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Jorge Barro
Louisiana State University

Stephen Barnes
Louisiana State University

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Department of Economics
Louisiana State University
Baton Rouge, LA 70803-6306
http://www.bus.lsu.edu/economics/

Federal Subsidization and Optimal State Medicaid Provision*

Jorge Barro † Stephen Barnes ‡

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Abstract

This paper quantifies the effect of federal subsidies on state Medicaid provision in the United States. The U.S. federal government matches each state at least one dollar for each dollar that the state spends on Medicaid. This subsidy creates an incentive for states to provide a more generous Medicaid program. We measure the effect of the subsidy by constructing a multi-regional, heterogeneous-agent, dynamic general equilibrium model with incomplete insurance markets and calibrating it to the U.S. economy. In the model, state governments take the federal subsidy as given and choose the Medicaid policy that maximizes the welfare of its citizens. We compare the results of the benchmark model to an economy with the subsidy removed and find that states rely almost entirely on the federal subsidy to finance their Medicaid programs.

Keywords: fiscal policy; public health insurance; federalism.

JEL Classification Numbers: E60, H77, I13, I18

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†Corresponding author. Address: Department of Economics, Business Education Complex, Room 2300, Louisiana State University, Baton Rouge, LA 70803-6306, USA, telephone: 1-225-405-8171, e-mail: *jbarro@lsu.edu*

‡Address: Department of Economics, Business Education Complex, Room 2300, Louisiana State University, Baton Rouge, LA 70803-6306, USA, telephone: 1-225-578-3783, e-mail: *barnes@lsu.edu*

1 Introduction

In the United States, the Medicaid program is the primary source of financing for the medical expenses of low-income citizens. Medicaid is a means-tested program administered by states (subject to federal limitations) and financed jointly by the state and federal governments. For each dollar that a state spends on Medicaid, the federal government contributes at least one dollar to the state's Medicaid expenditures. The percentage of the federal subsidy is determined by the Federal Medical Assistance Percentage (FMAP) formula.[1] Because the federal subsidy effectively reduces the marginal cost of Medicaid provision, the policy creates an incentive for states to increase the generosity of the program. This paper measures the distortion of state Medicaid provision caused by the federal subsidy.[2]

To measure the effects of federal Medicaid subsidies, we construct a multi-regional overlapping-generations, general equilibrium model with idiosyncratic medical expenditure and productivity risk. Regional governments choose an income threshold that determines eligibility for a government-financed health insurance program (Medicaid). A percentage of medical expenses incurred by the regional government are subsidized by the federal government, and the remainder is financed through local taxes. The federal government, in turn, finances the subsidy through taxes collected from every region. The design of the federal policy creates an incentive for regional governments to increase the income eligibility threshold.

A key feature of the model is the interdependence of regional government decisions. While individuals are measure-zero, regions are not. An increase in one region's Medicaid income eligibility threshold increases both the regional government's expenses as well as the federal government's expenses. In order to finance the increase in federal expenses, the federal government must increase the federal tax rates on individuals in all regions. This change in the federal tax rate, in turn, affects the shape of the welfare function of every region. The federal policy then generates optimal decisions of individual regions that are best responses to the decisions of all other regions, and

[1] Specifically, the formula is $FMAP^i = min\left\{.83, max\left\{.5, 1 - .45 \times (\frac{y^i}{Y})^2\right\}\right\}$, where y^i is state i's per capita income, and Y is federal per capita income.

[2] In discussions of the theoretical model, we will generally refer to geographic states as "regions" to differentiate geographic states from probabilistic states of nature.

equilibrium regional policies are outcomes of a game between the regions.

We recreate many features of the U.S. government and health care system in order to understand the decisions of regional governments. We allow for limited public and private health insurance, as well as age-dependent and means-tested transfer payments. Both levels of government must also finance an exogenous stream of expenses. Regional governments finance expenditures by levying a consumption tax and progressive income tax, while the federal government finances expenditures through a progressive income tax and Medicare premiums. Medical expenses and other features of the U.S. health care system are calibrated using estimates from the Medical Expenses Panel Survey (MEPS).

The benchmark model delivers an equilibrium Medicaid eligibility threshold such that approximately 8.3% of working-age individuals are covered by the Medicaid program. This percentage is remarkably close to the average across U.S. states. In order to measure how much of state Medicaid provision is induced by the federal subsidy, we eliminate the federal subsidy and find that Medicaid coverage for that age group is almost entirely eliminated. We also consider a policy experiment in which the federal government fixes Medicaid transfers to regional governments at levels determined in the benchmark economy and eliminates the per dollar subsidy. We find that transitioning to a block grant program effectively eliminates the incentive for any additional regional Medicaid provision.

Within the class of incomplete-market general equilibrium models, our paper extends Huggett (1996) to include medical expenditure risk, health insurance markets, and multiple levels of government. Our paper builds on the health care models of Attanasio et al. (2011) and Pashchenko and Porapakkarm (2013). The first paper studies Medicare policy reform in a neo-classical growth model with medical expenditure and productivity risk, while the second paper measures the level of redistribution generated by Medicaid policy reform in the Patient Protection and Affordable Care Act of 2010 (ACA) using a similar model. Our model extends the literature by focusing on the role of intergovernmental subsidies in health care financing. In order to keep our model computationally tractable, we focus on the federal policy prior to the increase in the federal Medicaid subsidies that began in January 2014.

Medicaid is a multi-faceted program that affects certain age groups in different ways. For example, the State Children's Health Insurance Program (SCHIP) under Medicaid influences states to increase coverage to low-income children whose parents might not qualify for Medicaid. Because children's economic decisions are largely made by their parents, our framework does not explicitly consider SCHIP or the medical expenditure risk faced by children. Medicaid also pays for nursing home services, which benefit the disabled and low-income elderly. While our model does not explicitly account for the possibility of entering a nursing home, Kopecky and Koreshkova (2012) and De Nardi et al. (2010) find this to be a large source of risk for the elderly. We simplify these models by considering a single type of medical expenditure shock that depends only on age and previous medical expenditures.

The influence of federal policy on state decisions in our model falls under the topic of fiscal federalism. Bordignon et al. (2001) study a theoretical model of optimal federal redistribution when regional governments are both an agent to the federal government and a principle to its own citizens. Regions in our model have identical economic environments, which limits the value of inter-regional redistribution. Instead, we focus explicitly on the responsiveness of optimal state Medicaid provision to changes in the federal subsidy. A generalized version of the inter-regional game generated by a federal subsidy is solved in Barro (2012). That paper applies a similar model to study the effects of U.S. federal subsidization of state-provided extended unemployment insurance. Because the intergovernmental financing of Medicaid is the same as the financing of unemployment insurance extensions, a similar algorithm is also applied to solve the computational model in this paper.

The rest of the paper is organized as follows: Section 2 of the paper presents the model, and Section 3 describes the calibration. Section 4 discusses the results, and Section 5 concludes. An overview of the parameters, the computational algorithm, and a description of the data are each provided in the appendix.

2 Model

The model economy presented in this section is a dynamic general equilibrium with overlapping-generations of heterogeneous agents. Insurance markets are incomplete, and the financing of public insurance programs is determined in a federalist system of government.

