Macroeconomic Analysis of Universal Coverage in the U.S.

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Abstract. In this paper I employ a dynamic general equilibrium model to study macroeconomic effects and welfare implications of health policies for universal coverage in the U.S. The model is calibrated to the U.S. data. Numerical simulations indicate that adopting universal coverage has several important macroeconomic effects on health expenditures, hours worked, and increases welfare by improving aggregate health status, and removing adverse selection.

Keywords: Health care reform, Heterogeneous agents model, Welfare analysis.

1 Introduction

National health expenditures accounted for 16.3% of the U.S. GDP in 2007, compared to 5.2% in 1960 (Department of Health & Human Services, 2006). The rapid growth of medical costs leaves a large fraction of the population without health insurance.[1] The lack of insurance has serious negative consequences that include lack of access to needed care, declining health, and the possibility of crushing financial burdens. Uninsured adults are far more likely to postpone accessing health care or to forgo it altogether and are less able to afford prescription drugs or follow through with recommended treatments. A report by the Institute of Medicine (2003) states that the uninsured have a more rapid decrease in general health and a higher risk of dying prematurely than the insured. According to their estimation the cost for diminished health and shorter life span due to lack of insurance was between $65 and $130 billion in 2003. There are also financial externalities imposed by the uninsured on the third party through uncompensated care, whose costs were estimated to be $57.4 billion in 2008 [Hadley et al. (2008)].

These facts have stirred up various proposals for changing the U.S. health care system and to cover the uninsured. There are many empirical studies that explore

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[1] 17% of the nonelderly in the US was uninsured in 2007 according to Kaiser (2008).

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the impacts of health care reforms on individual's behavior such as crowding-out by public insurance [e.g. see Culter and Gruber (1996), Lo Sasso and Buchmueller (2004), Gruber and Simon(2008)], medical usage [Cheng and Chiang (1997)], and health status [Lurie et al. (1984), Currie and Gruber (1996), Hanratty (1996), Decker and Remler (2005)]. However, there is a paucity of economic models that address the macroeconomic and welfare implications of reforming the U.S. health care system.

A reform of the health insurance system could potentially affect macroeconomic variables by distorting the labor market through changes in tax rates, reducing the number of uninsured, and raising the aggregate health expenditure. Reforming the health insurance system will affect the household's demand for health insurance. Some individuals may shift from existing private insurance coverage to either the newly subsidized form of private coverage or to public coverage. This in turn alters the pool of agents insured, which affects insurance premiums. Similarly, different insurance decisions result in changing health status and labor productivity, which then will affect wages and hours worked. A change in the labor income tax may be required to fund the reform, which consequently will influence individual's labor supply decisions. A reform will also change agents' saving behavior (and thus the aggregate capital stock and factor prices) because health insurance may reduce precautionary saving motives. At the same time, better health implies longer life expectancy and thus a higher saving incentive. These complicated tradeoffs can only be fully captured in a general equilibrium framework.

The aim of this study is to analyze the macroeconomic impacts and welfare implications of alternative reforms to the health insurance system in the U.S. I employ a stochastic OLG framework developed by Feng (2009), which helps to capture general equilibrium effects of health care reforms on some important aggregate variables. I consider the expansion of Medicare to the entire population, which is one of the major reform proposals discussed in the U.S. I calibrate my model to the U.S. data. Then, I conduct several policy experiments to shed light on the costs and benefits of changing the health insurance system. My numerical experiments suggest that general equilibrium effects are substantial, and the impact of various reforms on the social welfare can be quite sizable.

The paper is organized as follows. Section 2 introduces the OLG model, while section 3 details reform proposal and presents all numerical results. The last section concludes.

2 The Dynamic Model

2.1 Demographics

This economy has overlapping generations of agents who live a maximum of three periods as *young*, *middle-aged*, and *old*. Let $g \in \{1, 2, 3\}$ denote the age. In the first period, the measure of newly born agents is normalized to 1. Individuals alive in period t survive to the next period with a certain probability. For old people this probability is always 0. For young and middle-aged people, the survival probability is given by $\rho(h_g)$, which depends on the health status h_g at the end of age g as described below. The population of young individuals grows at a constant rate n, implying that the population of young in period t is $(1+n)^t$. I denote the relative size of age g to the population as μ_g, which is determined in the equilibrium.

