Market Inefficiency, Insurance Mandate and Welfare: U.S. Health Care Reform 2010
Supplementary Documentation

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Abstract

This is supplementary document accompanies Jung and Tran (2010) and covers material that is not included in the paper due to space constraints.

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1 Solving the model

We solve the model backwards discretizing along a, and h. Choosing the optimal health level from a grid allows us to substitute health expenditures m_j out of the optimization problem via the law of motion of health

$$h_j = \phi_j m_j^{\xi} + (1 - \delta_j) h_{j-1} + \varepsilon_j^h.$$

Instead of choosing how much to spend on health in period j, the consumer picks the new health level h_j directly. Health expenditure m_j is then the obtained via the following expression

$$m_j = \left[\frac{h_j - (1 - \delta_j) h_{j-1} - \varepsilon_j^h}{\phi} \right]^{\frac{1}{\xi}}.$$

This method turns out to be simpler than picking m_j directly, since that would require an additional discretization over m_j. An alternative specification would be to let depreciation be a function of current health expenditures, $\delta(m_j)$. However, if the function $\delta(m_j)$ is nonlinear we cannot easily solve for m_j anymore which would increase the computational burden. We therefore limit the depreciation of health to only be a function of the current age j. We solve the model backwards using a grid search over all states $\{a_j, h_{j-1}, in_j, \varepsilon_j, \epsilon_j, i_{GI,j}\}$. The algorithm follows the steps given below

1. Discretize $x_j = \{(a_j, h_{j-1}, in_j, \varepsilon_j, \epsilon_j, i_{GI,j})\}$ according to
   - $a = [0, ..., 3]_{1\times 30}$
   - $h = [0.01, ..., 3.5]_{1\times 16}$
   - $age = [20, ..., 90]_{1\times 14}$
   - $ins = \{0, 1, 2\}$
   - $\varepsilon_j^h = \{\varepsilon_1^h, \varepsilon_2^h, \varepsilon_3^h\}$, where $j = \{1, ..., 9\}$ income shocks
   - $\varepsilon_j^l = \{\varepsilon_1^l, \varepsilon_2^l, \varepsilon_3^l\}$, where $j = \{1, ..., 9\}$ health shocks
   - $i_{GI,j} = \{0, 1\}$, where $j = \{1, ..., 9\}$ employer provided health insurance (yes/no)
2. Guess prices w, R, p, p^{Med}, tax rates τ^{Med}, τ^{Soc}, and an initial capital stock K^{old}
3. Solve the model backwards for optimal policy functions $a^*(x_j), c^*(x_j), l^*(x_j), m^*(x_j)$, and $in^*(x_j)$ assuming that savings in the last period are equal to zero
4. Solve forward: track agent masses over all states assuming that newborn generations have very low asset holdings at the beginning of their economic life at age 20 and store the distribution in an array μ_W and μ_R, for workers and retirees respectively (this method does not allow us to track individual agent histories)
5. Calculate aggregate asset holdings K^{new} using μ_W and μ_R

6. Calculate errors $\left\| K^{new} - K^{old} \right\|$, if error is small stop, if error is large update the capital stock $K^{old} = \lambda K^{new} + (1-\lambda) K^{old}$

7. Calculate new prices from firm first order conditions and insurance companies zero profit condition and repeat step 3 until convergence

Asset and health spending grids are coarse and are likely to influence the comparative static results. The forward solving part of the algorithm can be improved upon by simulating the health shock and survival history of a large number of households. This method would then allow us to condition policies on agent income histories, a feature that is not captured by the current solution method.

2 Welfare calculations

In this section we provide details about the two welfare measures. We start with the following observation. When calculating the compensating consumption levels that equate an agent's utility as measured by her value function from the original steady state V with the value function from the new regime W, we can express the consumption levels needed as percentage ϕ of the current consumption levels. If an agent is worse of in the new regime, she needs to be given extra quantities of consumption, so that $\phi > 0$. If, on the other hand, the agent is better off under the new regime, then $\phi < 0$.

In addition we compensate the agent with fraction ϕ of her consumption in all of her life periods, so that the two value functions V (before the regime change) and W (after the regime change) become identical. In other words, we equate

$$\begin{aligned} V\left(x_1^1, \Psi^1\right) &= W\left(x_1^2, \Psi^2, \phi, t\right), \\ &= \max\left\{u\left((1+\phi)\, c_1^2, l_1^2, s_1^2\right) + \beta E W\left(x_2^2, \Psi^2, \phi, t\right)\right\}, \end{aligned}$$

where superscripts denote regime 1 (before the change) and regime 2 respectively, the subscript denotes the agent's age, $x_j^l = \{(a_j, h_{j-1}, in_j, \varepsilon_j, \epsilon_j, i_{GI,j})\}$ is the state vector summarizing asset holdings, health capital, the insurance state, the health shock, the income shock, and the employer matching state of a j period old agent in regime l, and t is the calendar time when the agent is born. Using the above described functional form for preferences we have

$$u(c, l, s) = \frac{\left[\left(c^{\eta} l^{1-\eta}\right)^{\kappa} s^{1-\kappa}\right]^{1-\sigma}}{1-\sigma},$$

so that

$$
\begin{aligned}
u(c,l,s,\phi) &= \frac{\left[\left(((1+\phi)c)^{\eta} l^{1-\eta}\right)^{\kappa} s^{1-\kappa}\right]^{1-\sigma}}{1-\sigma}, \\
u(c,l,s,\phi) &= (1+\phi)^{\eta\kappa(1-\sigma)} \frac{\left[\left(c^{\eta} l^{1-\eta}\right)^{\kappa} s^{1-\kappa}\right]^{1-\sigma}}{1-\sigma}, \\
u(c,l,s,\phi) &= (1+\phi)^{\eta(1-\sigma)} U(c,l,s).
\end{aligned}
$$