2.1 Individuals

2.1.1 Preferences and Demographics

The model economy is a federation, which is defined as a union of disjoint regions $i \in \{1, \dots, N\}$, populated by overlapping generations of agents. In each period, a measure of agents is born into each region, where they remain permanently. Individuals reside in exactly one region. Each individual survives to the next period of life with age-dependent probability s_{j+1} and lives for a maximum of T periods. The population grows at rate η. Individuals are endowed with a unit of time in each period, which can be allocated to labor n or leisure $1-n$, and they begin retirement at age Tr. They have utility over consumption c and leisure:

$$u(c, 1-n) = \frac{\left(c^{\chi}(1-n)^{1-\chi}\right)^{1-\sigma}}{1-\sigma}, \tag{1}$$

where σ is the coefficient of relative risk aversion, and χ is the consumption share of utility. Future utility is discounted at rate β.

2.1.2 Medical Expenditures and Health Insurance

In each period, $j = 1, \dots, T$, the agent realizes an exogenous health shock $h \in \mathcal{H} = \{h_1, \dots, h_H\}$ that determines, with certainty, the magnitude of medical expenditures, $m(h, j)$. Health shock h has transition probability $\pi_h(h'|h, j)$ that depends on age and current health shock. We assume that health shocks do not directly affect utility, productivity, or survival. Individuals potentially have access to public or private insurance plans that pay a portion of medical expenses realized. Insurance markets in our model follow Pashchenko and Porapakkarm (2013). An insurance plan,

$ins \in \mathcal{I}$, is defined as a premium, Π_{ins} paid to the insurer by the individual at time j (after the realization of the shock at time j) and a fully committed promise by the insurer to pay a (potentially nonlinear) fraction $\phi_{ins}(m(h', j+1))$ of the realized medical expenses at time $j+1$. The set of insurance plans is $\mathcal{I} = \{$Medicaid, private, ESHI, Medicare, uninsured$\}$.

Medicaid is a means-tested insurance plan. If an individual's gross income level y^m is less than the Medicaid income-eligibility threshold $\bar{y}^i$ set by their regional government, then the individual can choose the Medicaid insurance plan. This plan has premium $\Pi_{Medicaid} = 0$, and the insurer's fraction of the medical expenses $\phi_{Medicaid}(m(h', j+1))$ is paid jointly by the regional and federal governments.

Private insurance companies are perfectly competitive and risk-neutral. Their overhead costs are exogenous and are comprised of a proportional insurance load γ, a fixed cost per enrollee, π, and the fraction of expenses paid by the insurer $\phi_{private}(m(h', j+1))$. To simplify the model, we assume that private insurers can observe an individual's age and current medical expenses. No arbitrage then implies that premiums are simply the insurer's discounted expected costs:

$$\Pi_{private}(j, h) = \frac{\gamma}{1+r} \sum_{h' \in \mathcal{H}} \pi_h(h'|h, j)\phi_{private}(m(h', j+1))m(h', j+1) + \pi, \tag{2}$$

where r is the equilibrium interest rate. In each period, the agent has a chance of being offered an employer-sponsored health insurance (ESHI) plan. This option is the same as a private insurance plan, except the premium is subsidized at rate $1-\psi$. The likelihood of getting an ESHI offer ($g = 0$ implies not offered, $g = 1$ implies offered) depends on age and previous offer outcome and has transition probability $\pi_g(g'|g, j)$. The subsidy is then financed by the federal government.[3] ESHI premiums are determined by the equation:

$$\Pi_{ESHI}(j, h) = (1-\psi)\left(\frac{\gamma}{1+r} \sum_{h' \in \mathcal{H}} \pi_h(h'|h, j)\phi_{ESHI}(m(h', j+1))m(h', j+1) + \pi\right) \tag{3}$$

We assume that private and ESHI insurance plans are only available to working-age agents.

Once individuals reach retirement ages $j \geq Tr$, they pay premium $\Pi_{Medicare}$ and Medicare pays

[3] In reality, ESHI is implicitly subsidized as a tax deduction to employees.

a constant fraction $\phi_{Medicare}$ of medical expenses. The Medicare portion of expenses are financed by the federal government. Further, the retiree may also qualify for Medicaid, which pays the fraction $\phi_{Medicaid}(1 - \phi_{Medicare}m(h', j+1))$ of the remaining medical bill.

Finally, an individual may choose to be uninsured. This means that the individual pays no premium but must finance the entire amount of the medical expenses in the following period.

2.1.3 Labor Productivity

Labor productivity $\epsilon(j, z)$ depends on age and a persistent exogenous productivity shock z, with transition probability $\pi_z(z'|z)$. Individuals choose their labor supply in each of the first $Tr-1$ periods of life and do not work thereafter. In the working years, labor supply n returns labor income $w\epsilon(j, z)n$, where w is the wage.

2.2 Technology

A constant returns to scale technology takes aggregate capital K and aggregate efficient labor L as inputs and produces output Y according to

$$Y = K^a L^{1-a}, \tag{4}$$

where a is the capital share of production. Capital depreciates at rate δ in each period.

2.3 Taxes and Government Transfers

Individuals pay a proportional consumption tax τ_c and a progressive income tax $\tau^i(y)$ to the regional government. They also pay progressive income taxes to the federal government. A Social Security tax $min\,\{\bar{y}^{ss}, \tau_{ss}y\}$ is levied by the federal government, where $\bar{y}^{ss}$ is an upper bound on this tax. The taxes on income levied by the regional government and federal government are, respectively:

$$\tau^i(y) = \kappa_0(y - (y^{-\kappa_1} + \kappa_2^i)^{-\frac{1}{\kappa_1}}) \tag{5}$$

$$\tau^f(y) = \kappa_0(y - (y^{-\kappa_1} + \kappa_2^f)^{-\frac{1}{\kappa_1}}) + min\left\{\bar{y}^{ss}, \tau_{ss}y\right\}, \tag{6}$$

where the first term is the Gouveia and Strauss (1994) income tax function. Beginning at age Tr, agents receive lump-sum Social Security payments ss in each period. The regional and federal governments jointly finance a consumption floor $\underline{c}$, which ensures that agents have a minimum consumption of $\frac{\underline{c}}{1+\tau_c}$.[4] Unintended bequests are collected by the regional government and redistributed to living residents of that region.[5]

2.4 Government Revenue and Expenditures

Government activity is conducted at both the regional and federal level. The federal government and each regional government must finance an exogenous stream of expenditures, G^f and G^s, respectively. In addition to G^f, the federal government finances Social Security, Medicare, and a percentage $1 - \alpha$ of each region's Medicaid program. Regional governments then finance the remaining percentage α of Medicaid expenditures and the exogenous stream of expenditures. Federal government expenditures are financed through federal income taxes and Medicare premiums, while regional government expenditures are financed by consumption taxes and regional income taxes.

2.5 Individual Optimization

Working age individuals choose consumption, labor supply, health insurance, and asset holdings to maximize their expected utility. Retired households only choose over consumption and asset holdings to maximize expected utility, as the health insurance choice of retirees is directly implied by asset holdings. Individuals of all ages can purchase a single risk-free asset to smooth consumption and insure against any remaining uninsured risk, implying that asset markets are incomplete.

[4] In the U.S., social welfare programs, such as Temporary Assistance to Needy Families, are jointly financed by the state and federal government.

[5] Redistributing unintended bequests at the regional level significantly reduces the computation without compromising the model's realistic features.