2.2 Agent Types

All individuals enter the economy with the same level of health $\bar{h}_0$, an idiosyncratic endowment e_0, and an idiosyncratic health risk types i_h. Health risk type determines the probability of drawing a certain health shock $\varepsilon_t \in \Omega_\varepsilon = \{\varepsilon^1, ..., \varepsilon^{N_\varepsilon}\}$. The probability distribution of the shock is assumed to be age-type-dependent. Specifically, the probability of drawing $\varepsilon \in \Omega_\varepsilon$ by type i_h agent at age g is denoted by $p_{g,i_h}(\varepsilon)$, with $\Sigma_{\varepsilon \in \Omega_\varepsilon} p_{g,i_h}(\varepsilon) = 1$ for all (g, i_h). A typical history of shocks up to time t is denoted by $\sigma_t \equiv \{\varepsilon_0, ..., \varepsilon_t\}$, with $\sigma_{t+1} = \{\sigma_t, \varepsilon_{t+1}\}$. Agents are endowed with a fixed amount of time per period that can be allocated to leisure or labor. Agents participate in the labor market during the first two periods and receive a wage income $\tilde{w}e^{\zeta h}l$. Here ζ measures the effect of health on labor productivity.

During their work stage agents receive income in the form of wages and profit Π_t from the firm. They can also save a_g units of the consumption good using a storage technology with gross rate of return $R_{t+1} = 1 + r$. Retired agents have income through previous saving and profit, and consume all of their income at their last period of life.

2.3 Preferences

Preferences over stochastic sequences of consumption, leisure and health are given by

$$U = \mathbf{E}_t \left\{ \sum_{g=1}^{3} \beta^{g-1} \Pi \rho(h_{g-1}) \cdot u(c_g, L_g, h_g) \right\} \tag{1}$$

where β denotes the discount factor, ρ survival probability, c consumption, L leisure and h health status. $\mathbf{E}_t$ denotes the conditional expectation with the information available when the agent is born.

2.4 The Evolution of Health

I use the idea of health capital introduced by Grossman (1972). In the model, each agent chooses an optimal amount of medical consumption m to offset the negative effect of health shock ε on health and builds up health capital h. The accumulation process of health is given by:

$$h' = (1 - \delta_h)h + \frac{\varepsilon}{\exp\left[A_m m^{\varsigma}\right]}. \tag{2}$$

where δ_h represents the natural deprecation rate of health and A_m measures the medical technology. I assume that technological progress in the production of medical service A_m is exogenously given. The price of medical care p_m is exogenously given so that each unit of consumption good can be transformed into $\frac{1}{p_m}$ units of medical care.

Conditional on being alive at the current age with end of period health stock h, agent will survive to the next period with probability $\rho(h)$. Death is certain when health falls below zero ($\rho(h) = 0$ if $h \leq 0$). I assume that $\rho'(h) > 0$. Deceased agents leave their savings a as an accidental bequest that is collected by the government as revenues.

2.5 Medical Expenses and Health Insurance

Non-elderly can choose one out of three possible insurance states labeled as $in = \{1, 2, 3\}$. To purchase private health insurance is $in = 1$, $in = 2$ denotes that the agent has Medicaid, and $in = 3$ indicates that the agent is uninsured. The out of pocket health expenditure will be $(1 - \tilde{q}(p_m m, 1))p_m m$ if the agent chooses to buy insurance and $(1-\tilde{q}(p_m m, 2))p_m m$ when he/she is covered by the government program Medicaid. [2] It will cost the entire expenditure $p_m m$ if the agent does not have insurance($\tilde{q}(p_m m, 3) = 0$). Here $\tilde{q}(p_m m, in)$ is function that represents the coinsurance rate and varies with the health insurance state in as we discuss in the following subsection. Agents take coinsurance rate as given and it is calibrated from the data. Retired agents are insured under Medicare.

2.6 The Representative Agent's Problem

A representative agent of generation $g = \{1, 2\}$ enters each period with characteristics $s_g = (i_h, x, h_{g-1}, i_{ma})$, where i_h is the risk type of the agent, x is the net wealth, h_{g-1} is the health status at the beginning of the period, and i_{ma} is the indicator function that signals the availability of the Medicaid benefit in the current period. Since all old agents are automatically enrolled in the Medicare program and leave the labor market, their characteristics simply are $s_3 = (i_h, x, h_2)$. The distribution of households over their state space is given by $f_g(s_g, \sigma_t)$, which is endogenously determined in the equilibrium and evolves over time.

