I}_P(i) = \begin{cases} 1 & \text{if } i = i_P \\ 0 & \text{otherwise} \end{cases} \\
& \qquad \ell \in \{0, \ell_p, \ell_f, \ell_e\} \\
& \qquad c, a' \geq 0 \\
& \qquad i' \in \{i_P, i_S\}
\end{aligned}
$$

All households start receiving Medicare and Social Security benefits at age jr.[2] Neither program is tied to retirement, and hence households continue to receive both Medicare and Social Security benefits even if they choose to work in old age. Out-of-pocket medical expenses are given by $\chi_{CARE} m_{jh}$ for self-insured households and $\chi_{CARE}\chi_P m_{jh}$ for agents that purchased private insurance in the preceding period.

3.3 Welfare

We quantify the welfare effects of the policy experiments by computing perfect income indices. The change in this index measures how much an individual's lifetime income has to increase to make her indifferent between the old steady state and the economy under the new policy.[3]

3.4 Definition of equilibrium

Given a replacement rate b_e, copayment parameters χ_P, χ_E, χ_{CARE}, and χ_{CAID}, and initial conditions for capital K_1 and the measure of types Φ_1, an *equilibrium* in our model is a sequence of model variables such that:

1. Given prices, insurance premia, government policies, and accidental bequests, households maximize utility subject to their constraints.
2. Factor prices satisfy marginal product pricing conditions.
3. Government policies satisfy the government budget constraint.
4. Goods, factor, and insurance market clearing conditions are met.
5. Aggregate law of motion for Φ is induced by the policy functions and the exogenous stochastic processes for idiosyncratic risk.

[2]For simplicity, we abstract from the fact that individuals can start claiming reduced Social Security benefits before full retirement age. Nor are agents in the model allowed to wait until age 70 before they start claiming Social Security benefits in order to earn "delayed retirement credits."

[3]The perfect income index for an individual of type s is given by:

$$PII(s) = \left[\sum_{t=1}^{J} E_t \beta^{t-1} (c_t^{\gamma}(1-l_t)^{1-\gamma})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

Integrating across types:

$$PII = \int_s PII(s)\Phi(ds)$$

The difference in perfect income indices can then be used to quantify the welfare effects of various reforms.

4 Calibration

In this section, we discuss our calibration strategy. We introduce demographic changes into the model and study how macroeconomic aggregates evolve between 1955 to 2094 given different predictions for the evolution of the relative price of the medical care in the next century. We start by introducing the the Medical Expenditure Panel Survey (MEPS) and how we utilize it to compute the medical expenditure associated to each health shock in our model in subsection 4.1. Table 1 and table 2 present the non-insurance and insurance parameters that are determined outside of the model and subsections 4.2 and 4.3 summarize the calibration of the Medicaid eligibility criteria, preferences, technology paramters, and earning process parameters respectively. Finally, in subsection 4.4 we discuss how we calibrate the model along the transition path and discuss the demographic changes that we introduce into the model.

4.1 Health expenditure in the data

We utilize data from the MEPS to compute the copayment parameters for the private insurance, employer insurance, Medicare, and Medicaid. The MEPS survey contains records on medical expenditure, insurance, income, and demographics for a nationally representative sample of households. The survey consists of two-year overlapping panels for the period 1996 to 2013, of which we pool data from 2000 to 2013 for individuals aged 20 to 85 years. All nominal series are converted to 2010 dollars using the GDP deflator.

The MEPS divides the payments for medical expenses into five categories: private insurance, Medicare, Medicaid, out-of-pocket, and a residual source denoted by “other.” Private insurance contains both employer-provided insurance and privately purchased health insurance. Medicare and Medicaid are public health insurance programs that provide health insurance to the elderly and to the poor, respectively. Lastly, the residual category includes other federal or state programs and Workers’ Compensation. In the model, we have three levels of medical expenditure: low, high, and catastrophic. To estimate these cost levels, we pool all medical expenses of each age group and the 60th and 99.9th percentile for each age bin. Then, we assign the mean value of 0 to 60th percentile, 60th to 99.9th percentile, and 99.9th percentile and above to low, high, and catasrophic expenses, respectively. Finally, we detrend the series using a log-linear trend.

4.2 Health insurance parameters and Medicaid eligibility criteria

Copayment parameters of private insurance, employer insurance, Medicaid, and Medicare are computed using MEPS data in the same manner as Conesa et. al. (2016). First, we specify each indiviual’s primary insurance provider. Primary insurance provider is the insurer that pays the largest share of individual’s health expenses. Then, we compute the average share of expenses paid by each insurer, given that the insurer is the primary insurance provider of the individual. The numbers we obtain are reported in table 1. Moreover, to compute the Medicaid income and asset test parameters, we utilize data from Kaiser Family Foundation. The data shows, in 2009, in 33 states the financial eligibility criteria was around $10,800 which is equivalent of 23 percent of GDP per capita. The weighted average categorical income limit, with weights given by each state’s share of total health expenditures, was 90.2 percent of the FPL.

Similarly, the corresponding weighted average of medically needy income and asset limit was 41.9 percent of the FPL and $1,950 in 2009, respectively. Given this information, we set the Medicaid income and asset thresholds to match the corresponding weighted average limits in the data. A summary of these health insurance parameters is given in table 1.

4.3 Preference, technology, and life-cycle parameters

In our model, each time period is 5 years and agents enter the model at age 20. We set jr to 10. Therefore, households start receiving Medicare and Social Security benefits between the age of 65 to 69. The last age bin of the model is set to 100-104 years.[4] To set the population growth rate, we follow Conesa and Krueger (1999) and set it to 5.6 percent (equivalent of 1.1 percent per year). Capital’s share of income is set to 0.36 and the depreciation rate to 0.262. We set the consumption share in intratemporal utility to 0.574 to match

[4]The MEPS pools all medical expenses for individuals older than 85. As the maximum age in the model is 104, we extrapolate medical expenses for individuals aged 85 to 104.

estimates in French (2005). Finally, σ is set to 2.667 to match an intertemporal elasticity of substitution of 0.5. (CHANGE THE UTILITY FUNCTION EVENTUALLY?)

In our model, households are endowed with one unit of time that will be allocated between labor and leisure. We let the labor supply of each individual can take 4 values, $\ell \in \{0, 0.225, 0.300, 0.375\}$, in which agents can choose not to work, work part time, full time, or overtime. Moreover, we assume health specific labor productivity, $\xi(h)$, takes the value of 1 for individuals with low or high health expenditure and it takes the value of 0 for individuals with catastrophic health expenditure. We use MEPS data to estimate deterministic labor productivity profiles, ϵ_{je}. Lastly, transition probabilities between health states are computed by running an ordered probit regression of next period's health on current age, age squared, education, health, and interaction terms. A similar probit regression is used to estimate survival probabilities. A summary of the non-insurance parameters that are determined outside the model is given in table 2.

Parameters in table 3 are jointly determined in equilibrium using the data between 2005 to 2009. Values extracted from the data are converted to match the 5 year long time periods in the model. Total factor productivity, θ, is calibrated to generate a steady state GDP per capita of 1 in the benchmark model. The discount factor, β, is set to 0.70 to match a capital to output ratio of 3. We use the average Social Security benefits of individuals with and without a college degree to estimate the Social Security replacement rates, b_c and b_{nc}. Consumption floor, $\underline{c}$, is set to match the average of the annual value of food stamps of $\$1,300$. In this model, a fixed fraction of inidviduals have access to employer provided insurance. The mass of 20 year olds with employer insurance is calibrated to match the mass of individuals with both private and employer insurance in the data.

To estimate the earning process parameters, similar to Conesa et al. (2016), we follow Castañeda et al. (2003) and calibrate the parameters of the labor earnings process to match the empirical earnings distribution in the U.S.. We choose a right skewed productivity shock process to match the top decile of the earnings distribution, and calibrate the variance of the process to match the dispersion observed in the data. The comparison of the labor earnings distribution in the model and the data reported in table 4 shows that the model successfully matches the empirical distribution. A similar comparison of the wealth distribution is given in table 5. Although we do not calibrate the model to match this distribution, the table verifies that the model generates a concentration and right skewness of wealth that is comparable to what we observe in the data. For completeness, the tables also report the corresponding distributions in the model without Medicare. We find that Medicare only has minor effects on the wealth and labor earnings distribution in the economy.

4.4 Transition and demographic changes

The model is calibrated along the transition path and it embodies four features of the U.S. economy. The model starts in 1955 with social security and food stamps plus basic medical relief. We introduce Medicare and Medicaid to the model in 1965. The model also features increasing relative price of medical care from 1960 to 2009. We consider different paths for how the relative price might evolve in the next century. Finally, we increase the survival probability and number of college graduates from 1960 to 2094 and study the effects on output, government financing, health expenditure, and inequality during the transition. We assume the economy is in steady state in 2009, target moments of interest, and then we fix parameters over time in the model. (AM I RIGHT?)