Plugging this into the post reform value function we get

$$
\begin{aligned}
W\left(x_1^2,\Psi^2,\phi,t\right) &= (1+\phi)^{\eta\kappa(1-\sigma)} \max \left\{ \begin{array}{c} u\left(c_1^2,l_1^2,s_1^2\right) \\ +\beta\left[(1+\phi)^{\eta\kappa(1-\sigma)} \max\left\{u\left(c_2^2,l_2^2,h_2^2\right)+\beta EW\left(x_3^2,\Psi^2,t\right)\right\}\right] \end{array} \right\}, \\
&\rightarrow W\left(x_1^2,\Psi^2,\phi,t\right) = (1+\phi)^{\eta\kappa(1-\sigma)} \max\left\{u\left(c_1^2,l_1^2,s_1^2\right)+\beta EW\left(x_2^1,\Psi^1,t\right)\right\}, \\
&\rightarrow W\left(x_1^2,\Psi^2,\phi,t\right) = (1+\phi)^{\eta\kappa(1-\sigma)} W\left(x_1^2,\Psi^2,t\right).
\end{aligned}
$$

We can now equate the value function from before and from after the reform $V\left(x_1^1,\Psi^1\right) = W\left(x_1^2,\Psi^2,\phi,t\right)$, which yields

$$
V\left(x_1^1,\Psi^1\right) = (1+\phi)^{\eta\kappa(1-\sigma)} W\left(x_1^2,\Psi^2,t\right).
$$

The proportional increase in consumption can be computed analytically for each agent type over the transitions by

$$
\phi\left(x_1^2,t\right) = \left[\frac{V\left(x_1^1,\Psi^1\right)}{W\left(x_1^2,\Psi^2,t\right)}\right]^{\frac{1}{\eta\kappa(1-\sigma)}} - 1.
$$

If $V\left(x_1^1,\Psi^1\right) > W\left(x_1^2,\Psi^2,t\right)$, then $\phi > 0$, if $V\left(x_1^1,\Psi^1\right) < W\left(x_1^2,\Psi^2,t\right)$, then $\phi < 0$.

We have reported two welfare measures. The first measures the fraction of aggregate compensating consumption per aggregate consumption for each generation t over the transition period. This measure allows us to identify which generations on average stand to win or lose from the reform. We can write this measure as

$$
\frac{\sum_{j=1}^{J} \mu_j \int \left(\phi\left(x_j^2,\tau\right) c\left(x_j^2,\tau\right)\right) d\Lambda\left(x_j^2\right)}{\sum_{j=1}^{J} \mu_j \int c\left(x_j^2,\tau\right) d\Lambda\left(x_j^2\right)} \text{ for each transition generation } \tau = \{-13,-12,..1,...,T-J\},
$$

where transition generation $\tau = -13$ is the generation born 13 periods before the reform. This generation has one period $j = 14$, left to live under the new policy regime. Generation $\tau = 0$ is the first generation born under the new regime at calendar time t.

The second welfare measure calculates how much it would cost to compensate the individuals over the transition period in order to make them indifferent between the current U.S. economy and the equilibrium with health insurance vouchers. We express this cost in terms of fraction of GDP. Formally this can be expressed as

$$\frac{\sum_{j=1}^{J} \mu_j \int \left(\phi\left(x_j^2, t-j+1\right) c\left(x_j^2, t-J+1\right)\right) d\Lambda\left(x_j^2\right)}{Y_t} \text{ for each transition period } t = \{0, ..., T\}.$$

3 Data

3.1 General

Data from the Medical Expenditure Panel Survey (MEPS) are available for the years 2003 to 2006. MEPS provides a nationally representative information about health care use, health expenditures, health insurance coverage as well as demographics data and data on income, health status, and other socioeconomic characteristics. The household component of MEPS was initiated in 1996. Each year a about $15,000$ households are selected and interviewed 5 times over 2 full calendar years.

We use data from year 2004 and year 2005 of the MEPS. The dataset contains $34,403$ individuals in 2004 and $33,961$ individuals in 2005. After dropping individuals younger than age 20 and individuals that do not report the appropriate data we are left with $45,005$ individual observations over the two year period. For $10,589$ individuals we have observations from two years which allows us to construct a panel if needed. For the other $23,827$ individuals we either have observations from year 2004 or from year 2005.