Agents observe s_g at the beginning of the period. They take prices and taxes as given and make the insurance decision $in_g(s_g)$ and choose a set of state-contingent decision rules, $\{c_g(s_g, \varepsilon_g), a_g(s_g, \varepsilon_g), m_g(s_g, \varepsilon_g), L_g(s_g, \varepsilon_g)\}$, to solve the following problem.

$$\max_t \mathbf{E}_t \left\{ \sum_{g=1}^{3} \beta^{g-1} \Pi \rho(h_{g-1}) \cdot u \left[c_g(s_g, \varepsilon_g), L_g(s_g, \varepsilon_g), h_g(s_g, \varepsilon_g) \right] \mid \sigma_t \right\} \tag{3}$$

[2] To simplify the analysis, I only consider the Employer-Sponsored Health Insurance *(EHI)*. As a matter of fact, more than 90% non-elderly who have private insurance purchase through their employers.

subject to the budget constraint and a no-borrowing constraint

$$(1+\tau_c)c_1(s_1,\varepsilon_1) + [1-\tilde{q}(p_m m_1, in_1)] \cdot p_m m_1(s_1,\varepsilon_1) + \tilde{\pi}(in_1) + a_1(s_1,\varepsilon_1)$$
$$\leq e_0 + \Pi_t + (1-0.5\tau_{mr})\left[\tilde{w}_t e^{\zeta h_1} l_1(s_1,\varepsilon_1) - 1_{\{in_1=1\}}\tilde{\pi}(in_1)\right] - T(y_1) \quad (4)$$
$$a_1(s_1,\varepsilon_1) \geq 0 \quad (5)$$

when young;

$$(1+\tau_c)c_2(s_2,\varepsilon_2) + [1-\tilde{q}(p_m m_2, in_2)] \cdot p_m m_2(s_2,\varepsilon_2) + \tilde{\pi}(in_2) + a_2(s_2,\varepsilon_2)$$
$$\leq R_{t+1}a_1 + \Pi_{t+1} + (1-0.5\tau_{mr})\left[\tilde{w}_{t+1} e^{\zeta h_2} l_2(s_2,\varepsilon_2) - 1_{\{in_2=1\}}\tilde{\pi}(in_2)\right] - T(y_2) \quad (6)$$
$$a_2(s_2,\varepsilon_2) \geq 0 \quad (7)$$

when middle-aged; and

$$(1+\tau_c)c_3(s_3,\varepsilon_3) + [1-q_{mr}(p_m m_3)] \cdot p_m m_3(s_3,\varepsilon_3) + \pi_{mr}$$
$$\leq R_{t+2}a_2 + \Pi_{t+2} - T(y_3) \quad (8)$$

when old.

2.7 Aggregate Production Function

The consumption goods are produced by a neoclassical production function. The aggregate production function takes a nested Cobb-Douglas specification in the following form.

$$Y_t = A_t E_t^{\alpha} \quad (9)$$
$$E_t = \sum_{g=\{1,2\}} \mu_g(t) \int \left[e^{\xi h_g} l_g(s_g,\varepsilon_g)\right] f_g ds_g \quad (10)$$

where A_t is a total factor productivity, and E_t is an aggregate efficiency labor input, which depends on individual worker's health status. The firm's profit maximization problem is

$$\max_{\{E_t\}} A_t E_t^{\alpha} - w_t E_t. \quad (11)$$

Profits Π_t are distributed back to households in a lump-sum payment.

2.8 The Government

I impose a government balanced budget constraint period by period. The government has three different types of outlays: general public consumption, Medicaid and Medicare expenses. The government collects revenues from various sources: income taxation according to a progressive tax function $T(\cdot)$, consumption taxation at rate τ_c, Medicare taxation at rate τ_{mr}, Medicare premium π_{mr}, Medicaid premium π_{ma}, and accidental bequests B collected from deceased agents.

2.9 Health Insurance Company

The health insurance company is competitive. Hence, in equilibrium the premium π_E is charged such that expected expenditures on the insured are precisely covered.

$$\pi_E = \frac{\sum_{g=\{1,2\}} \mu_g(t) \int \left[q_E(p_m m_g) p_m m_g \cdot 1_{\{in=1\}} \right] f_g ds_g}{\sum_{g=\{1,2\}} \mu_g(t) \int 1_{\{in=1\}} f_g ds_g} \tag{12}$$

Notice the coverage ratio function $q_E(\cdot)$ is taken as exogenously given.

3 Numerical Results

In this section, I conduct counterfactual experiments as in Feng (2009) to determine the effect of reforming the health insurance system. In line with Conesa and Krueger (1999), I measure the welfare effect of a reform by computing the consumption equivalent variation (CEV).[3]

Alternative sources of revenue to fund these reforms are also considered. I first consider supporting the reform by adjusting the income tax. I also conduct companion experiments where the government funds the reform through a labor income tax and through a lump-sum transfer separately.