Similar to Conesa et al. (2016) we estimate age efficiency, survival probabilities, health transition probabilities, and medical expenses in 2006-2009 using data from the MEPS and convert them to 5 year estimates. From these estimates, we conclude that college graduates are more productive and they tend to survive longer on average comapred to individuals without a college degree. However, elderly and college gradutes are more likely to transition to high and catasrophic health states.

To incorporate the rise in the relative price of the medical care, we utilize the health expenditure to GDP ratio in the data. Health expenditure to GDP ratio was around 0.05 in 1955 but this ratio has increased to 0.16 over the past 60 years. We calibrate the 2005-2009 relative price of the medical care such that the 2005-2009 health expenditure to GDP ratio matches that of data. The evolution of the relative price of the medical care in the future impacts our analysis of how macroeconomic variables in the economy will behave in the next century. Thus, we consider multiple alternative scenarios in which the relative price of the medical care will 1. remain the same as its level in 2009, 2. increase in a log linear trend 3. increase in a way similar to its evolution in Europe. (MAYBE ADD A PLOT THAT SHOWS THEM)

To predict the evolution of macroeconomic variables in the economy, it is crucial to know how the relative price of the medical care will evolve

The two major demographic changes over the past 50 years has been the increase in the share of college graduates and the increase in the survival probabilities. In this paper, we aim to study the effects of these changes on macroeconomic aggregates over time. Thus, we start with fixed survival probabilities and share of college graduates in the initial steady state and then introduce the above two changes into our model along the transition path.

A higher share of college graduates in the economy leads to a higher dependency ratio (since on average college graduates live longer) which increases health spending. Moreover, conditional on age, having more college graduates lead to higher medical expenditure since college graduates spend more on health. However, this increase in the health spending might be canceled out by the increase in the output which is the result of increase in the share of college graduates who tend to be more productive comapred to individuals without a college degree. Therefore, the overall impact of increasing the share of college graduates on the health expenditure to GDP ratio is ambigous. To capture this demographic change, we calibrate the share of newborns (aka 20 year olds) with a college degree in 1955-2009 to match the fraction of college graduates among the 25+ people in 1960-2014. We extrapolate the share of college graduates using a log linear trend in 2015-2094.

To match the survival probabilities over time, we introduce a demographic change along the transition path. We estimate the trend for age specific survival probabilities using data from U.N. from 1960 to 2094. Then, we scale the age, educaltion, and health dependent survival probabilities that we computed from MEPS to match the survival probabilities from UN that are age and time dependent:

$$\psi_{jeht} = \psi_{jt}(scale)\psi_{jeh}(MEPS)$$

This equation implies that we assume given a specific age j, survival probabilities do not vary across time for different education or health categories. After we introduce these two demographic changes in the model, we study how macroeconomic aggregates such as output, government financing, health expenditure, and inequality evolve over the next century.

5 Results

In this section, we evaluate the impact of two demographic changes on the various aggregate varibales in the economy using the model described above. Both of the demographic changes considered in this paper increase the dependecy ratio. [5] Figure 1 shows the increase in the dependecy ratio due to the increase in the share of college graduates and survival probabilities.

We use the model to evaluate the effects of aging in the economy and then study potential government policies and investigate if these policies can dampen the effects of increase in the dependecy ratio on aggregate variables for each given path of price of the medical care. More specifically we will focus on the following policies. 1. Investing in increasing the share of college graduates. Increase in the share of college graduates increases the dependency ratio. However, higher share of college graduates increases the aggregate productivivty of the economy, thus, the GDP. 2. Relying on increasing productivity of elderlies. 3. Allowing for more immigration.

In our benchmark model, we fix the price of medical care after 2009. Later, we relax this assupmtion and consider two other paths for evolution of the relative price of the medical good. As one might expect, when we assume an increasing pattern for the relative price, the outlook of the economy looks noticably worse in terms of health expenditure. We show most of the increase in the health expenditure is driven by the increase in the relative price of medical good and not by aging of the economy.

First, we discuss the results of the benchmark model. Then, we study 3 potential government policies to investigate if any of these policies can cancel out the effects of ageing. Then, we assume a different path for the evolution of the relative price and revisit the potential government policies.

[5] Dependency ratio is defined as the share of total number of individuals of age 65 to 104 over the total number of individuals of age 20 to 64.

In the benchmark model with fixed relative price of medical care the output per capita increases. Figure 3 shows the percentage increase in the ouyput per capita compared to its level in 1955. To examine the contibution of each of the two dempgraphic changes on aggregate variables, we evaluate the effect of each of them separately. It can be seen in figure 3 that when only survival probability increases, due to a larger share of retired individuals, the output per capita drops. However, when we only increase the share of college graduates, we observe that output per capita increases. That is due to the increase in the share of higher productivity individuals in the economy. The overall impact of these two demographic changes is an increasing trend in the output per capita that means the increase in the share of college graduates has a stronger impact on the overall output per capita comapred to the increase in the survival rate.

REWRITE THESE PARTS WITH PRECISE NUMBERS WHEN GRAPHS ARE FINZALIZED [Consumption per capita drops relative to 1955 due to the increase in the survival probability. Even though the increase in the college graduates dampens the decrease in percentage change compared to 1955, the effects are not strong enough to make the overall change positive. Figure 4 shows the impact of demographic change on consumption per capita and consumption plus medical expenditure per capita.

As one might predict the total health expenditure, health expenditure per capita, and health expenditure to output ratio all increase. Since we assume the price of medical care does not increase after 2005 in the benchmark model, the increase in the health expenditure slows down. After 2005 health expenditure grows solely due to the increase in the dependecy ratio. Figure 5 shows that if the price of medical care does not increase the increase in the share of college graduates can reduce the health expenditure to output ratio.

The increase in dependency ratio, increases the share of social security expenditure to output and public health expenditure to output. To finance its expenditure, government increases the labor tax rates. Our model predicts an increase of 12 percentage point in labor tax rate in 2100 as compared to the rate in 1955. As figure 6 illustrates increase in the survival probabilities has a stronger effect on public spending.

Hours worked per capita decreses more than 10 percentage point compared to the hours worked in 1955. When the share of college graduates increases higher share of working age population choose to work and lower share choose to be on Medicaid or food stamp programs. Yet, due to the higher share of retired population, higher tax rates, and lower wages the overall impact of increasing the college graduates is negative on the hours worked per capita. Figure 7 how wage rates and hours worked per capita are effected by demographic change. Labor earning and wealth inequality both increase. Figure 8 depicts Gini index and coefficient of variation for labor income and wealth inequality.]

In the next subsection, we relax the assumption of fixing the price of medical care. We extrapolate the relative price in two different manners and restudy the effects of demographic change when price of medical care increases. First, we assume a logaritmic trend for the relative price from 1980 to 2009 and then extrapolate it until 2099. Then, we consider a more subtle path for the evolution of the relative price of the medical care that is similar to its evolution in Europe. Finally, we study 3 alternative government policies to evaluate if these policies can dampen the impacts of aging and possible increase in the relative price of medical care and keep health expenditure in the U.S. sustainable.

5.1 Increasing the relative price of medical care

In the benchmark model, we assumed the relative price of the medical care does not increase after 2009 due to data limitation. [6] In this subsection we relax this assumption and evaulate the aggregate variables in the economy by extrapolating the relative price. First, we assume an logaritmic trend from 1980 to 2009 and extrapolate the trend until 2099.

REWRITE WITH FINAL NUMBERS[As one can expect, increasing the relative price of the medical care increases the health expenditure, health expenditure per capita, and health expenditure as a share of GDP dramatically. Health expenditure to GDP share increases by 14 percentage points in 2155 as compared to the benchmark model in the same year. Figure 9 and 10 ilustrate the estimate for the increase in the relative price of medical care and the health care expenditures, respectively. As the result of the increase in the price of medical care, government faces higher share of public health expenditure to GDP. The social security expenditure does not vary compared to the benchmark model. To finance the higher expenditures, government increases the labor taxes rates. The new rates reach 28 percentage points above the rates in 1955. These rates are comparable to tax rates reported by Attanasio, Kitao, and Violante (2010). Figure 11

[6] The data is available from 1960 to 2009.

shows labor tax rate, public health expenditure to output ratio, and social security expenditure to output ratio.

Effective labor per capita and hours per capita decrease compared to the benchmark model since higher price for medical care forces a larger share of population to opt to programs such as food stamp for which individuals choose not to work. Moreover, the rise in the price of medical care reduces the saving incentives of the idividuals and that results in a large drop in the capital per capita. Capital per capita faces a 20 percentage point drop by 2155 compared to its value in 1955 if relative price of medical care increases in manners similar to what we estimate. Thus, the output drops compared to the benchmark model and falls below its 1955 levels. These aggregate variables are depicted in figure 12.]