In our analysis we concentrate on heads of households in $2004-2005$. MEPS groups individuals into so called Health Insurance Eligibility Units (HIEU), variable: HIEUIDX. We define the person with the highest income within each HIEU as the head of the household. If individuals have equal income, we pick the older one as the household head. We concentrate on heads of households since they are most likely to be the person making the health insurance choice, group vs. individual market. Dependents in the household are often times added to the head's insurance policy. In addition this strategy allows us to abstract from family size effects. The data is now reduced to $32,106$ individual observations over two years, where for $6,825$ individuals we have information in both years. For the other $18,456$ individuals we either have observations from year 2004 or from year 2005. We present summary statistics of the available data, pooled over the years $2004-2005$ in table 1. All dollar values are denominated in 2004 dollars using the Personal Consumption Expenditures (PCE - chain price) index.

3.2 Health Expenditure, Healthy Individuals, and Insurance Profiles

Figure 1 presents the life-cycle profiles of annual health expenditure, annual total income, medical expenditure to income ratio, and average weekly work hours.

The expenditure definition in MEPS refers to what is paid for health care services. More specifically, expenditures are defined as the sum of direct payments for care provided during the year, including out-of-pocket payments and payments by private insurance, Medicaid, Medicare, and other sources. Payments for over-the-counter drugs are not included in MEPS total expenditures. Indirect payments not related to specific medical events, such as Medicaid Disproportionate Share and Medicare Direct Medical Education subsidies, are also not included (This definition is from MEPS documentation HC-097: 2005 pp. C-106ff).

Figure 2 presents the life-cycle profiles of health status, where we define a healthy individual as a person with a health status of excellent, very good, or good. Persons with health status of fair and poor are considered unhealthy.

Figure 3 reports the insurance status over all age groups. We distinguish between no insurance, public insurance only, and some private insurance. In figure 4 we describe individuals with private insurance bought in the individual market and individuals with group insurance (from their employers). Group insurance are variable HELD31X, HELD42X, and HELD53X). The variable for type of health insurance coverage is INSCOVyy (where yy=05 for 2005).

MEPS data also contains data on who was offered group insurance (variables OFFER31X, OFFER42X, and OFFER53X) which allows us to calculate take up ratios.

3.3 Methodology

3.3.1 Markov transition matrix for working ability/efficiency units

We measure the individuals' working ability/efficiency unit in terms of the hourly wage rate (labor income per hour) of individuals, or

$$\text{Hourly wage} = \frac{\text{Gross labor income}}{\text{Total hours worked}}.$$

We classify individuals into 3/5 quantiles of hourly wage rates and $J_w = 9$ separate five year age cohorts. The cohorts assumed to be active in the labor market are: $20-24$, $25-29$, $30-34$, $35-39$, $40-44$, $45-49$, $50-54$, $55-59$, and $60-64$. We assume that individuals in each age-quantile group have identical working abilities, so that each cohort consists of 3/5 discrete states of productivity. To measure the discrete levels of working ability we use the average hourly wage rate conditioning on the income quantile and on age. We can therefore write the productivity of an individual age j in income group i as

$$e_j^i = \frac{\sum_{i=1}^{N_j^i} \text{Hourly wage}_j^i}{N_j^i},$$

where i denotes the income class, j denotes the age-cohort, and e_j^i is the level of working ability (average working ability within income/age class), and N_j^i is the total number of individuals of cohort age j and income i. We report graphs of the average productivity profiles per income group in figure 4

We use a Markov transition matrix to characterize the dynamics of working abilities over the life cycle. One often used method is a simple counting approach to calculate the transition probabilities (e.g. Nishiyama and Smetters (2005) or Jeske and Kitao (2009)). We record the number of individuals in income class 1 of cohort 1 and then count how many of those stayed in income class 1 in the next period and how many moved to income classes $2-3/5$ in the next period. We then get the transition probability $p_j^{i',i}$ of an individual of age j in income class i who moves to income class i' when age is $j+1$ as

$$p_j^{i',i}\left(e_{j+1}^{i'}|e_j^i\right) = \frac{n_{j+1}^{i'|i}}{N_j^i},$$

where N_j^i is the total number of individuals with working ability i at age j, $n_{j+1}^{i'|i}$ is the number if individuals of pool N_j^i who have working ability i' in the next period $j+1$. Note that all individuals with working ability i' in period $j+1$ can be calculated as $N_j^{i'} = \sum_{i=1}^{3/5} n_{j+1}^{i'|i}$. We report the number of individuals in each productivity class per age cohort in table 2 and summary statistics of labor productivities of all individuals that report income data in two consecutive years in table 3.

Since we assume that each period in the model corresponds to five years, we need to calculate the transition probability matrix of working abilities for $5-year$ periods. We assume that the transition probabilities are constant for a five year span and therefore express the labor productivity transition matrix of an individual of age j for one period (of five years) as the matrix product

$$P_j = P_{j1} \times P_{j1} \times P_{j1} \times P_{j1} \times P_{j1},$$

where P_{j1} is the annual transition matrix with elements $p_j^{k,i}$.

3.3.2 Markov transition matrix for health states

We group agents in the MEPS data into healthy and sick types according to their self reported health status. We define agents with health status *excellent*, *very good*, and *good* as healthy agents whereas agents with a self reported health status of $fair$ and *poor* are defined as sick agents. We then calculate the transition probabilities of going from one health state to another for each age group j. The transition probabilities are stored in matrix $P\left(\varepsilon_j, \varepsilon_{j-1}\right)$ and we report the 14 matrices in table 15.