2.5.1 Working-Age Individuals

Let Π be the vector of insurance premiums. Then, an individual of age $j < Tr$ residing in region i with capital k, insurance status ins, health shock h, labor productivity shock z, and ESHI offer status g takes as given the prices $\{w, r, \Pi\}$, government policy $\left\{\bar{y}^i, \tau_c, \tau^i(y), \tau^f(y), \tau, ss\right\}$ and solves:

$$V_{j,i}(k, ins, h, z, g) = \max_{n,k',ins'} u(c, 1-n) + s_{j+1}\beta E_{\{h',z',g'|h,z,g\}} V_{j+1,i}(k', ins', h', z', g') \tag{7}$$

$$\text{s.t.} \quad (1+\tau_c)c = (1+r)k - k' + w\epsilon(j,z)n - (1-\phi_{ins}(m(h,j))m(h,j) - \Pi_{ins'} - \tau^i(y^t) - \tau^f(y^t) + \tau + beq. \tag{8}$$

$$\tau = \max\left\{0, \frac{\underline{c}}{1+\tau_c} - ((1+r)k - k' + w\epsilon(j,z)n - (1-\phi_{ins}(m(h,j)))m(h,j) - \Pi_{ins'} - \tau^i(y^t) - \tau^f(y^t) + beq)\right\} \tag{9}$$

$$y^t = rk + w\epsilon(j,z)n - (1-\phi_{ins}(m(h,j)))m(h,j) \qquad \text{(Taxable income)} \tag{10}$$

$$y^m = rk + w\epsilon(j,z)n \qquad \text{(Medicaid means test)} \tag{11}$$

where E is the expectation operator, τ is a government transfer that ensures individuals have consumption no less than $\underline{c}$, y^t is taxable income, and y^m is the income tested for Medicaid eligibility. Total health spending is determined by age, the idiosyncratic health shock, and insurance status ins. Medicaid is in the individual's insurance choice set only if the individual's means-tested income level y^m is less than the region's Medicaid eligibility threshold $\bar{y}^i$. Similarly, ESHI is in the individual's insurance choice set only if $g = 1$. Insurance choices of working-age agents are mutually exclusive.

2.5.2 Retired Individuals

The decision of retired agents is limited to consumption and savings. Retirees receive Social Security benefit ss in each living period, and Medicare pays for a constant fraction $\phi_{Medicare}$ of their medical expenses. Medicare premiums $\Pi_{Medicare}$ are levied by the federal government. If a retiree's income is sufficiently low, they may also become eligible for Medicaid. We assume that the income eligibility threshold for the retirees $\bar{y}^R$ is exogenous and equivalent across regions. All remaining medical expenses are paid out-of-pocket. Retired agents take prices and government policy as given and solve:

$$V_{j,i}(k, ins, h) = \max_{k'} u(c, 1) + s_{j+1}\beta E_{\{h'|h\}} V_{j+1,i}(k', ins', h') \tag{12}$$

s.t. $(1+\tau_c)c = (1+r)k - k' + ss - (1-\phi_{ins}(m(h,j)))(1-\phi_{Medicare})m(h,j) - \tau^i(y^t) - \tau^f(y^t) + \tau + beq.$

$$\tag{13}$$

$$\tau = \max\left\{0, \frac{\underline{c}}{1+\tau_c} - ((1+r)k - k' + ss - (1-\phi_{ins}(m(h,j)))(1-\phi_{Medicare})m(h,j) - \tau^i(y^t) - \tau^f(y^t) + beq)\right\} \tag{14}$$

$$y^t = rk - (1-\phi_{ins}(m(h,j)))(1-\phi_{Medicare})m(h,j) \qquad \text{(Taxable income)} \tag{15}$$

$$y^m = rk \qquad \text{(Medicaid means test).} \tag{16}$$

2.6 Recursive Competitive Equilibrium

To suppress notation, define an individual's state vector over region, age, and all other state variables as (i, j, x), where $x = \{k, ins, h, z, g\}$, $i \in \mathcal{N} = \{1, \ldots, N\}$, $j \in \mathcal{J} = \{1, \ldots, T\}$, $k \in \mathcal{K} = [0, \infty)$, $h \in \mathcal{H}$, $z \in \mathcal{Z}$, $g \in \mathcal{G} = \{0, 1\}$, $ins \in \mathcal{I}$. Define the state space to be $\mathcal{X} = \mathcal{K} \times \mathcal{H} \times \mathcal{Z} \times \mathcal{G} \times \mathcal{I}$, and define $\Sigma_{\mathcal{X}}$ as the Borel σ-algebra on $\mathcal{X}$. Denote the probability measure over the measurable space $(\mathcal{X}, \Sigma_{\mathcal{X}})$ by $\psi_j^i(\mathcal{X})$ for individuals with state $x \in \mathcal{X}$, in region i and cohort j.

Then, for a given government policy $\left\{\tau_c, ss, c_{floor}, \bar{y}^R, \phi_{Medicaid}(m), \phi_{Medicare}, \Pi_{Medicare}\right\}$ and $\left\{\bar{y}^i\right\}_{i=1}^N$, a recursive competitive equilibrium is a set of value functions $V(i, j, x)$, decision rules $\{n(i, j, x), k(i, j, x), ins(i, j, x)\}$, factor prices $\{r, w\}$, insurance premiums $\{\Pi_{private}, \Pi_{ESHI}\}$, tax functions τ, $\tau^f(y)$, and $\left\{\tau^i(y)\right\}_{i=1}^N$, and distributions $\left\{\psi_1^i, \ldots, \psi_T^i\right\}_{i=1}^N$ such that:

1. Given government policy, prices, and tax functions, the value function and decision rules solve the individual optimization problem.

2. Factor prices are determined competitively:

$$r = F_K(K, L) - \delta \tag{17}$$

$$w = F_L(K, L). \tag{18}$$

3. The labor market clears:

$$L = \sum_{i=1}^{N} \sum_{j=1}^{T} \int_{\mathcal{X}} \epsilon(j, z) n(i, j, x) d\mu \tag{19}$$

4. The asset market clears:

$$K = \sum_{i=1}^{N} \sum_{j=1}^{T} \int_{\mathcal{X}} k(i, j, x) d\mu \tag{20}$$

5. The final good market clears:

$$F(K, L) + (1-\delta)K = \sum_{i=1}^{N} \sum_{j=1}^{T} \int_{\mathcal{X}} \left[c(i, j, x) + m(i, j, x)\right] d\mu + (1+\eta)K + G, \tag{21}$$

   where $G = G^f + G^s N$ is the sum of exogenous regional and federal government expenditures.

6. Equations (2) and (3) hold so that the private health insurers make zero profits.

7. Distributions of agents in each region are consistent with individual behavior:

$$\psi_{j+1}^{i}(\mathcal{X}) = \int_{\mathcal{X}} Q_j^i(x, \mathcal{X}) d\psi_j^i, \tag{22}$$

   where Q_j^i is determined by agent decision rules, survival probabilities, and the transition probabilities over productivity, health, and ESHI insurance offer.