HERE ADD THE RESUTLS FOR THE CASE THAT RELATIVE PRICE MIMICS EUROPE PATH

The increase in the relative price of medical care has significant impacts on all aggregate variables in the economy.

6 Government policy

In this section, we investigate if the effects of aging population and potential increase in the price of medical care can be canceled out by some recent phenomenon obsevered and documented in the economy or by some government policies.

6.1 Increase the share of college graduates

GET RESULTS ON THIS POLICY FOR ALL THREE POSSIBLE RELATIVE PRICE OF MEDICAL CARE AND WRITE UP.

6.2 Compression of morbidity

The preceding subsection studies the impact of a documented phenomenon called compression of morbidity. This phenomenon points out that along with the increase in the survival probabilities the number of years individuals live healthy has increases as well. Several studies have shown in the past few decades the quality of the life of elferlies have increased. TALK ABOUT A FEW PAPERS HERE

We assume individuals below the age of 65 have not become more productive since most of the change is observed for individuals at older ages. However, we adjust medical expenses, health transition probabilities, and age efficiency of individuals above 65 such that these values for a 100 year old in the year bin 2005-2009 are equal to the same values for a 90 year old in age bin 2000-2004. Then, having the values fixed as before for 65 years old, we interpolate these variables for individuals between 65 and 100. Moreover, we allow for time trends from 2010 to 2095. Figure 13 shows how medical expenditure, health transition probabilities, and age efficiency change under theis phenomenon. Medical expenses decrease in low, high, and catastrophic health states. Age specific productivity levels for both college and non college individuals increases for indivuduals after age 65. Furthermore, the probability of landing in the health state with a low cost increases while the probabilities of moving to the states with high and catastrophic health states decreases.

IN THIS PART, MAYBE HAVE PLOTS WITH ALL THREE RELATIVE PRICES IN THE SAME PLOT

THE RESULT PART NEEDS TO BE REWRITTEN

[[First we discuss the implications of this phenomenon on aggregate variables in the benchmark model. Figure 14 demonstrates percentage change in the output per capita in the economy compared to 1955. 100 is the new 90 assumption increases the output per capita compared to the benchmark model. Since individuals are more productive in older ages they choose to retire later in life. Moreover, they face lower medical costs and lower probabilities of transitioning to high cost states. All these changes result in indivuals that are healthier, work until older ages in life, and save more. However, when we add the increasing relative price of the medical care to the benchmark model, the effects of 100 is the new 90 on output and capital per capita dampen dramatically. Output per capita seems to be slightly about its level at 1955 but capital per capita decreases more than 10 percentage points as compared to its value at 1955. The high price of medical care discourage individuals from saving and guides them toward medical programs financed by the government.

However, effective labor pc increases close to 10 percentage points as compared to the 15 percentage point increase when we do not consider the increase in the price.

When we only consider 100 is the new 90, all measures of health expenditures decrease slightly compared to the benchmark. Notice that due to demographic changes over time these expenses increase drastically when comapred to their levels in 1955. However, when we add the increasing price of the medical care, the impact of the increase in th eproductivity of the elderlies gets washed out. As figure 15 shows the impact of the 100 is the new 90 is not strong enough to dampen the effects of rising price of medical care. Thus, the extended version of the model predicts more than 300 percentage points increase in the total health expenditure when compared to 1955. Health expenditure per capita is also predicted to rise close ro 300 percentage points. Finally, the share of health expenditure in the output increases by nearly 20 percentage points.

The increase in the health levels and productivity of elderlies results in lower public health expenditure as a share of output as depicted in figure 16. Moreover, labor tax rates decrease slightly compared to the benchmark model since the government faces lower health expenditures. Social secutiry payments as a share of GDP remain unchanged since survival probabilities do not vary. However, as it can be seen in figure 16 similar to other aggregate variables government financing needs increases noticably when we add increasing price of medical care to the model. The model with both extensions predict an increase of more than 25 percentage points in labor tax rates comapred to the rates in 1955.

We conclude that the overall impact of the increase in the relative price of the medical care tends to stronger than compression on morbidity phenomenon. However, aging and demographic changes in the economy do not seem to be the main source of increase in the medical expenditure and predicted labor tax rates.]]

6.3 Immigration

In this subsection, we investigate whether the increase in the share of working age population can reverse the impact of aging and increase in the relative price of medical care on the aggregate variables in the economy or not.

PUT IN REAULTS FOR 3 RELATIVE PRICE IF WE DECIDE TO PUT THIS IN

7 Sensitivity analysis

8 Conclusion

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Table 1: Insurance parameters determined outside the model

Parameter	Description	Source	Value
χ_P	Private insurance copayment parameter	MEPS	0.229
χ_E	Employer insurance copayment parameter	MEPS	0.229
χ_{CARE}	Medicare copayment parameter	MEPS	0.500
χ_{CAID}	Medicaid copayment parameter	MEPS	0.138
y^{cat}	Categorical income	Kaiser Family Foundation	0.197
y^{mn}	Medically needy income	Kaiser Family Foundation	0.092
a^{cat}	Categorical assets	Kaiser Family Foundation	0.041

Table 2: Non-insurance parameters determined outside the model

Parameter	Description	Source	Value
J	Maximum life span (20-104 years)		17
jr	Agents receive SS and Medicare (65-69 years)		10
g_n	Population growth rate (annual rate = 0.011)	Conesa and Krueger (1999)	0.056
α	Capital income share	BEA	0.360
δ	Depreciation rate (annual rate = 0.059)	BEA	0.262
γ	Consumption share in utility	French (2005)	0.574
σ	IES = 0.5		2.667
ℓ_p, ℓ_f, ℓ_e	Indivisible labor		0.225,0.300,0.375
$\xi(h)$	Health-specific labor productivity		1,1,0
	Fraction of agents with college degree	MEPS	0.235