References

Jeske, Karsten and Sagiri Kitao. 2009. "U.S. Tax Policy and Health Insurance Demand: Can a Regressive Policy Improve Welfare?" *Journal of Monetary Economics* 56(2):210–222.

Jung, Juergen and Chung Tran. 2010. "Market Inefficiency, Insurance Mandate and Welfare: U.S. Health Care Reform 2010." Working Paper.

Nishiyama, Shinichi and Kent Smetters. 2005. "Does Social Security Privatization Produce Efficiency Gains?" Michigan Retirement Research Center, WP 2005-106.

4 Tables and Figures

Table 1: Summary statistics of head of households of the pooled data 04 to 05

Variable	**Mean**	**(Std. Dev.)**	**Min.**	**Max.**	**N**
age as of 12/31/05 (edited/imputed)	46.174	(17.641)	20	85	32106
female	0.483	(0.5)	0	1	32106
married	0.412	(0.492)	0	1	32106
black	0.173	(0.379)	0	1	32106
wageIncome	24605.565	(28767.473)	0	437812	32106
totalIncome	29849.794	(29402.622)	0	437861	32106
healthExpenditure	3707.617	(10018.975)	0	440524	32106
yearEducation	12.326	(3.149)	1	17	31388
student	0.022	(0.146)	0	1	32106
healthy	0.849	(0.358)	0	1	31954
bmi	27.803	(6.263)	9.200	239.2	31011

Table 2: **Age - Today by Wage rate class - Today**

	Wage rate class - Today			
Age - Today	1	2	3	Total
1	309	337	370	1,016
2	425	381	400	1,206
3	352	360	327	1,039
4	338	334	333	1,005
5	309	335	319	963
6	289	305	345	939
7	313	238	277	828
8	235	205	232	672
9	122	138	128	388
Total	2,692	2,633	2,731	8,056

Source: .04to05.dta

Table 3: Summary statistics of the pooled data

Variable	Mean	(Std. Dev.)	Min.	Max.	N
Age - Today	4.429	(2.394)	1	9	8056
Wage rate - Today	15.993	(11.487)	0.07	70.059	8056
Wage rate class - Today	2.005	(0.821)	1	3	8056
Age - Next	4.523	(2.394)	1	9	4028
Wage rate - Next	15.884	(11.512)	0.078	70.059	4028
Wage rate class - Next	1.98	(0.820)	1	3	4028

Table 4: Markov transition matrix for earnings for age group: 1

	class1	class2	class3
class1	.4306582	.37860285	.19073894
class2	.34343946	.41853968	.23802086
class3	.25077599	.41660854	.33261547

Table 5: Markov transition matrix for earnings for age group: 2

	class1	class2	class3
class1	.77840123	.16108924	.06050954
class2	.5086613	.31344902	.17788968
class3	.2716173	.27734699	.45103571

Table 6: Markov transition matrix for earnings for age group: 3

	class1	class2	class3
class1	.90465852	.07022623	.02511525
class2	.56122633	.38187399	.05689969
class3	.23430181	.3483657	.41733248

Table 7: Markov transition matrix for earnings for age group: 4

	class1	class2	class3
class1	.85042687	.12250623	.0270669
class2	.28757565	.66526566	.04715869
class3	.06653564	.26517614	.66828822

Table 8: Markov transition matrix for earnings for age group: 5

	class1	class2	class3
class1	.78899864	.12840049	.08260087
class2	.35906711	.58377992	.05715297
class3	.06937002	.19921533	.73141465

Table 9: Markov transition matrix for earnings for age group: 6

	class1	class2	class3
class1	.85173011	.13513229	.0131376
class2	.22910051	.61444126	.15645822
class3	.06218231	.28571561	.65210208

Table 10: Markov transition matrix for earnings for age group: 7

	class1	class2	class3
class1	.86630537	.12432953	.0093651
class2	.29036284	.58295101	.12668616
class3	.07513653	.08284694	.84201653

Table 11: Markov transition matrix for earnings for age group: 8

	class1	class2	class3
class1	.78718784	.15892936	.05388279
class2	.35800711	.47934655	.16264635
class3	.06308082	.24048022	.69643896

Table 12: Markov transition matrix for insurance status for income group: 1

	Individual Insurance	Group Insurance
Individual Insurance	.61096411	.38903589
Group Insurance	.55351814	.44648186

Table 13: Markov transition matrix for insurance status for income group: 2

	Individual Insurance	Group Insurance
Individual Insurance	.47067959	.52932041
Group Insurance	.32858014	.67141986

Table 14: Markov transition matrix for insurance status for income group: 3

	Individual Insurance	Group Insurance
Individual Insurance	.40509134	.59490866
Group Insurance	.21282063	.78717937