8. The budget constraint of each regional government i clears:

$$\begin{aligned} &\tau_c \sum_{j=1}^{T} \int_{\mathcal{X}} c(i, j, x) d\mu + \sum_{j=1}^{T} \int_{\mathcal{X}} T^i(y) d\mu \\ = \alpha^w \sum_{j=1}^{T} \int_{\mathcal{X}} \tau d\mu + \alpha &\sum_{j=1}^{Tr-1} \int_{\mathcal{X}} \phi_{Medicaid}(m(h, j)) m(h, j) \mathbf{1}_{\{y^m \leq \bar{y}^i\}} d\mu \\ &\alpha \sum_{j=Tr}^{T} \int_{\mathcal{X}} \phi_{Medicaid}(m(h, j)) m(h, j) \mathbf{1}_{\{y^m \leq \bar{y}^R\}} d\mu + G^s \end{aligned} \tag{23}$$

   where $\mathbf{1}$ is an indicator function.

9. The federal government's budget constraint clears:

$$\sum_{i=1}^{N}\sum_{j=1}^{T}\int_{\mathcal{X}} T^f(y)d\mu = (1-\alpha)\sum_{i=1}^{N}\sum_{j=1}^{Tr-1}\int_{\mathcal{X}} \phi_{Medicaid}(m(h,j))m(h,j)\mathbf{1}_{\{y^m\leq \bar{y}^i\}}d\mu$$
$$+(1-\alpha)\sum_{i=1}^{N}\sum_{j=Tr}^{T}\int_{\mathcal{X}} \phi_{Medicaid}(m(h,j))m(h,j)\mathbf{1}_{\{y^m\leq \bar{y}^R\}}d\mu + \alpha^w\sum_{i=1}^{N}\sum_{j=1}^{T}\int_{\mathcal{X}} \tau d\mu \tag{24}$$
$$+\sum_{i=1}^{N}\sum_{j=Tr}^{T}\int_{\mathcal{X}} (\phi_{Medicare}(m(h,j))m(h,j) + ss - \Pi_{Medicare})d\mu + G^f$$

2.7 Optimal Regional Medicaid Provision

Up to this point, the Medicaid income eligibility thresholds $\{\bar{y}^i\}_{i=1}^{N}$ have been exogenous. We now focus on the endogenous determination of these values under the federal policy design. We restrict the set of actions and payoffs to the set of recursive competitive equilibria defined in the previous section, and we assume that the payoff to a region is the expected lifetime utility of all living citizens.[6]

Consider a marginal increase in the Medicaid eligibility threshold chosen by region i. To finance the federal portion of the increase in Medicaid expenditures in region i, the federal government must raise the federal income tax rate, which is paid by agents in every region. Because of diminishing marginal utility, the increase in the federal tax rate affects the shape of the welfare function in each region. Therefore, welfare-maximizing Medicaid provision chosen by region i is a best response to the decisions of all other regions.

The federal subsidization of regional Medicaid provision creates a game that we define formally as follows[7]:

Definition 1. *The normal-form game has the following elements:*

1. *The set of players is the set of regions $\mathcal{N}$ (or equivalently, a benevolent representative social planner of the region).*

[6] We could instead assume that the payoff is determined in a political equilibrium (as in Krusell et al. (1997)), but we find the utilitarian welfare function generates a close match to outcomes in the U.S. economy.

[7] We follow Fudenberg and Tirole (1991).

2. *The pure strategy space for each region $i \in \mathcal{N}$ is $\mathcal{Y}^i$, where $\mathcal{Y}^i = \mathbb{R}_+$ for all i.*

3. *Let $\bar{y}^i \in \mathcal{Y}^i$ for all i, and define $\bar{y}^{-i} = \left\{\bar{y}^1 \ldots \bar{y}^{i-1}, \bar{y}^{i+1}, \ldots, \bar{y}^N\right\}$. The payoff function for each region is $\tilde{V}(\bar{y}^i, \bar{y}^{-i})$, where*

$$\tilde{V}(\bar{y}^i, \bar{y}^{-i}) \equiv \sum_{j=1}^{T} \int_{\mathcal{X}} V(i,j,x) d\mu, \tag{25}$$

such that $V(i,j,x)$ is determined in a recursive competitive equilibrium.

Constraining the set of payoffs to values determined in a competitive equilibrium ensures that the federal tax rate has adjusted enough to finance the federal portion of each region's Medicaid expenses. In order to maximize its payoff, region i takes the actions of all other regions $\bar{y}^{-i}$ as given and chooses the Medicaid income eligibility threshold as a best-response to the decisions of the other regions as follows:

$$BR_i(\bar{y}^{-i}) = \underset{\bar{y}^i}{\operatorname{argmax}} \ \tilde{V}(\bar{y}^i, \bar{y}^{-i}), \tag{26}$$

where $BR_i(\bar{y}^{-i})$ is the best response function. Notice that the regional budget constraints are assured to be satisfied by the recursive competitive equilibrium restriction on the set of payoffs.

We refine the set of equilibrium outcomes to the set of outcomes that satisfy the definition of a Nash equilibrium as follows:

Definition 2. *A set of strategies $\left\{\bar{y}^{*i}\right\}_{i=1}^{N}$ is a Nash equilibrium if for all $i \in \mathcal{N}$,*

$$\tilde{V}(\bar{y}^{*i}, \bar{y}^{*-i}) \geq \tilde{V}(\bar{y}^i, \bar{y}^{*-i}) \quad \textit{for all} \quad \bar{y}^i \in \mathcal{Y}^i. \tag{27}$$

Finally, because regions are ex-ante identical, we search for single strategy $\bar{y}^*$ that satisfies the definition of a symmetric Nash equilibrium as follows:

Definition 3. *A strategy $\bar{y}^* \in \cap_{i=1}^{N} \mathcal{Y}^i$ is a symmetric Nash equilibrium if for all $i \in \mathcal{N}$,*

$$\tilde{V}(\bar{y}^*, \bar{y}^*) \geq \tilde{V}(\bar{y}^i, \bar{y}^*) \quad \textit{for all} \quad \bar{y}^i \in \mathcal{Y}^i. \tag{28}$$

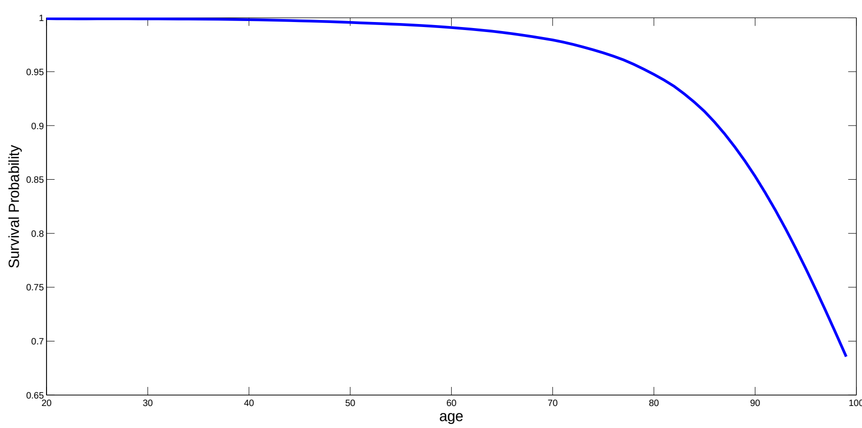
3 Calibration

This section discusses the calibration of the model economy. The model is calibrated to values representing the U.S. economy around the year 2011, and individual health care parameters are estimated using the MEPS.