Figure 1: Dependency ratio

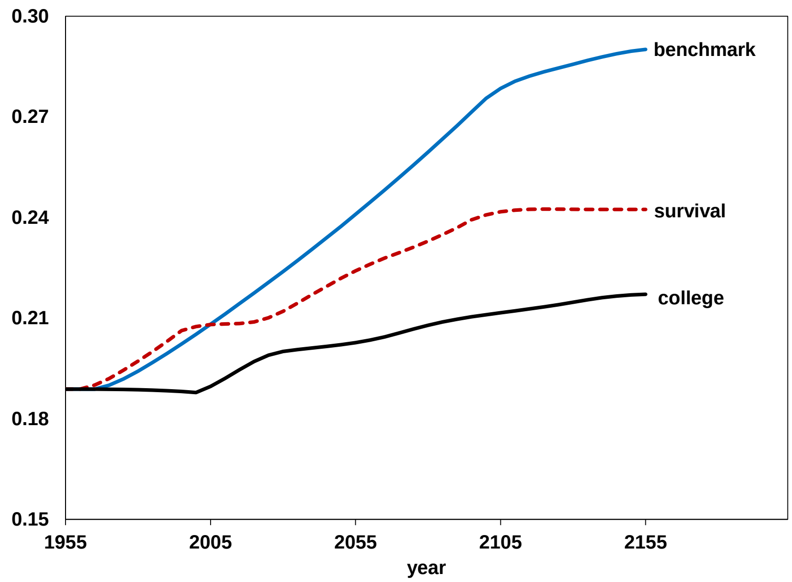


Figure 2: Health expenditure by source

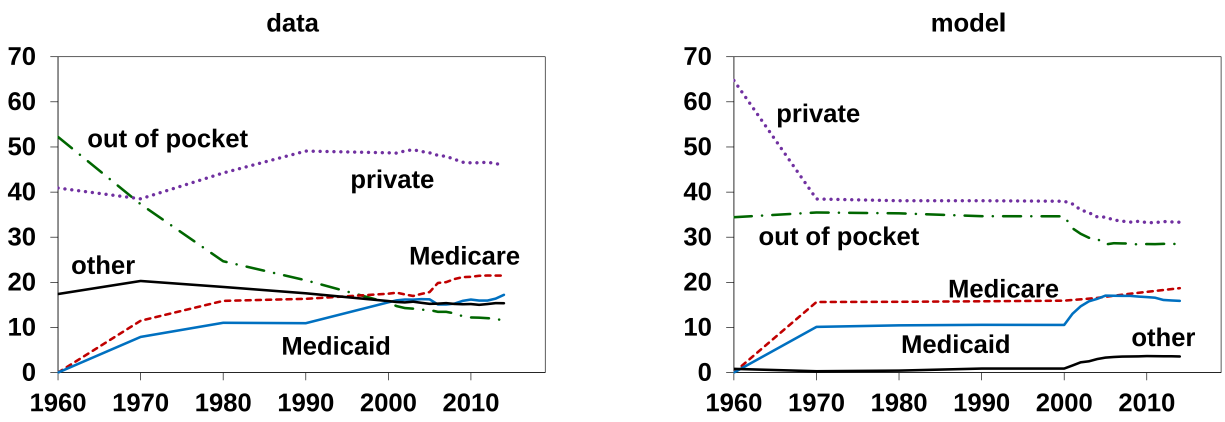


Figure 3: Output per capita

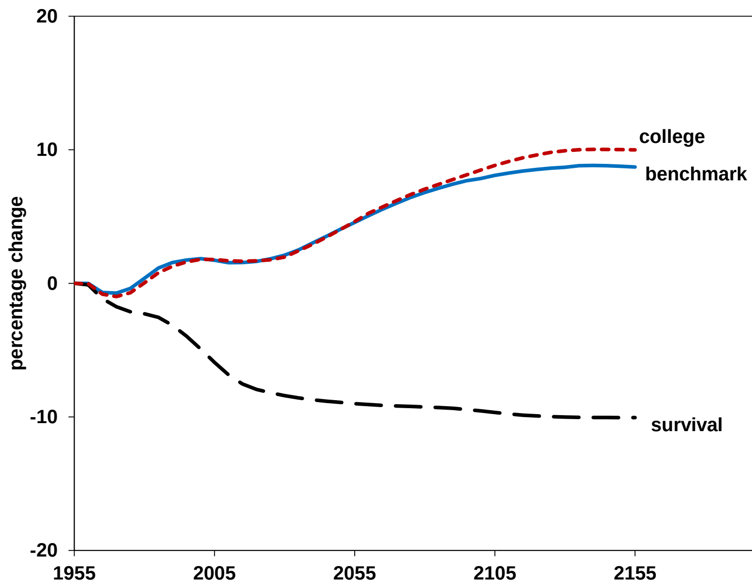
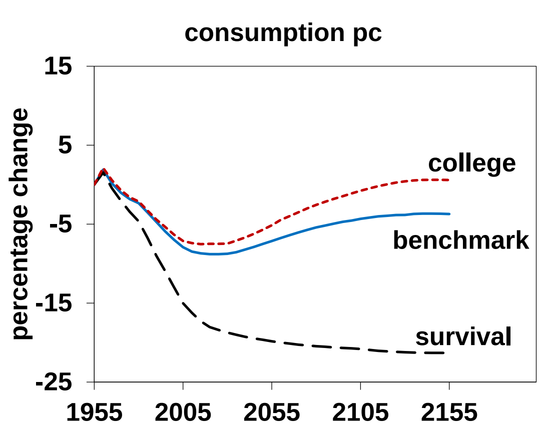