Table 15: Transition Probabilities between Health Shocks by Age Groups

	to	Shock 1	Shock 2
20 to 25	.	.	.
from	.	.	.
Shock 1	.	0.807	0.193
Shock 2	.	0.793	0.207
25 to 30	.	.	.
from	.	.	.
Shock 1	.	0.840	0.160
Shock 2	.	0.838	0.162
30 to 35	.	.	.
from	.	.	.
Shock 1	.	0.827	0.173
Shock 2	.	0.821	0.179
35 to 40	.	.	.
from	.	.	.
Shock 1	.	0.781	0.219
Shock 2	.	0.765	0.235
40 to 45	.	.	.
from	.	.	.
Shock 1	.	0.735	0.265
Shock 2	.	0.714	0.286
45 to 50	.	.	.
from	.	.	.
Shock 1	.	0.661	0.339
Shock 2	.	0.617	0.383
50 to 55	.	.	.
from	.	.	.
Shock 1	.	0.626	0.374
Shock 2	.	0.572	0.428
55 to 60	.	.	.
from	.	.	.
Shock 1	.	0.557	0.443
Shock 2	.	0.500	0.500
60 to 65	.	.	.
from	.	.	.
Shock 1	.	0.493	0.507
Shock 2	.	0.432	0.568
65 to 70	.	.	.
from	.	.	.
Shock 1	.	0.430	0.570
Shock 2	.	0.377	0.623
70 to 75	.	.	.
from	.	.	.
Shock 1	.	0.362	0.638
Shock 2	.	0.313	0.687
75 to 80	.	.	.
from	.	.	.
Shock 1	.	0.271	0.729
Shock 2	.	0.232	0.768
80 to 85	.	.	.
from	.	.	.