3.1 Demographics, Preferences, and Technology

In the model, agents are born at age 20 ($j = 1$), begin retirement at age 65 ($Tr = 45$), and live a maximum of 99 ($T = 61$) years. Survival rates, s_{j+1} depend only on age, and we use the rates reported in the 2008 Center for Disease Control and Prevention Life Tables. We follow Attanasio et al. (2010) and set the population growth rate at 1.2% per year.

Figure 1: 2008 CDC Unconditional Survival Probability



The risk aversion parameter σ is set to 4, and the consumption share of utility $\chi = .35$ generates on average 37% of the time endowment allocated to working. Together, these parameters imply a coefficient of relative risk aversion of 2.05 and a Frisch labor supply elasticity of .87. The personal discount factor $\beta = 1.016$ is calibrated to target an aggregate capital to output ratio of 3. We assume Cobb-Douglas production $F(K, L) = K^a L^{1-a}$, where $a = .36$ and the capital depreciates at rate $\delta = .085$ generates an investment to output ratio of 25%.

3.2 Labor Productivity

Labor productivity is decomposed into a deterministic age component, e_j and a persistent productivity shock z_j.

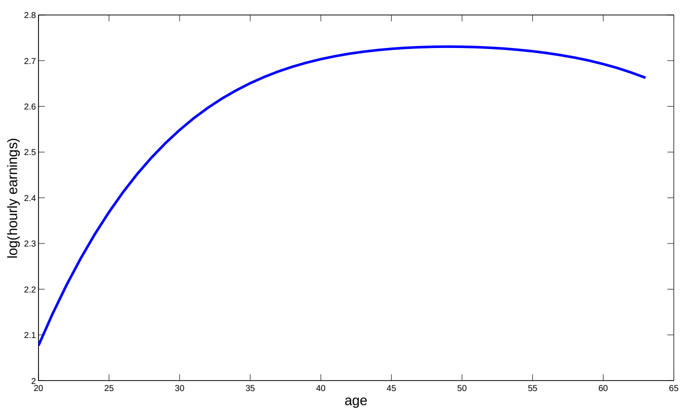
$$\epsilon(j,z) = e_j + z_j \tag{29}$$

The deterministic age component of labor productivity is estimated directly from the MEPS data. We estimate a quartic age earnings profile for log hourly earnings for those in the sample who are employed at the time of interview. The idiosyncratic component of productivity follows an AR(1) process:

$$z_j = \rho z_{j-1} + \nu_j \tag{30}$$

We set $\rho = .96$ and $\nu_j \sim N(0, \sigma_\nu^2)$, where $\sigma_\nu^2 = 0.045$, and initial draws have distribution $N(0, .36)$, as in Huggett (1996). We approximate the AR(1) process with a two-state Markov process solved by the method described in Adda and Cooper (2003).

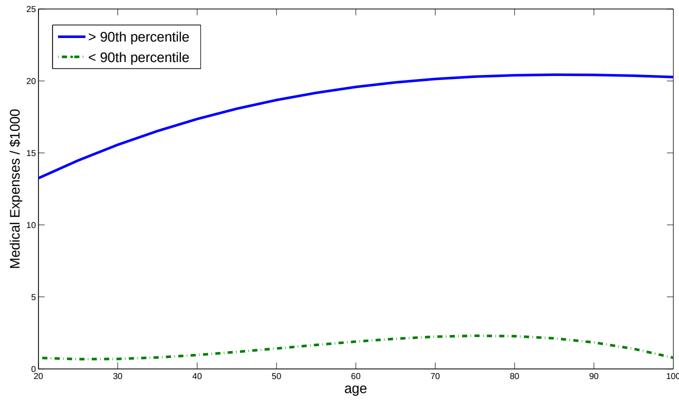
Figure 2: Labor Earnings Profile



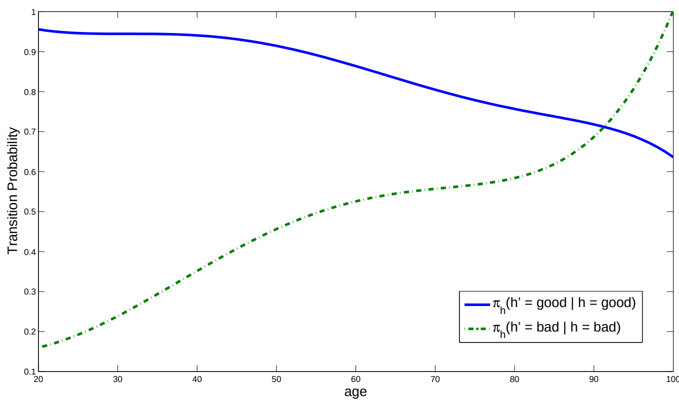
3.3 Medical Expenditures and Health Insurance

Health shocks, $m(h,j)$ are estimated by considering medical expenditures for those above and below the 90th percentile of medical expenditures, which separates those with high medical spending

Figure 5: Medical Expenditures and Persistence



Medical Expenditure by +/-90th Percentile

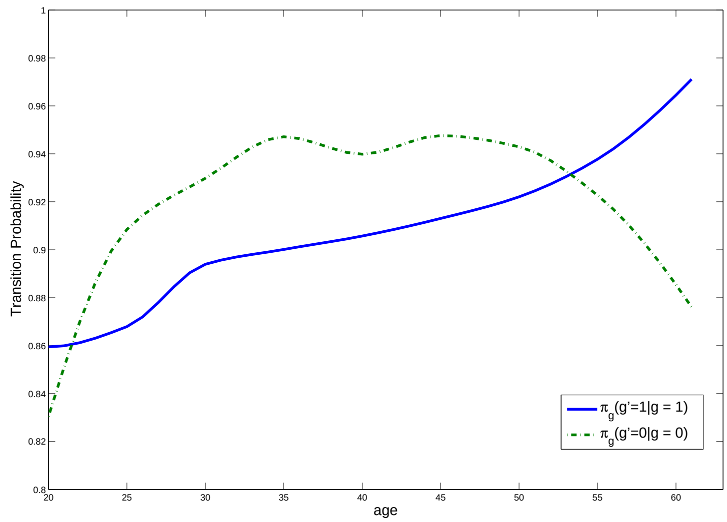


Medical Expenditure Persistence

from those with low medical spending. Within five-year age bins, average medical expenditures are then calculated in each expenditure group. In addition, transition probabilities $\pi_h(h'|h,j)$ are estimated from the sample within the five-year age bins by taking advantage of the longitudinal nature of the data. The probability that an individual moves from one spending level to another is calculated as the proportion of the sample in year one from each group that moves into each spending level in the second year of the MEPS survey.