Figure 4: Consumption per capita



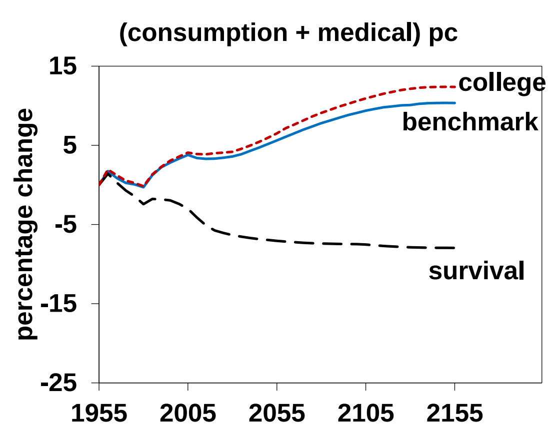


Figure 5: Health expenditure

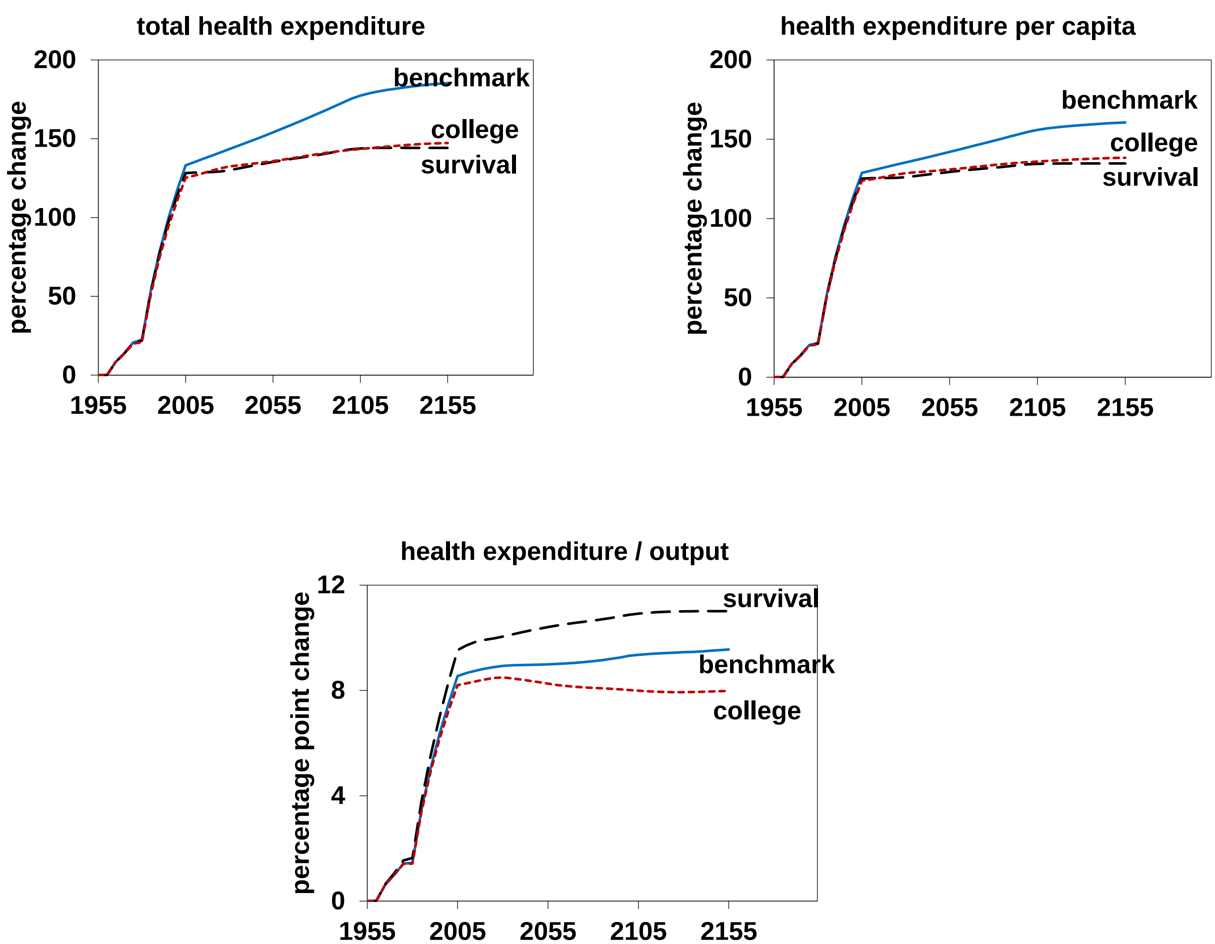


Figure 6: Government financing

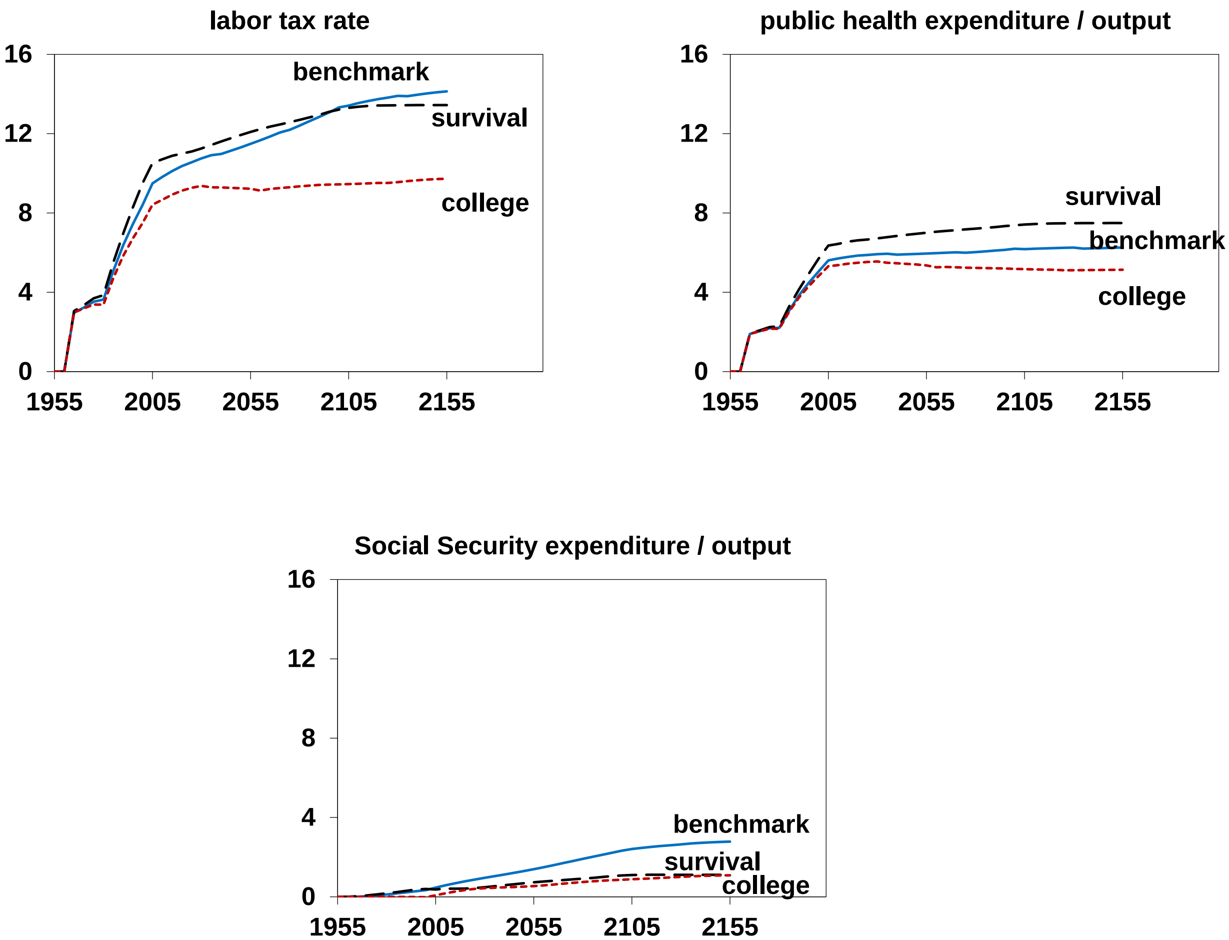


Figure 7: Wages and hours per capita

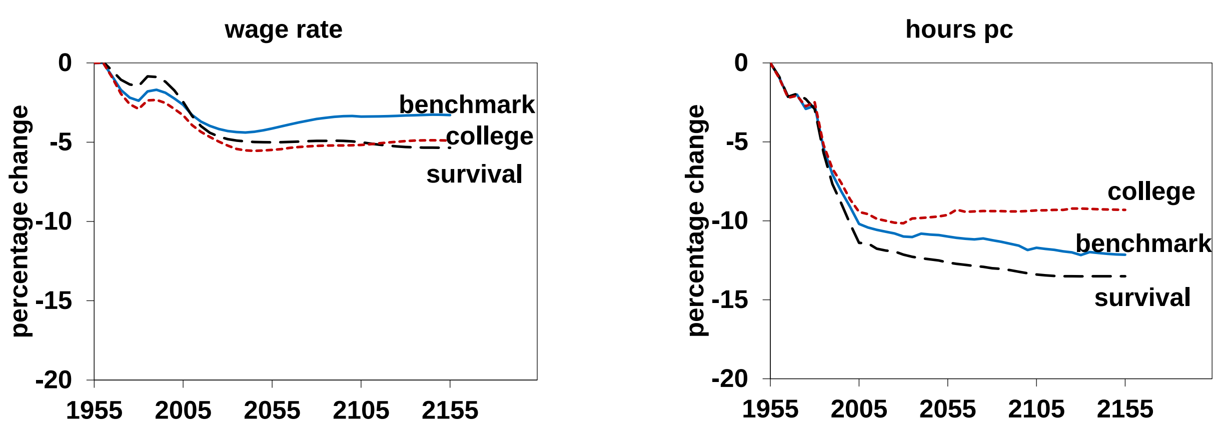


Figure 8: Labor income and wealth inequality

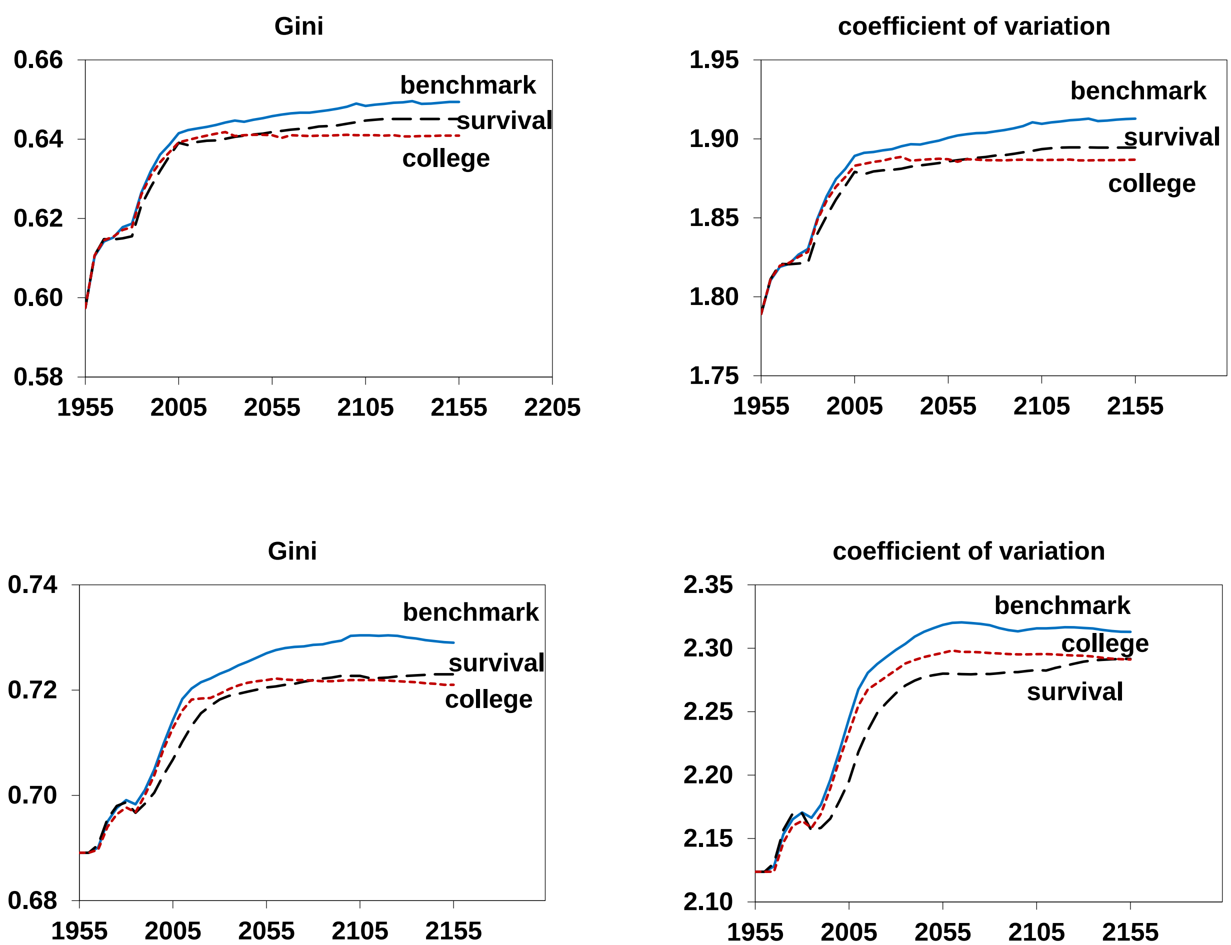


Figure 9: Increasing relative price of medical care

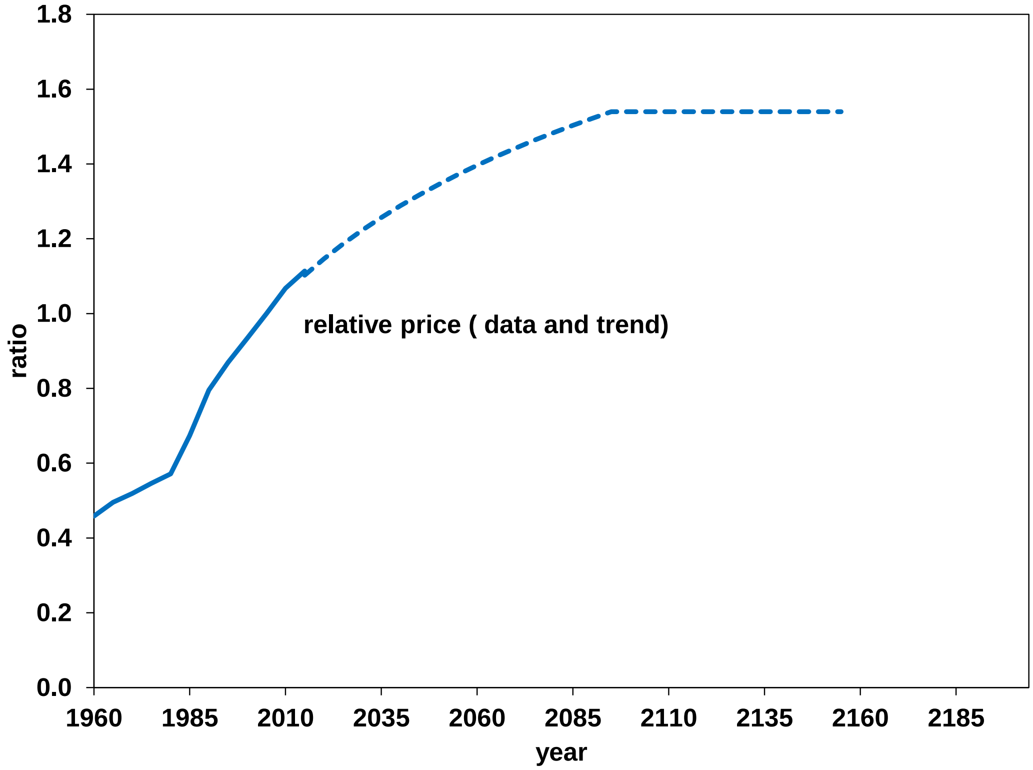


Figure 10: Increasing relative price of medical care: Health expenditure

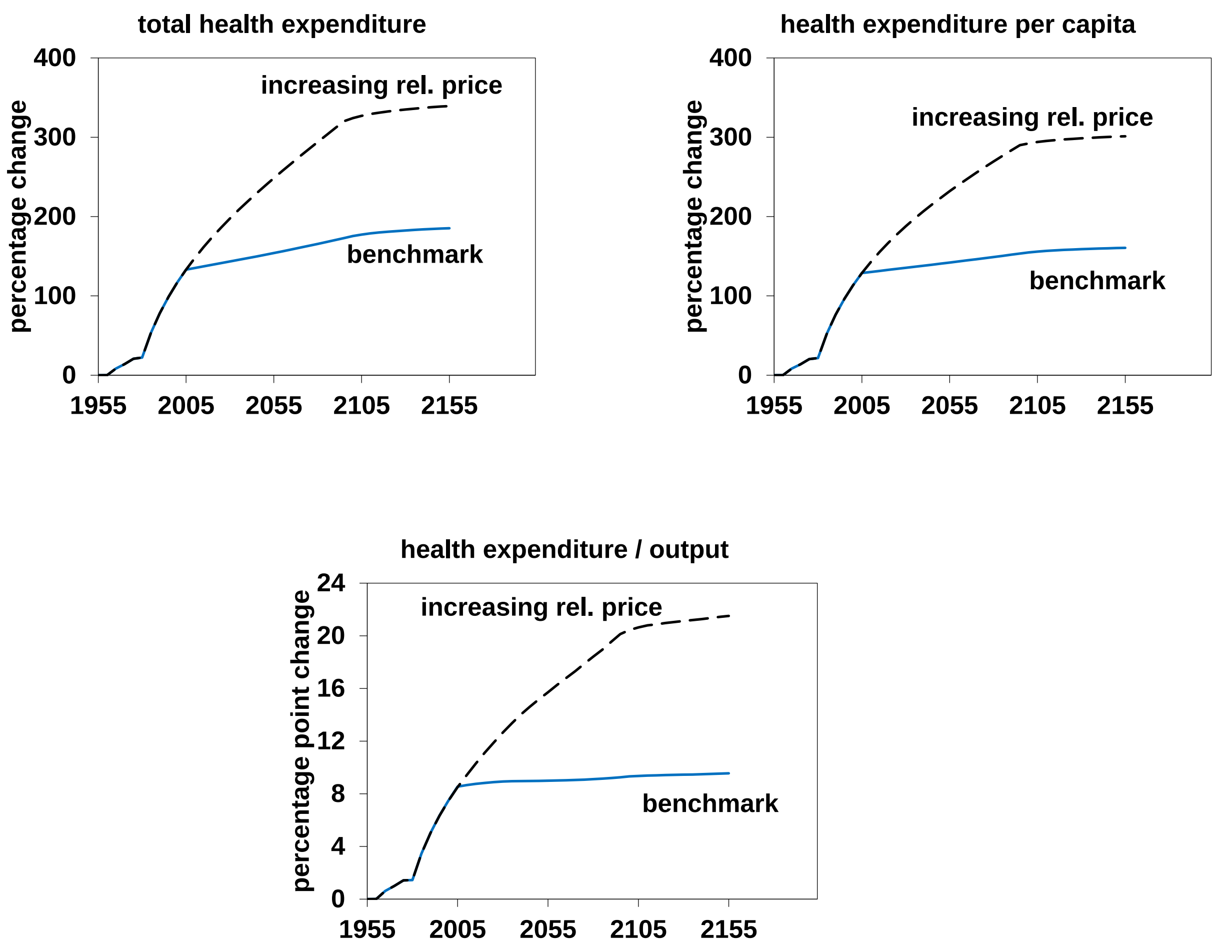


Figure 11: Increasing relative price of medical care: Government financing

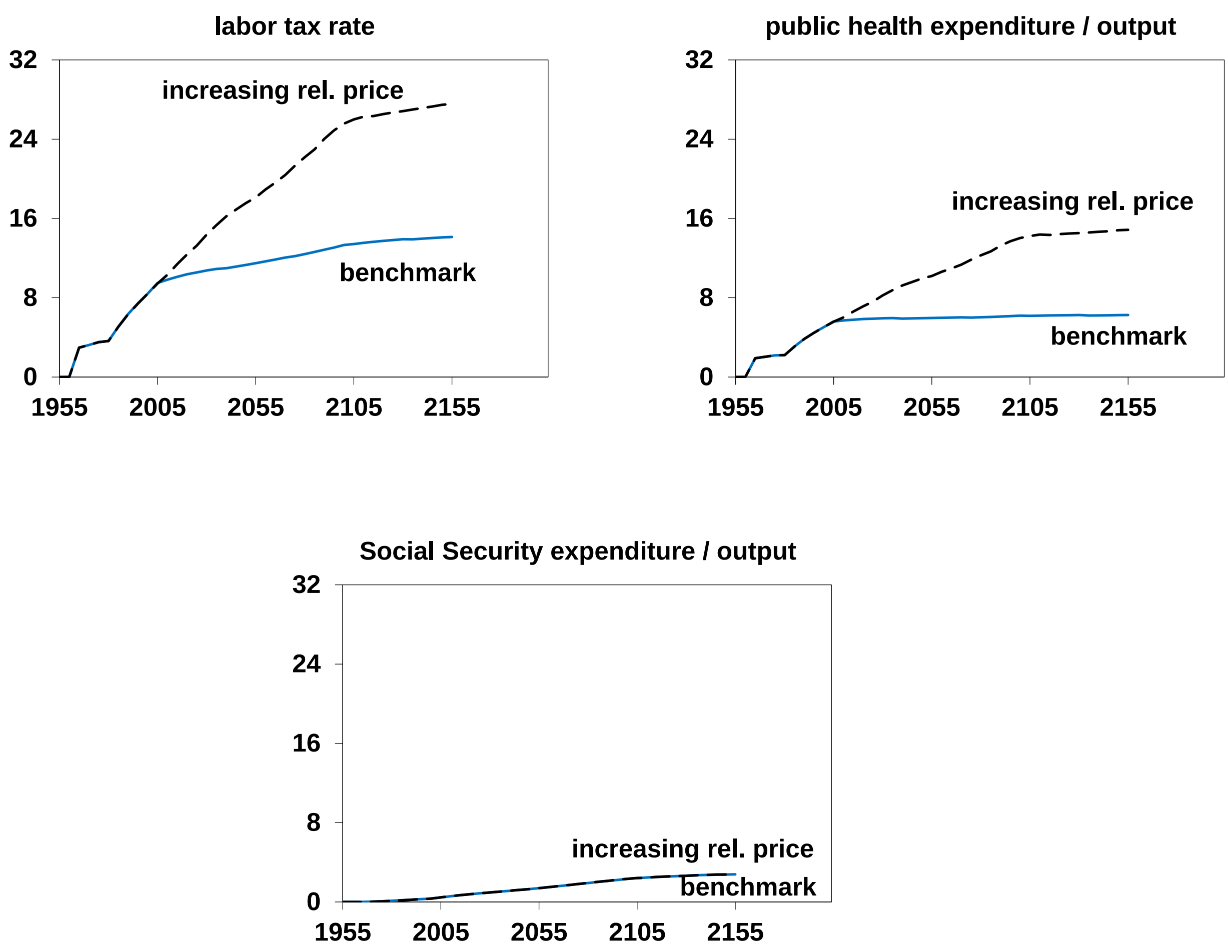


Figure 12: Increasing relative price of medical care: Aggregate variables