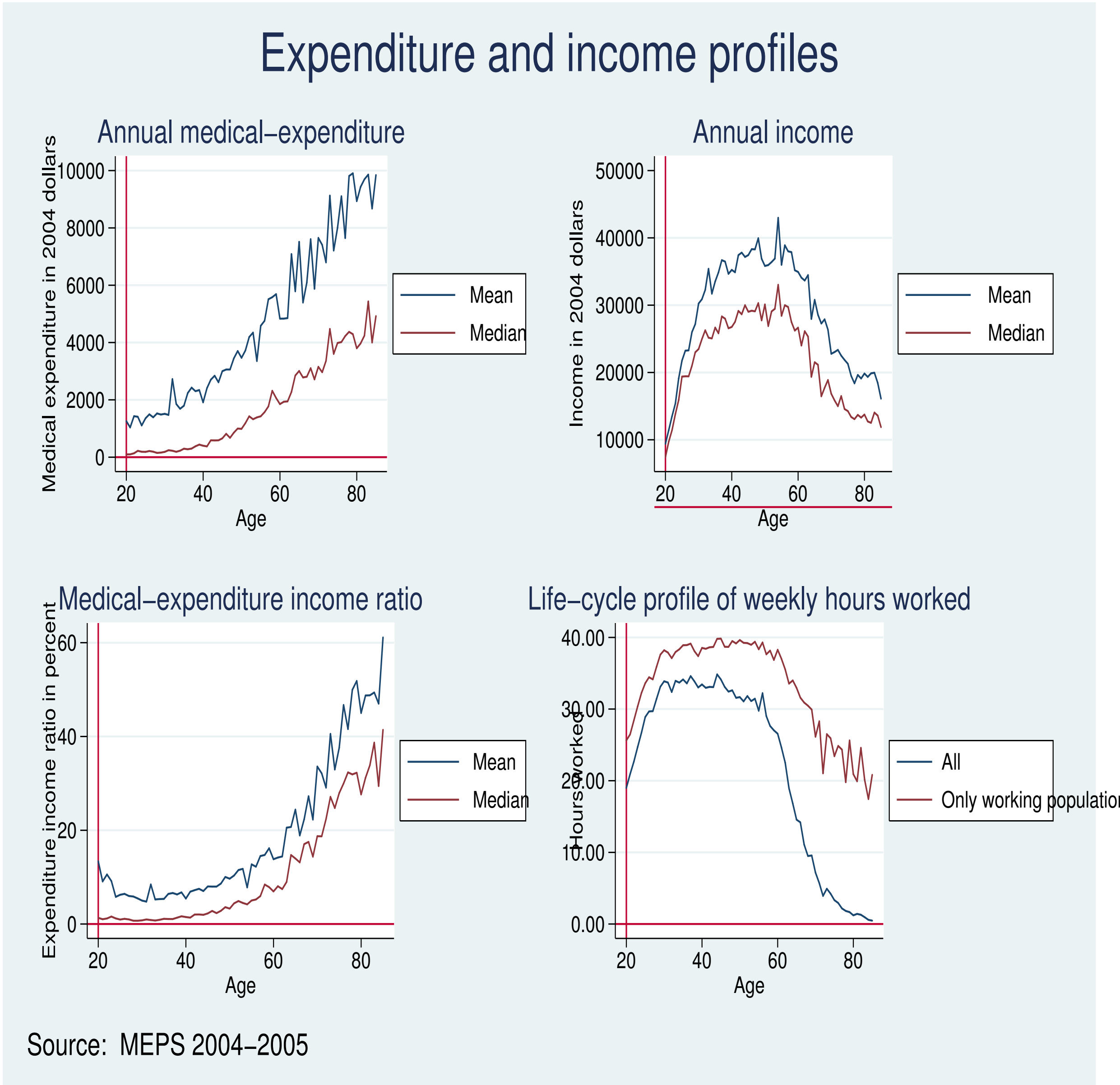

Figure 1: Life-cycle health expenditure profile: MEPS 2004-2005

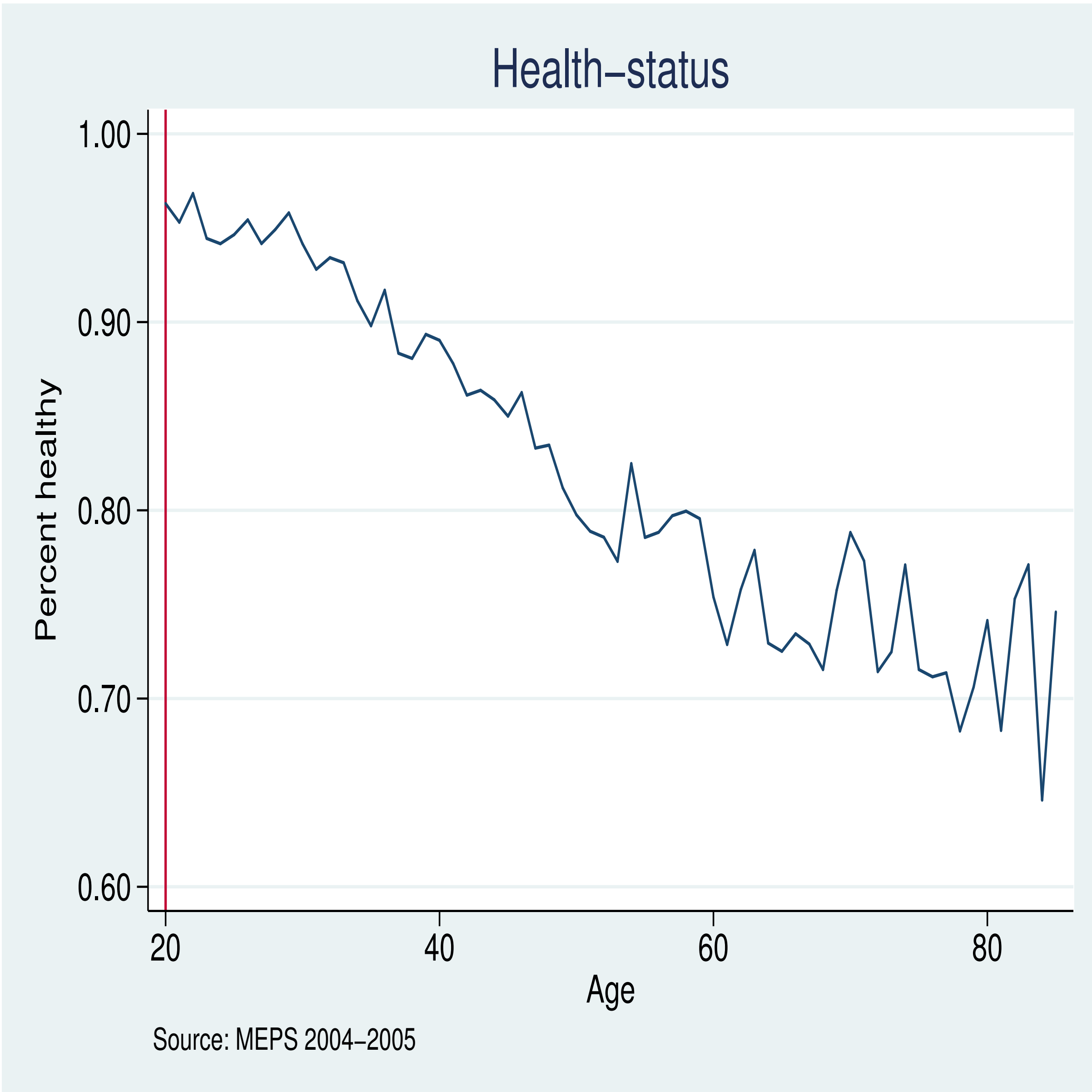