3.1 To Fund Reforms by Income Tax

In this experiment the private health insurance and the Medicaid program are abolished. Non-elderly will be covered by a uniform health insurance program, which is sponsored by the government, with premium π_{mr} and coverage rate $q_E(\cdot)$. Specifically, non-elderly pay for a premium that equals 2.1% of the per capita GDP, which is cheaper than the counterpart in the benchmark.[4] A fraction $q_E(p_m m)$ of their health expenditure will be paid by the government.

I assume that the average price level for medical service p_m and medical technology A_m are constant and exogenously given. I can also consider a case in which the technology slows down (or speeds up) as a result of the reform.

Experiment results are summarized in Table 1. The top section displays some statistics of aggregate variables: the fraction of insured non-elderly, the Medicare tax rate, the average effective income tax rate, average hours worked, average effective working hours, and the health expenditure as a ratio of GDP. The lower section displays the welfare effects of each reform. *% w/ CEV > 0* indicates the fraction of agents in the benchmark that would experience a welfare gain (positive CEV) if the alternative reform is taken place.

[3] A $CEV(i_h, x, i_{ma})$ of -10% implies that if the given policy reform is put into place, then an individual of type (i_h, x, i_{ma}) will experience a welfare loss due to the reform equivalent to sacrifice 10% of his consumption in the initial steady state with leisure, health insurance and health expenditure constant at the initial choices.

[4] In the benchmark, 72.5% of non-elderly who purchase private insurance pay an actuarially fair premium π_E, which is about 10.9% of the per capita GDP.

Expansion of Medicare to the entire population achieves a universal coverage as shown in the fraction of insured non-elderly. The aggregate health expenditure as a ratio of GDP increases by 0.3%. This is attributed to the fact that those newly insured non-elderly will utilize more medical service and incur higher amount of health expenditure as the reform provides them with cheaper health insurance. The current reform needs to raise tax revenue to cover 15.2% of the non-elderly who would be uninsured in the benchmark and to pay for part of the expenditure of the previously insured, who pay a premium of π_{mr} after the reform, which is about 20.0% of the premium they paid before the reform. The reform also saves some tax revenues through changes in the arrangement in the health care sector. In the benchmark, the government provides Medicaid to the low incomes, which costs 2.2% of total GDP. It also subsidizes the purchase of group insurance and the total subsidy amounts to 0.8% of total GDP. Once the reform is implemented, the government can save these spending, since both Medicaid and private insurance are abolished. Put them together, the government raises the proportional income tax rate by 4.5%, which will discourage labor supply. At the meantime, the individuals have access to better health insurance. Average health has been improved, which brings workers higher productivity and incentive to work longer. Consequently, average hours worked decreases by 4.8% to 28.7 hours per week. Total output decreases by 2.0% as labor supply shrinks and average consumption decreases by 3.0%.

Now let's look at the saving behavior. The average health stock of the non-elderly increases, which implies a longer life expectancy and a stronger saving incentive. A decreased exposure to the health shocks lowers the demand for precautionary saving, but this effect is dominated by the previous one and the aggregate saving rate slightly increases by 0.8%.

Although agents are subject to a higher income tax after the reform is implemented, the cheaper health insurance program from the government is enough to compensate this cost for most agents. As shown in *% w/ CEV > 0,* 72.6% of agents would experience a welfare gain from this reform, and the average welfare effect is in the order of 2.6% in terms of consumption in all states. However, low income agents, especially those covered by Medicaid before the reform, will suffer from this policy because the new insurance program from such a reform is less generous than Medicaid. On average, low income individuals would experience a welfare loss equivalent to 4.3% of consumption. Compared to agents who have income above the poverty line have a welfare gain equivalent to 6.0% of consumption.

In order to understand whether there exists a Pareto-improving variation of the above reform, I also consider experiment A-2. This experiment is similar to A-1 except that all low income agents are covered by Medicaid program. Under such reform, the tax rate needs a bigger increase since the health insurance provided to the low income is more generous than the one in experiment A-1. Consequently, they will consume higher amount of medical services which drives aggregate health expenditure to rise. Nevertheless, the benefit from such a guaranteed Medicaid coverage cannot offset the loss due to a higher tax rate, which is