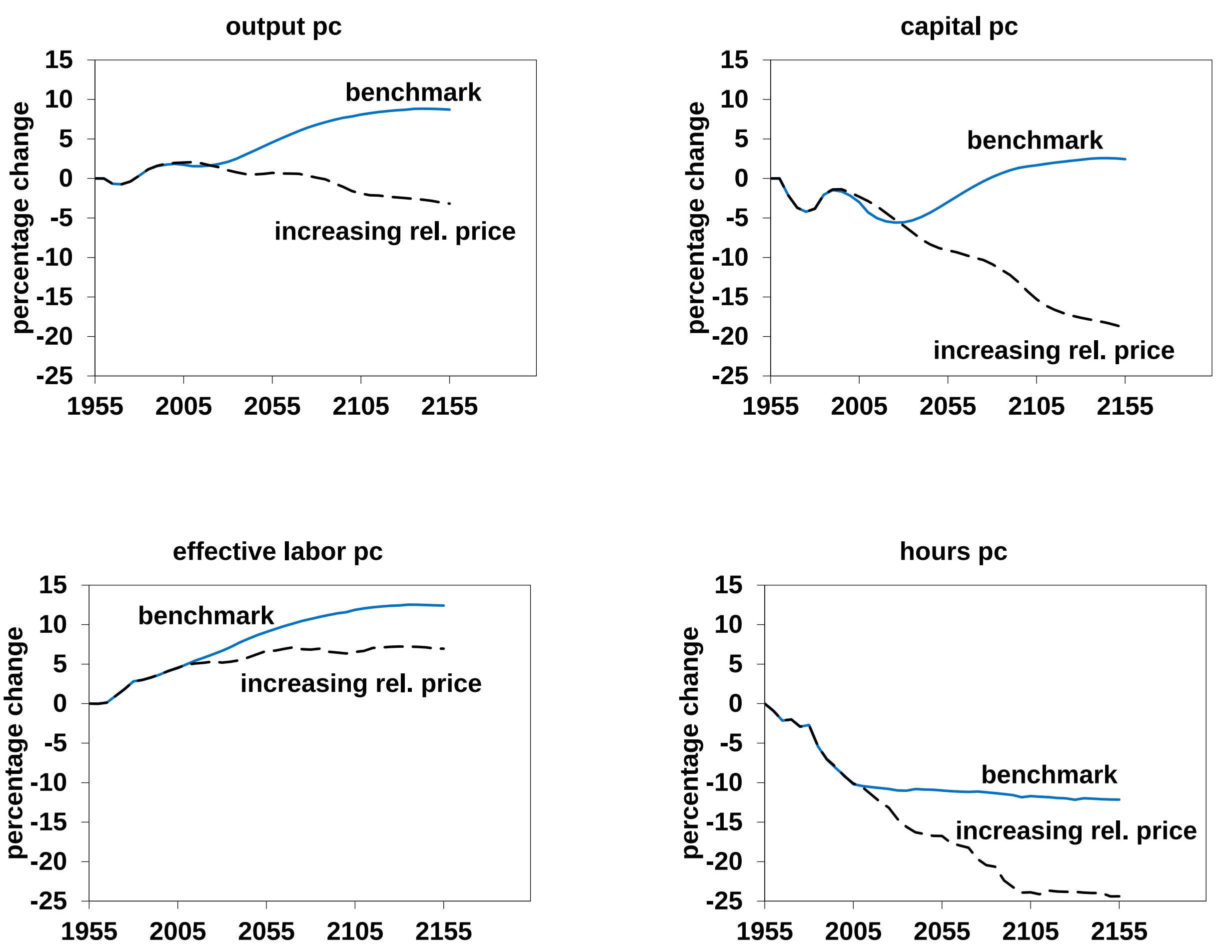


Table 3: Parameters determined joinly in equilibrium

Parameter	Description	Target	Value
θ	Total factor productivity	2005-2009 GDP pc = 1	1.19
β	Discount factor	Annual capital to output = 3	0.70
b_c	SS college parameter	Average SS payment: college	0.38
b_{nc}	SS non-college parameter	Average SS payment: non-college	0.32
$\underline{c}$	Consumption floor	Average food stamps $\approx \$1,300$	0.028
	Eligible for employer insurance	Share with both private and employer = 0.508	0.472
m_{jh}^{scale}	Scale for health care costs	Health expenditure/output = 0.165	1.886
σ_η	Variance normal	Labor earnings Gini = 0.63	4.71
η_{top}	Productivity top	Labor earnings top 1 percent = 14.8	34.03
π_{top}	Probability top	Labor earnings top 10 percent = 43.5	0.01
ρ_n	Persistence normal	2 year persistence: Bottom 80 percent = 0.94	0.60
ρ_{top}	Persistence top	2 year persistence: Top 1 percent = 0.58	0.42

Table 4: Labor earnings distribution

	Quintiles					Top			
	1st	2nd	3rd	4th	5th	90-95	95-99	99-100	Gini
Data	-0.40	3.19	12.49	23.33	61.39	12.38	16.37	14.76	0.63
Benchmark	0.25	4.75	9.59	20.67	64.74	11.97	16.58	14.81	0.63
w/o Medicare	0.37	5.14	9.60	20.53	64.35	11.90	16.48	14.72	0.63

Table 5: Wealth distribution

	Quintiles					Top			
	1st	2nd	3rd	4th	5th	90-95	95-99	99-100	Gini
Data	-0.39	1.74	5.72	13.43	79.49	12.62	23.95	29.55	0.78
Benchmark	0.25	0.49	4.78	18.30	76.17	15.86	25.65	15.49	0.75
w/o Medicare	0.25	0.47	4.41	17.97	76.90	16.04	26.07	15.61	0.75

Figure 13: 100 is the new 90: Change in medical expenses, health transition probabilities, and age efficiency