Figure 2: Life-cycle profile of health status: MEPS 2004-2005

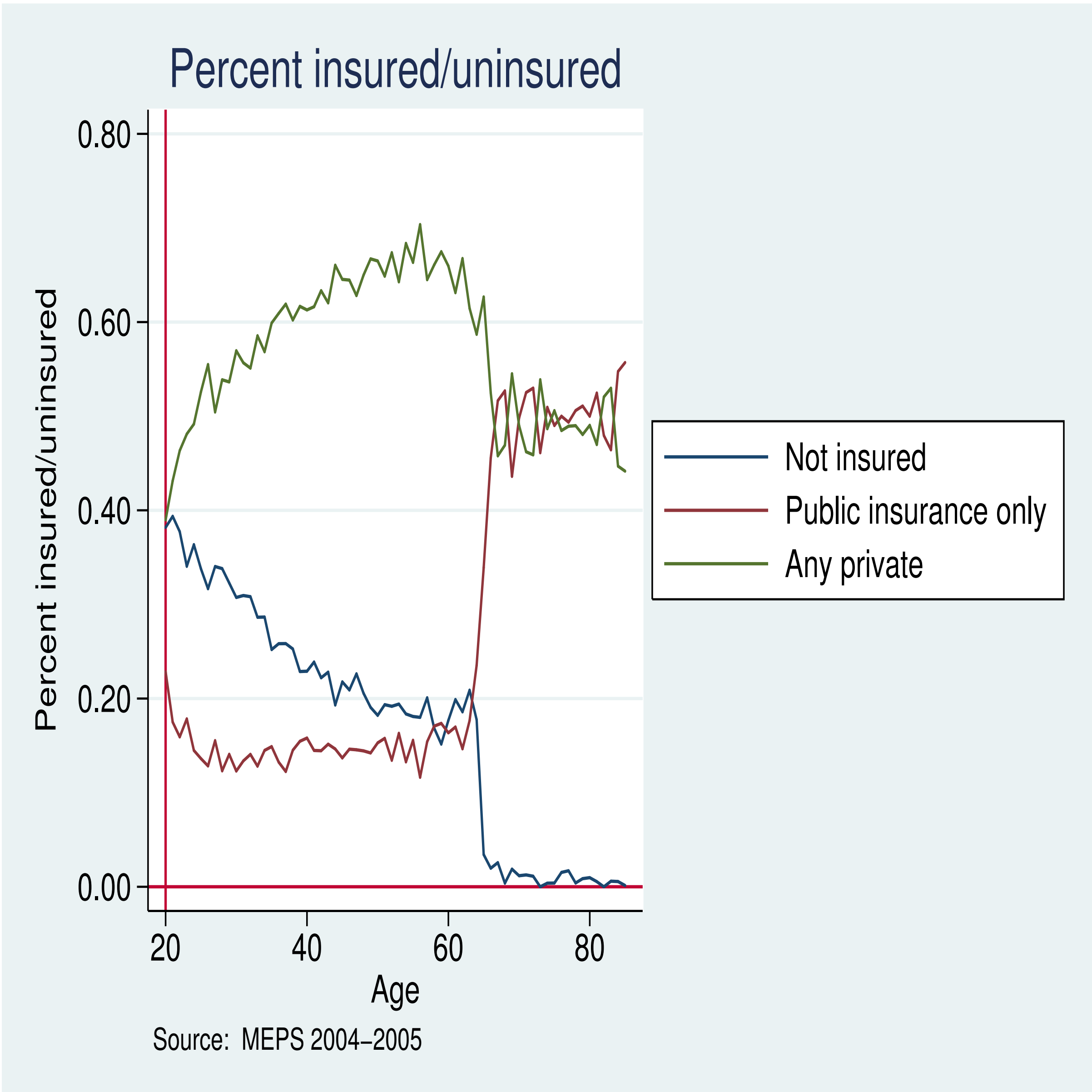

Figure 3: Health insurance profile: MEPS 2004-2005

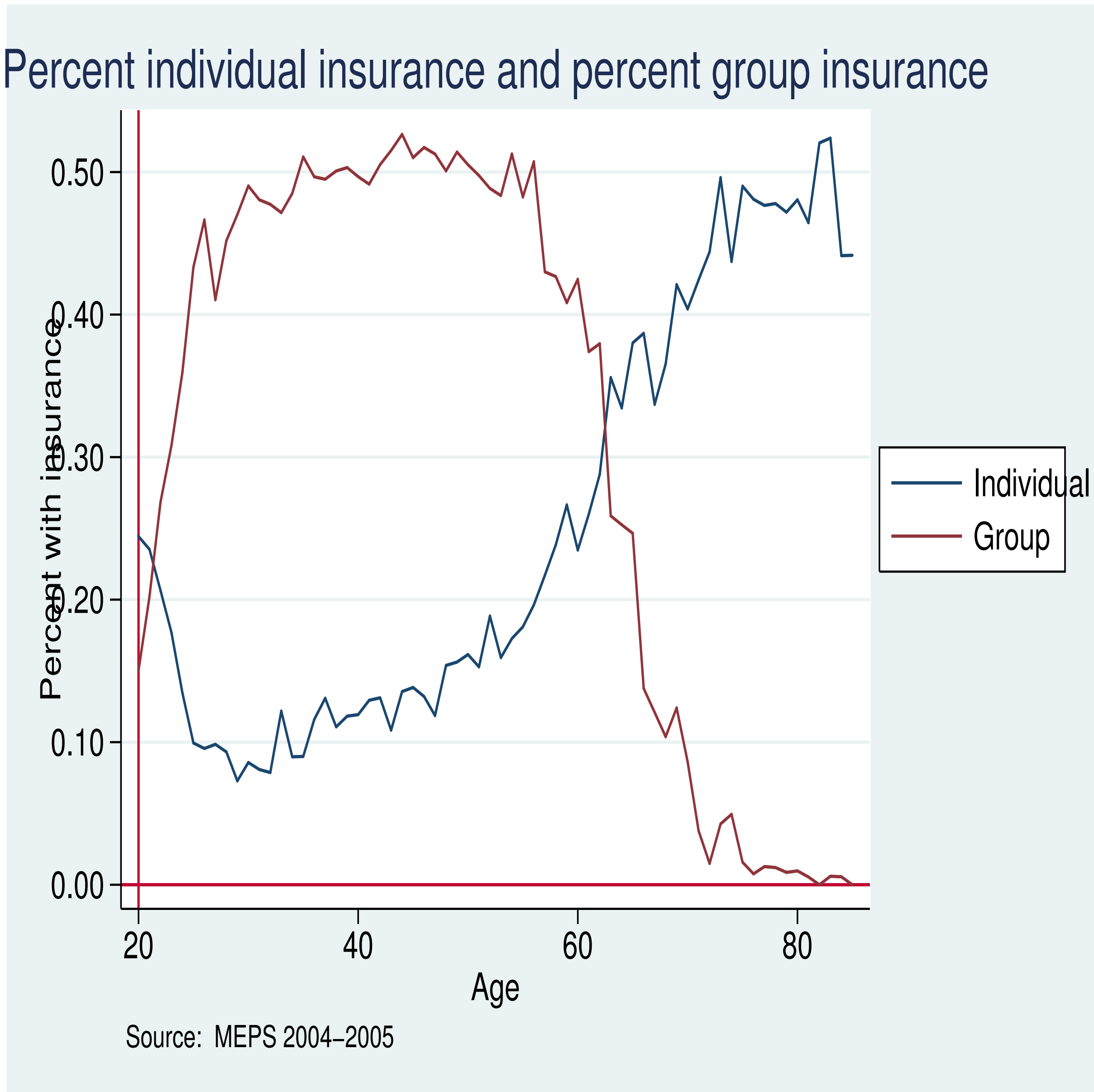