ESHI offers are defined based on whether a person was offered insurance in two of three reporting periods during the year (following Pashchenko and Porapakkarm (2013)). A person is defined

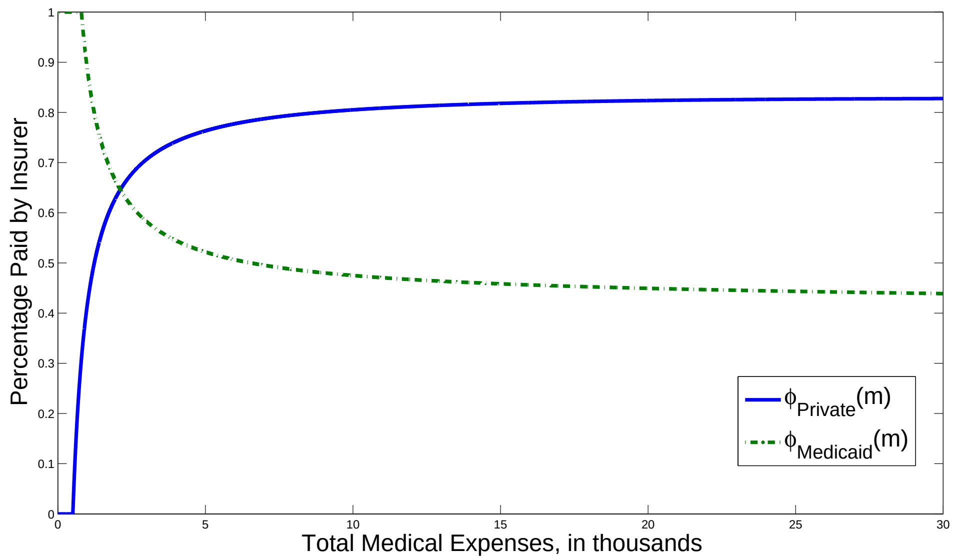
Figure 3: ESHI Offer Persistence



as being offered insurance if a working adult in the health insurance eligibility unit was offered insurance. The two years of data collected on each sample individual are used to estimate transition probabilities that an individual who was offered or not offered ESHI in the first year is offered or not offered ESHI in the subsequent year. The transition probabilities $\pi_g(g'|g, j)$ are estimated independently within each of the five-year age bins. The federal ESHI subsidy is set to $\psi = .3$ according to estimates in Burman et al. (2008). We set the value of the insurance load, $\gamma = 1.11$ based on Kahn et al. (2005), and the fixed cost of insurance, π is calibrated so that approximately 20% of adults do not have health insurance in an economy where 10% of working-age individuals are covered by Medicaid.

To determine the initial distribution of coverage by each type of insurance, individuals are grouped into discrete categories of insurance coverage. The type of insurance held by each individual is determined based on coverage for the entire year (e.g., an individual is considered covered by Medicaid if they report being covered by that insurance type in each month throughout the year). Insurance coverage types are restricted to ESHI, other private insurance, Medicaid, and uninsured. Insurance coverage status for 20 year olds as of April in the survey year is used to estimate the

Figure 4: Percent of Medical Expenses Covered by Insurer



initial percentage of individuals in each insurance coverage group.

To assess the generosity of Medicaid and private insurance coverage, the portion covered by each type of insurance is estimated by regressing total spending by Medicaid or private insurance on a quadratic of total medical expenditures. This is used to express average Medicaid and private expenditures per recipient individual as a function of total medical expenditures. We estimate that Medicare pays for approximately 50% of elderly medical expenses, so we set $\phi_{Medicare} = .5$. Attanasio et al. (2011) estimate Medicare premiums to be 2.2% of per-capita income, which implies $\Pi_{Medicare} = .0365$ in our model.

Following Attanasio et al. (2011), we normalize medical expenditures so that aggregate medical expenditures are 18% of GDP in the benchmark economy. According to the National Health Expenditure data from the Centers for Medicaid and Medicare Services, aggregate medical expenses were approximately 18% of GDP in each of 2009, 2010, and 2011.

3.4 Government

The number of regions is set to $N = 50$. To calculate the exogenous component of regional and federal government expenditures, G^i and G^f, respectively, we assume that total government expenditures are 20% of GDP in the benchmark economy. Then we set the region's fraction of aggregate government expenditures to one-third, leaving the federal government to finance the remaining two-thirds. Then we use data from the 2011 Annual Survey of State Government Finances from the U.S. Census Bureau to estimate the percentage of non-Medicaid state government expenses. We find that Medicaid comprises approximately 25% of state expenditures. We do the same for the federal government and find that Medicaid, Medicare, and Social Security comprise about 45% of federal expenses. The exogenous component of regional and federal government expenditures are then set to the remaining shares.

The Social Security benefit ss is calibrated so that federal benefits paid are 4.5% of GDP, as in Attanasio et al. (2011). The consumption floor is set to $c_{floor} = .1$, which is about 6% of per-capita income. This is close to the value specified in De Nardi et al. (2010).

We assume that the federal government has a progressive income tax function estimated by Gouveia and Strauss (1994) where the parameters $\kappa_0$and κ_1 are set to 0.258 and 0.768, respectively. We also assume that the federal government levies a proportional Social Security tax. This tax rate is set to $\tau_{ss} = 12.4\%$, which is the sum of the employer and employee portion of the tax. The maximum taxable income for the Social Security tax, $\bar{y}^{ss}$, is set to 2.5 times per capita income, which was approximately \$110,000 in 2012. The remaining parameter is κ_2, which we use to clear the federal government's budget constraint.

In reality, U.S. state governments vary significantly in the ways they finance expenditures. Because of the homogeneity in regional environments in our model, we simplify by assuming that each state levies a proportional consumption tax, τ_c, and the same progressive income tax function as the federal government. The consumption tax is set to $\tau_c = .057$ following Mendoza et al. (1994), the parameters κ_0 and κ_1 are the same as the federal income tax function, and κ_2 is adjusted to clear each state government's budget constraint.

The remaining parameter is percentage of the federal Medicaid subsidy, or the region's FMAP, α. We assume this value is exogenously set to the average of all states in 2011, which is 60%.

4 Results

This section presents the results of the computational exercise. The model economy is evaluated by comparing the benchmark economy to the corresponding values in the U.S. data. We then present the results of the counterfactual experiments.

4.1 The Benchmark Economy

The benchmark model matches several key features of the U.S. health care system. Most importantly, the model generates an equilibrium Medicaid coverage that is close to the average across U.S. states. Approximately 10% of working-age individuals in the U.S. are covered by Medicaid, while 8.3% of workers in the model are covered by Medicaid. Insurance coverage in the model and associated values for the U.S. economy are summarized in Table 1. The model also generates insurance coverage rates by age that closely match the values measured in the data. These profiles are shown in Figure 5.

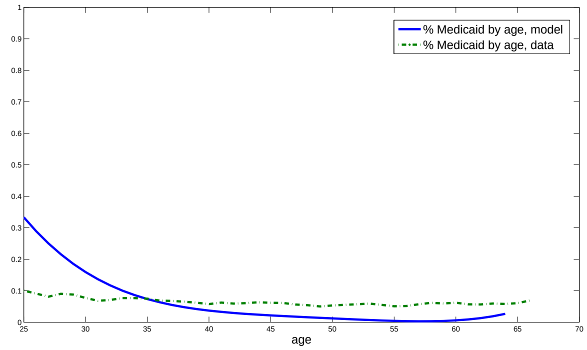
The Medicaid coverage rate in the model is high (relative to the data) when agents are young and low when agents are old. This implies that the value of Medicaid is potentially understated in the model, since agents are forward-looking. The model is a close match for the uninsured and the *total* private (i.e., private plus ESHI) health insurance profiles.