Table 1. Policy Experiment A

		income tax		labor tax		lump-sum tr.	
	Bench.	A-1	A-2	A-1	A-2	A-1	A-2
Insured non-elderly (in %)	84.8	100.0	100.0	100.0	100.0	100.0	100.0
Medicare tax (in %)	2.5	2.5	2.5	7.9	11.2	2.5	2.5
Ave. income tax (in %)	24.6	29.4	30.4	24.7	24.5	25.4	25.4
Ave. Working hrs.	30.6	28.7	28.5	28.9	27.8	30.5	30.6
Ave. Effective Working hrs.	61.1	57.3	57.0	57.7	55.8	60.9	61.2
Health exp. (in % of GDP)	16.6	16.9	17.7	16.8	17.7	16.7	17.5
π_E (in % of per capita GDP)	10.1	2.1	2.1	4.2	4.2	2.1	2.1
Output	100.0	98.0	98.1	97.2	95.1	99.3	98.6
Average health stock	46.6	46.9	46.8	46.9	46.8	46.8	46.9
Lifetime CEV after transition							
all (in %)	–	2.6	2.8	1.8	2.5	2.7	3.0
income $> Y_{ma}$ (in %)	–	5.9	4.9	5.5	4.4	6.0	4.9
income $\leq Y_{ma}$ (in %)	–	−4.3	−1.4	−5.6	1.3	−3.9	−0.9
% w/ CEV > 0	–	72.6	76.7	72.6	76.7	72.6	76.7

required to provide generous Medicaid program to low income agents. As shown in CEV from transition, agents with income lower than the poverty line still experience a welfare loss, but at a much smaller magnitude of 1.4%. The welfare gain of higher income agents decreases to 4.9% from 5.9% in experiment A-1. On average, agents have a welfare gain in the order of 2.8% in terms of consumption in all states. From this experiment, it seems possible to make expansion of Medicare a Pareto-improving program by appropriately funding the reform.

3.2 To Fund Reforms by a Labor Income Tax

In order to understand how the macroeconomic effects of these proposals change in response to how the government finances the reform, I also consider funding the reform by changing the Medicare tax τ_{mr}. Now, government expenditure G, consumption tax rate τ_c and the progressive part of income tax function $T(\cdot)$, as well as the proportional tax rate τ_y remain unchanged from the benchmark. The government adjusts the Medicare tax rate τ_{mr} to balance the budget.

As shown in average working hours in table 1, to fund the reform through labor income tax creates stronger distortions compared with income taxes.[5] Notice I change some policy targets in order to make the experiment meaningful. The Medicare premium doubles from 2.1% of GDP to 4.2%. Otherwise the labor income tax rate will skyrocket and partially crash the labor market as some agents will leave the market. To finance the reform with labor income tax requires

[5] There is no capital in my model. The profit Π is distributed back to the agent as a payment, which is inelastic supply to the individual. The interest rate is exogenous and the demand for saving is inelastic as well. Furthermore, the tax base of income tax is broader than labor income tax. These facts explain why taxing labor income creates more distortion than taxing gross income.

τ_{mr} to increases from 2.5% to 7.9%. As a consequence, average hours worked decreases by 5.6%. The welfare of a typical agent decreases compared to the case when the government finances the reform through the gross income tax.

3.3 To Fund Reforms by a Lump-Sum Transfer

The analysis so far indicates that the change in taxes may play a dominant role in how health care reforms affect the macroeconomy. In order to isolate the effect of tax distortion, I also conducted companion exercises in which the government funds the reform through a lump sum transfer. In the companion experiments, the tax rates are kept intact as in the benchmark. The government returns a lump sum transfer to each individual. The transfer is determined so that the government's budget is balanced.

Numerical results in Table 1 indicate that the labor supply effect of health care reforms is rather small. Medicare expansion increases welfare by improving health status and reducing adverse selection in the health insurance market.

4 Concluding Remarks

In this paper, I build up a micro-founded dynamic general equilibrium model to study the impact of alternative health care reforms on the aggregate labor supply, health expenditures, savings, welfare, and the fraction of uninsured population. In contrast to some papers in the literature, I consider a model with a labor-leisure choice as well as a health expenditure decision. These latter choices may change the demand for medical services, which in turn affects the individual's health status and labor productivity. Moreover, financing reform may create distortions on the labor supply by requiring additional tax revenues. The magnitude of the distortion depends on the details of the reform as well as the funding method. My results suggest that the aggregate health expenditure rises as the insured population increases. Funding the reform through payroll taxes does not seem promising because such a policy can heavily distort the labor market.

Welfare analysis from numerical simulation suggests that universal health coverage increases lifetime CEV. The primary sources of welfare gains include improved aggregate health status through more inclusive health insurance coverage, decreased adverse selection, and higher labor productivity associated with individual health. These results raise a question why is universal health coverage highly unpopular in the U.S.? The gap between this theoretical prediction and political antipathy to universal healthcare in reality is an interesting research topic. However it is beyond the scope of the current study. Another interesting extension is to look at the macroeconomic effects of health care reform in other countries or to conduct an international comparison. I leave these subjects for future research.

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