Figure 4: Individual vs. group insurance.profile: MEPS 2004-2005

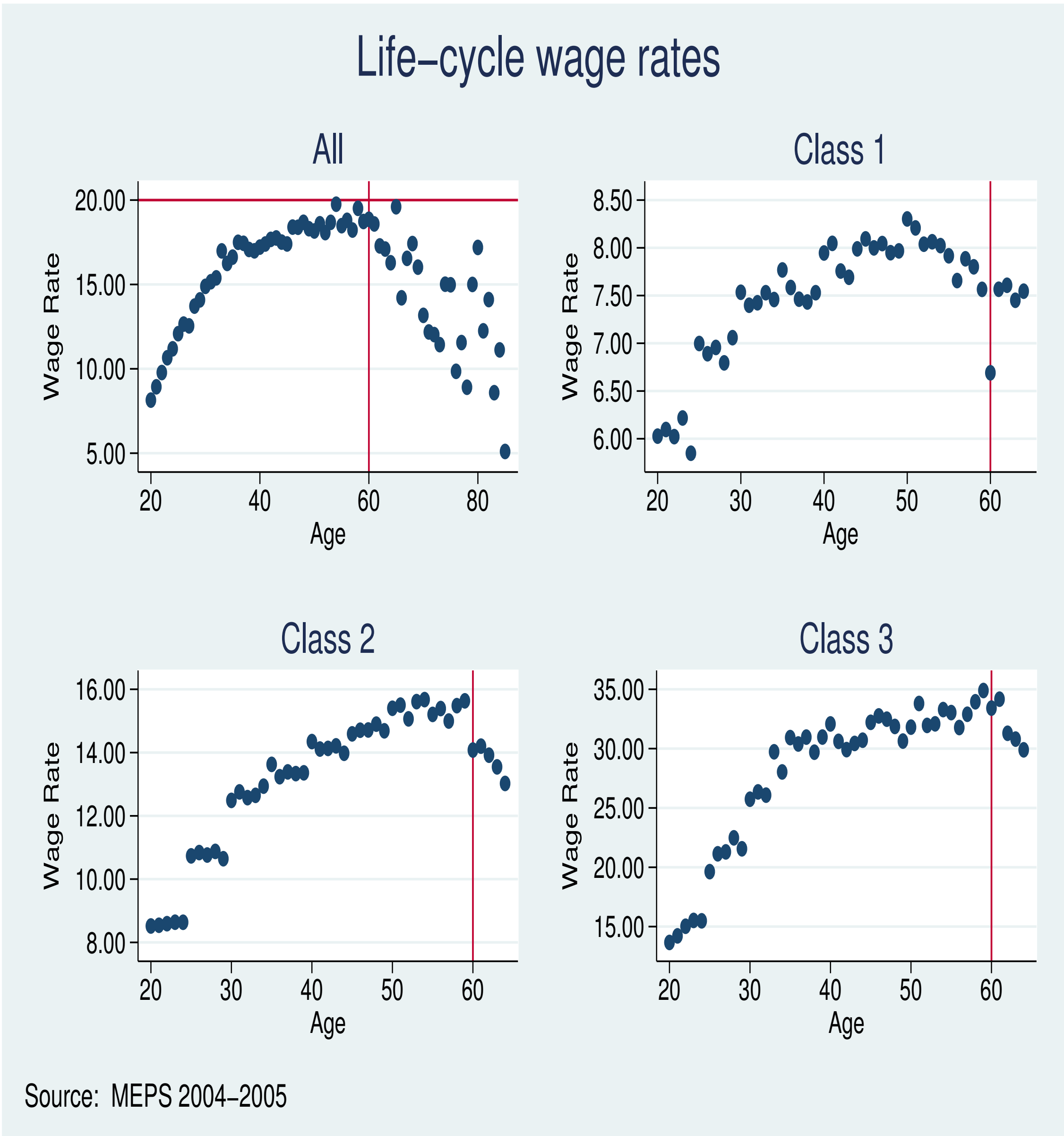

Figure 5: Efficiency profiles per income quantile.