Table 1: Comparing the benchmark model to the U.S. economy

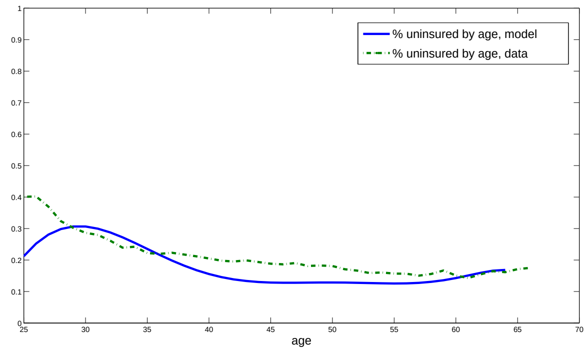
Variable	U.S. data	Benchmark Model
Medicaid coverage	10%	8.30%
Uninsured*	21%	21.05%
Privately insured	6 %	14.18%
ESHI	58%	56.14%
Other	3%	0%

*Calibrated value in the benchmark model.

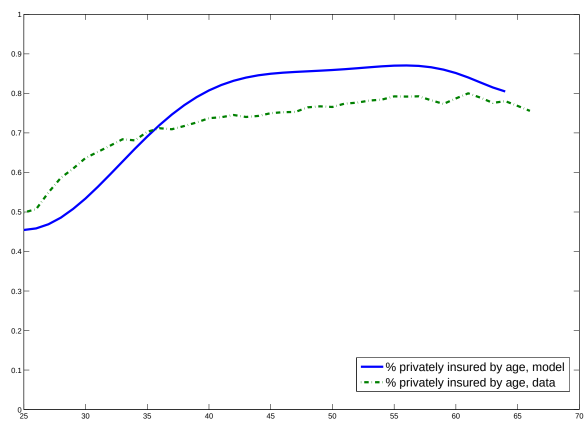
Figure 5: Insurance Coverage Rates by Age



Medicaid



Uninsured



Total Private

4.2 Effect of the Federal Subsidy

The goal of this paper is to measure how much the federal subsidy distorts the optimal Medicaid provision by U.S. states. To that extent, we solve the model again with the federal subsidy set to zero and compare the equilibrium outcomes. We find that removing the federal Medicaid subsidy decreases the percentage of working-age individuals from 8.30% down to 0.46%. The percentage of individuals covered by Medicaid effectively falls to zero, since the only remaining Medicaid recipients are individuals age $j = 1$, fixed on Medicaid in the initial distribution of health insurance types.

The percentage of uninsured rises from 21.05% to 22.49%, suggesting that the Medicaid program reduces the amount of uninsured individuals. Much of the change in Medicaid recipients, however comes from individuals that switch from private and ESHI insurance to Medicaid. Increases in public health insurance coverage caused by a reduction in total private health insurance is known called *crowd-out*, and it is measured as $\frac{\Delta\text{total private}}{\Delta\text{Medicaid}}$. We find that Medicaid crowd-out is 81.63%. By comparison, Cutler and Gruber (1996) report estimates of Medicaid crowd-out in the range of 50% to 100%.

Our model finds that elimination of the federal subsidy would effectively end the Medicaid program. To determine whether this is a reasonable outcome, our best comparison is the state provision of public health insurance that existed prior to the inception of the Medicaid program in 1965. Gruber (2003) gives a brief history of the Medicaid program and notes that state-financed public health coverage for low-income citizens was extremely limited before 1965. Even after the Medicaid program began, many states were slow to adopt the new policy. These findings are consistent with the results of our model.

4.3 Block Grants to Regions

An important policy experiment is a proposed legislation that would fix federal Medicaid payments to U.S. states at their current level and eliminate any matching funds from the federal government. Since the federal contribution would not depend on the state contribution, the policy would effectively increase the states' marginal cost of Medicaid provision to 100% once the amount of the federal block grant had been reached. To evaluate the effects of this policy, we fix the federal contribution to the amount determined in the benchmark economy and set FMAP to zero. We find regional governments choose a Medicaid eligibility threshold such that total Medicaid payments are almost exactly equal to the magnitude of the block grant. In other words, the block grant entirely eliminates the incentive for regions to provide additional funding for the Medicaid program. The resulting Medicaid coverage of adults in this case falls from 8.3% in the benchmark to 5.47%. A comparison of the benchmark economy to each policy experiment is summarized in Table 2 and Table 3.[8]

Table 2: Comparing working-age insurance coverage rates and equilibrium tax rates

Variable	Benchmark Model	Zero Subsidy	Block Grants
Coverage Rates (percentages)			
Medicaid coverage	8.30	0.46	5.47
Uninsured	21.05	22.49	21.18
Private	14.18	18.17	15.47
ESHI	56.47	58.88	57.88
Equilibrium Taxes			
κ_2^f (federal tax parameter)	.539	.496	.538
κ_2^s (regional tax parameter)	.096	.092	.089

Changes in the federal and regional tax rates are directly linked to the tax parameter κ_2, which changes to clear the government budget constraint at each level of government. The elimination of the federal subsidy reduces the equilibrium value of κ_2 at both the federal and regional levels. Since the block grant keeps the federal transfer to regions fixed at the benchmark level, the equilibrium federal value of κ_2 is roughly unchanged after a switch to block grants. Perhaps more surprising is the finding that the equilibrium regional value of κ_2 is lower in the case of block grants than in the case of the zero subsidy. This happens because the Medicaid eligibility threshold for retirees is exogenous and constant in each experiment. Then in the case of zero subsidies, regional governments are required to pay this entire amount.

[8]We follow Conesa et al. (2009) and measure CEV as $CEV = \left[\frac{V^S}{V^B}\right]^{\frac{1}{\chi(1-\sigma)}}$, where V^B is benchmark economy welfare, and V^S is economy welfare in policy experiment S.

4.4 Aggregate Effects of Policy Alternatives

Federal policy influences regional Medicaid policy by distorting the trade-off between lower regional taxes (and to a small extent, federal taxes), and higher means-tested public health insurance eligibility. To that extent, we measure the effects of the federal policy on aggregate quantities by decomposing the total effect into a tax reduction effect and a income eligibility threshold reduction effect. Throughout the discussion, we note that the zero federal subsidy indirectly sets the Medicaid income eligibility threshold to zero.

Table 3: Total Effects of Policy Changes on Aggregate Variables*

Variable	Zero Subsidy	Block Grants
Capital Stock (K)	0.661	0.136
Total Labor (L)	1.071	0.245
Output (Y)	0.923	0.206
Aggregate Consumption (C)	1.560	0.380
Average Labor Hours (n)	1.592	0.307
CEV	0.622	0.106

*Quantities are in percent changes from the benchmark economy.

The total effects of the policies on aggregate variables are summarized in Table 3. We first notice that the aggregate effects of eliminating federal Medicaid subsidies tend to be larger than the switch to a block grant program. In both cases aggregate capital and labor (labor hours and effective labor) increase, which in turn, increases aggregate output. Aggregate consumption rises by more than aggregate output because a reduction in the tax rates allows individuals to consume more of their income. Further, because of risk aversion, uninsured individuals are generally willing to reduce earned income by an amount greater than expected medical expenses in order to become eligible for Medicaid. Since the price of private (non-ESHI) health insurance exceeds the expected medical expenses, reducing earned income makes sense for non-ESHI-eligible individuals whose income is near the Medicaid eligibility threshold. Therefore, the elimination of the federal subsidy has a large effect on aggregate consumption. Finally, because regions in this model are homogeneous and the federal policy effectively redistributes income across regions, the economy realizes welfare gains as the federal policy becomes more limited.