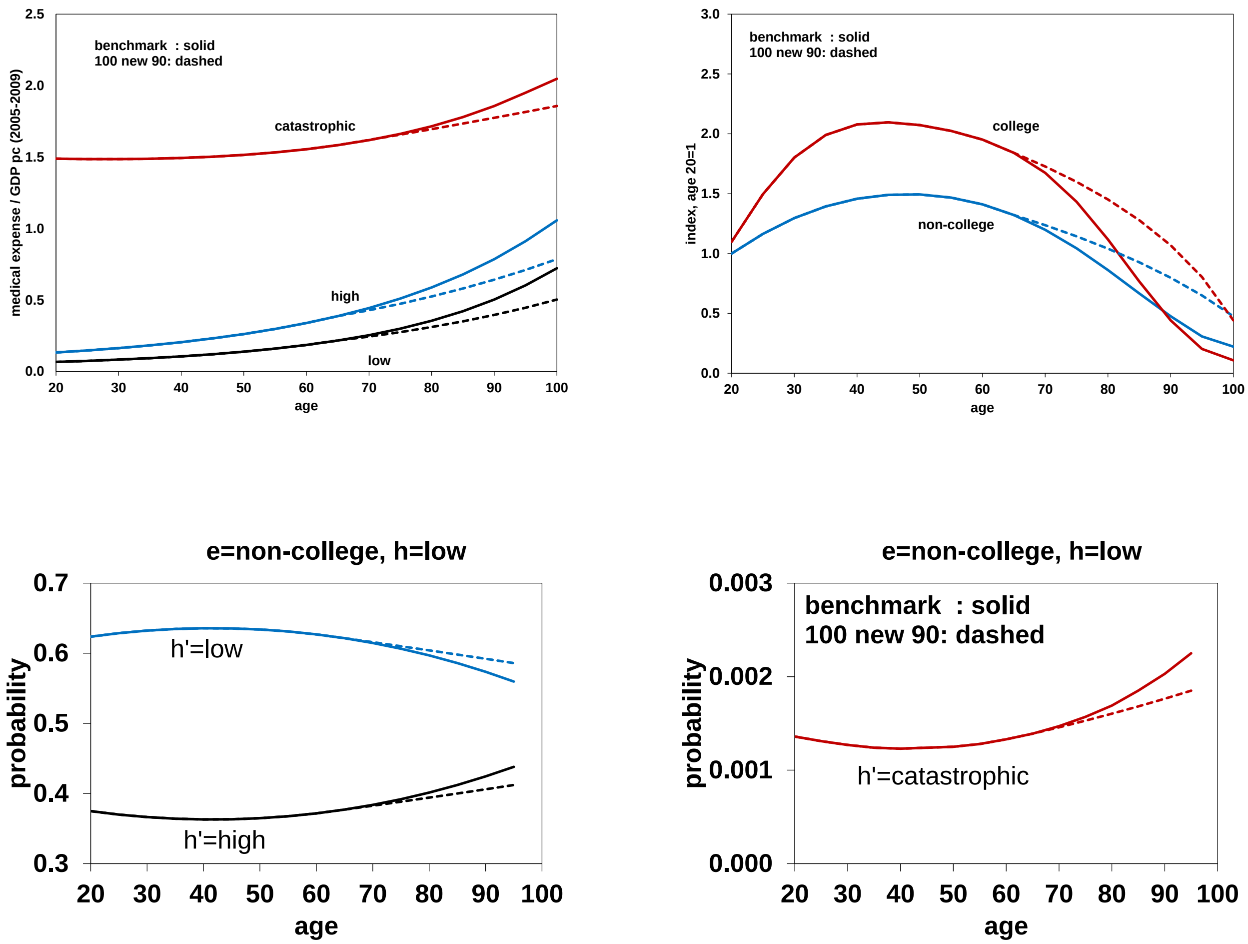


Figure 14: 100 is the new 90: Output

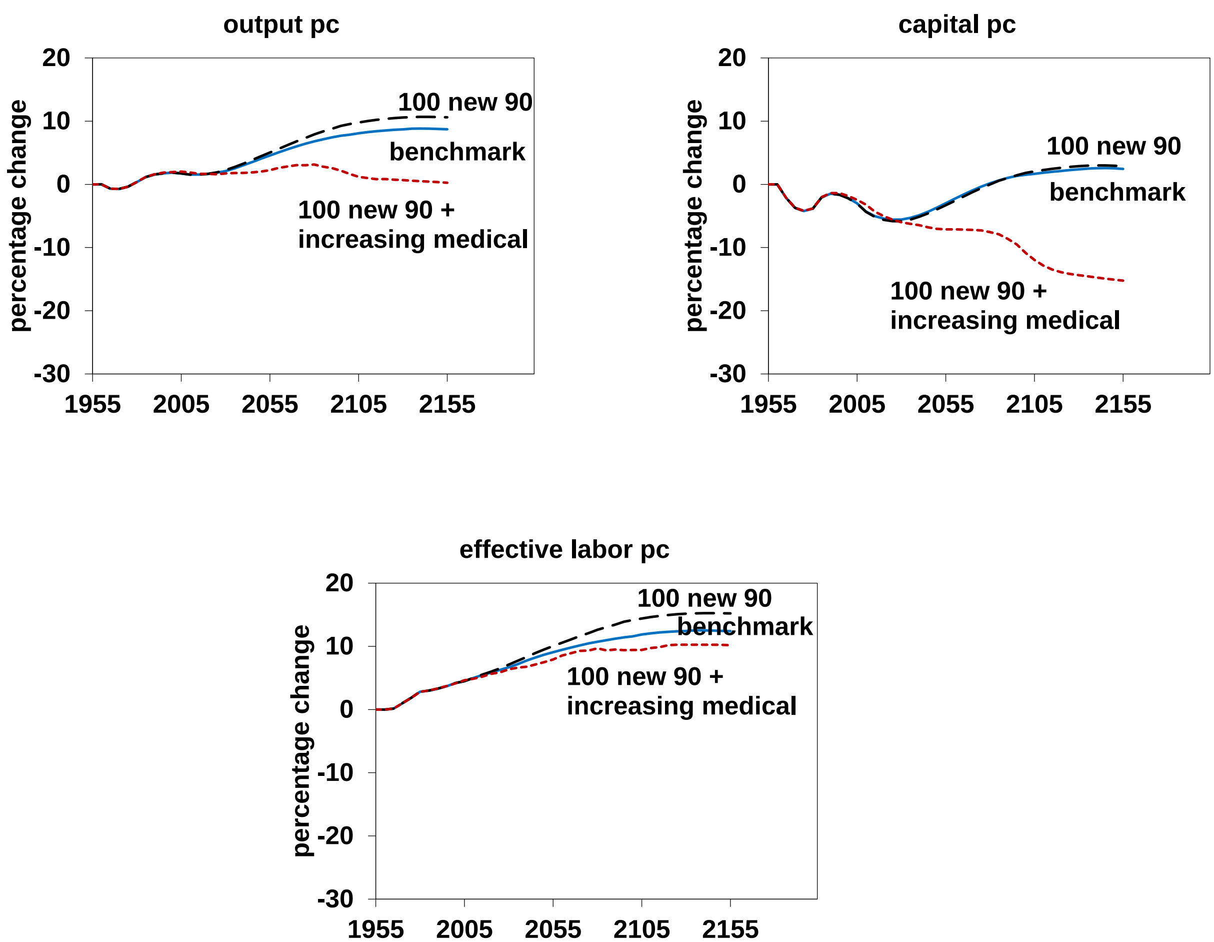


Figure 15: 100 is the new 90: Health expenditure

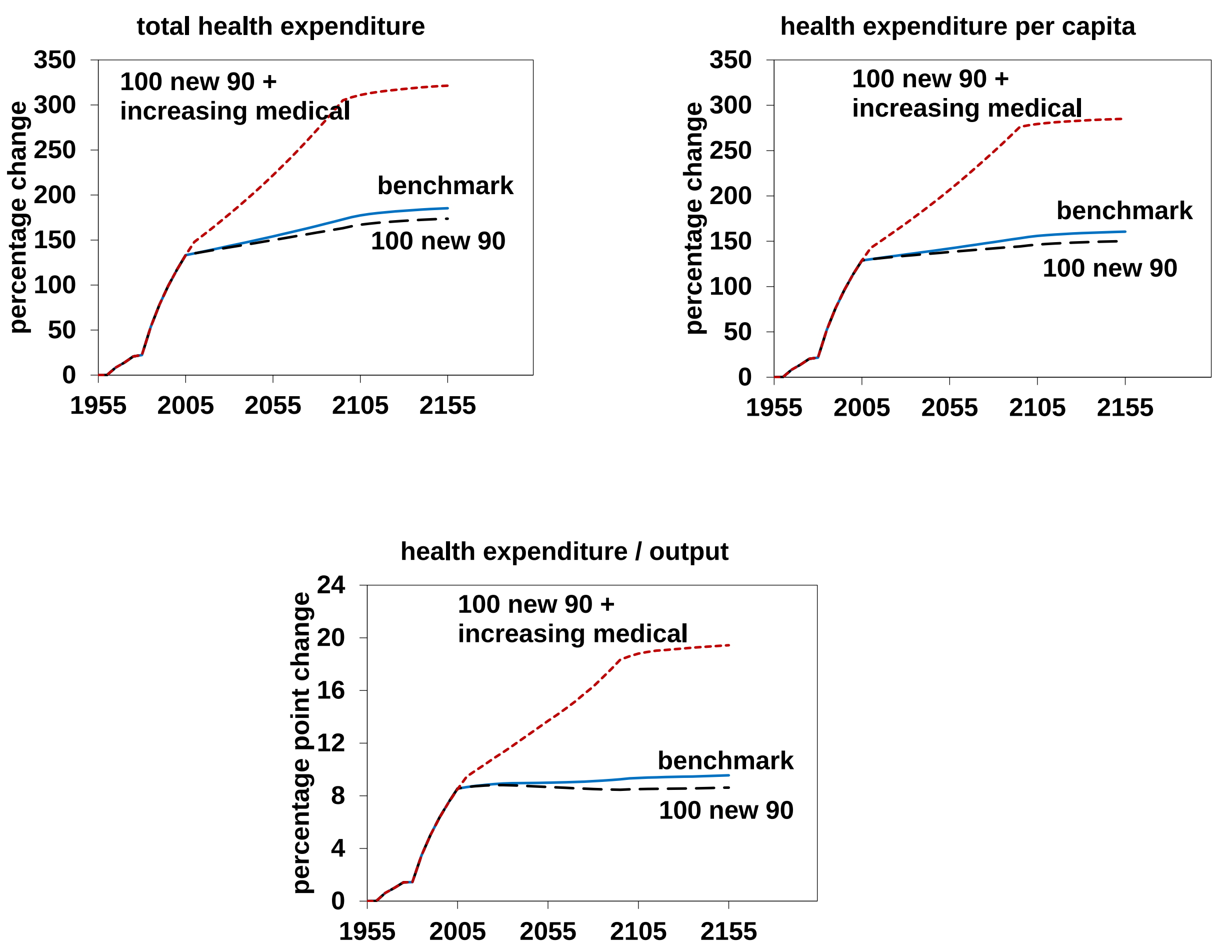


Figure 16: 100 is the new 90: Government financing