The individual effects of tax rate changes and eligibility threshold changes on aggregate variables are summarized in Table 4. Reductions in the tax rates can account for much of the rise in consumption and welfare. The total changes in the remaining variables are mainly attributed to changes in the eligibility threshold. We find three interesting results from this experiment. First, the individual effects of tax reduction and eligibility threshold reduction create a strong substitution away from capital income and towards labor income. Second, the combined effects on labor supply are less than the individual effects, accounting for the rise in capital in the combined effect case. Finally, a reduction in the income eligibility threshold causes CEV to rise slightly, implying a strong moral hazard cost of the policy.

Table 4: Decomposing the Effects of Policy on Aggregate Variables*

Variable	Zero Subsidy	Block Grants
Tax Change Only		
Capital Stock (K)	-0.036	0.070
Total Labor (L)	0.123	0.040
Output (Y)	0.066	0.051
Aggregate Consumption (C)	1.157	0.380
Average Labor Hours (n)	0.190	0.056
CEV	1.009	0.199
Eligibility Threshold Change Only		
Capital Stock (K)	-0.054	0.071
Total Labor (L)	0.994	0.173
Output (Y)	0.615	0.136
Aggregate Consumption (C)	0.499	0.010
Average Labor Hours (n)	1.467	0.204
CEV	0.082	0.080

*Quantities are in percent changes from the benchmark economy.

5 Conclusion

The primary goal of this paper was to measure the distortion caused by U.S. federal subsidies on optimal state Medicaid provision. We accomplished this by developing a theory of means-tested public health care financing in a federalist system. We then calibrated the theoretical model to the U.S. economy and solved for optimal state provision, given the design of the federal policy. This allowed us to conduct a counter-factual experiment in which we eliminated the federal subsidy to determine the magnitude of the distortion. Our main finding was that eliminating the federal Medicaid subsidies would effectively end state provision of means-tested public health care financing.

Our framework allows for the evaluation of other policies that would alter the incentives created by the federal government. An important consideration is the transition to a block grant program that would change Medicaid from a proportional subsidy to a lump-sum transfer. We found that such a policy would also eliminate incentives for states to provide means-tested public health care financing.

In order to keep our model computationally tractable, we simplified the economic environment by assuming that regions were identical. However, an important application of our model would allow regional heterogeneity for the welfare evaluation of regional redistribution generated by the federalist design of Medicaid. A heterogeneous-region model could also evaluate the recent Medicaid expansion that gave states the option to expand Medicaid to 133% of the federal poverty level. For the newly covered portion of the income distribution, the federal government subsidizes 100% of Medicaid expenditures for the years 2014-2017, falling incrementally to 90% by 2024. Despite this generous offer by the federal government, many states have elected not to expand Medicaid eligibility, which presents an important topic of future research.

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Appendix 1: Overview of Parameters

Table 5: Model Parameters

Parameter	Value	Target
Demographics		
Retirement age (Tr)	46 (65)	Assumed
Max lifetime (T)	80 (99)	Assumed
Survival probability (s_{j+1})	Figure 1	CDC Life Tables (2008)
Population growth (η)	.012	Literature
Preferences		
Discount factor (β)	1.016	$K/Y = 3$
Risk Aversion (σ)	4	IES = .5
Consumption share (χ)	.36	avg. hours = .36
Health care		
Private insurance load (γ)	1.11	Kahn et al. (2005)
Fixed insurance cost (π)	.05	21% uninsured when 10% on Medicaid
Relative health care prices (p_m)	6.0×10^{-5}	Aggregate medical expenses 18% of GDP
Medicare premium ($\Pi_{Medicare}$)	.8	59.20
ESHI subsidy (ψ)	.3	Burman et al. (2008)
Elderly Medicaid threshold ($\bar{y}^{m,e}$)	.04	6% of noninstitutionalized elderly on Medicaid
Labor Productivity		
Variance of entering workers (σ_1^2)	.38	Huggett (1996)
Persistence (ρ)	.96	Huggett (1996)
Variance of innovation (σ_ν^2)	.045	Huggett (1996)
Technology		
Capital share (a)	.36	Data
Depreciation rate (δ)	.085	I/Y = 25.5%
Government Policy		
Tax parameter 1 (κ_0)	.258	Gouveia and Strauss (1994)
Tax parameter 2 (κ_1)	.768	Gouveia and Strauss (1994)
Consumption tax (τ_c)	.057	Mendoza, Razin, and Tesar (1994)
Social Security tax (τ^{ss})	.124	Data
Consumption floor (c_{floor})	.08 ($2700)	De Nardi et al. (2010)

Appendix 2: Computational Algorithm

This section provides an overview of the computational algorithm used to solve the model. The computation involved two levels: the outer loop that solves the Nash equilibrium and the inner loop that solves the competitive equilibrium.

A2.1 Solving the Symmetric Nash Equilibrium

1. Create a grid of Medicaid income eligibility thresholds, $\bar{y} = \{\bar{y}_1, \ldots, \bar{y}_M\}$. Fix $\bar{y}^i$ at a point on the grid. Then fix $\bar{y}^{-i}$ at a point on the grid, and use this value for $N-1$ regions.

2. Find the κ_2^f, κ_2^i, and κ_2^{-i} that clear the government budget constraint in the competitive equilibrium. Save the welfare function $\tilde{V}(\bar{y}^i, \bar{y}^{-i})$.

3. For each $\bar{y}^{-i}$, maximize over interpolated values of $\left\{\bar{y}^i, \tilde{V}(\bar{y}^i, \bar{y}^{-i})\right\}$ to find the best response function, $BR_i(\bar{y}^{-i})$ at discrete points on the grid of $\bar{y}^{-i}$.

4. Interpolate over the points $\{\bar{y}, BR_i(\bar{y})\}$ to find the fixed point y^* such that $y^* = BR_i(y^*)$.

A2.2 Solving the Competitive Equilibrium

1. Guess initial values of the capital-to-labor ratio and the bequest, *beq*.

2. Solve the individual agent problem over a grid of assets, insurance, and labor supply.[9]

3. Solve for the distribution over all types, and determine aggregate variables.

4. If the guessed bequest is equal to all unintended bequests, then this loop is complete. Otherwise, update the bequest and iterate to convergence.

5. If the capital-to-labor ratio generated in this equilibrium is the same as the guess, then this loop is complete. Otherwise, update (using partial adjustment) and iterate to convergence.

[9]Ensuring that the highest gridpoint has a mass of zero in every exercise.

Appendix 3: Data

We use data from the MEPS for the years 1996-2010 to estimate empirical moments and parameters related to medical expenses and health insurance. The MEPS is a household survey with overlapping panels that are followed for two years and interviewed a total of five times. The sample is restricted to adults age 20 or older resulting the sample sizes shown in Table 6 for the first year of each panel.

Table 6: Sample Size by Year

Panel	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Sample Size	15,101	8,715	7,495	9,412	7,518	15,275	11,149	11,518	11,520	11,291	11,918	9,196	13,191	12,050	10,734

Data are weighted to represent the civilian non-institutionalized population, but because person-level weights are generated within a year, weights are divided by 15 in the pooled sample. Expenditure data are adjusted for inflation to 2010 dollars using the Medical Consumer Price Index.