The Macroeconomics of Health Savings Accounts: Supplementary Document

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Abstract

This is the supplement to the paper "The Macroeconomics of Health Savings Accounts" by the same authors. We present a short history of Health Savings Accounts (HSAs), describe the solution algorithm, and illustrate details about the estimation technique for the Markov transition matrices of the health shocks.

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1 A Brief History and Institutional Details of Health Savings Accounts

Four countries have introduced HSAs in various forms, the U.S., Singapore, China, and South Africa. We briefly discuss their experience with HSAs and give pointers to the related literature.[1]

1.1 United States

Medical Savings Accounts. Medical Savings Accounts (MSAs) were authorized by the Health Insurance Portability and Accountability Act of 1996 (HIPAA, P.L. 104-191) for a four year period. This bill started a demonstration project that allowed up to $750,000$ MSAs for people without health insurance, self-employed individuals, and small employers with less than 50 employees. These accounts, also called *Archer MSAs,* allowed enrollees to use MSA savings to pay for portions of their health care bills that were not covered by their health insurance. The project was later expanded. MSAs never gained much popularity. Lyke and Peterson (2003) attributes the slow growth of MSAs to many factors such as consumer unfamiliarity and risk aversion and the reluctance of insurance agents to sell lower-price policies. Furthermore, proponents of the legislation argued that the many federal requirements relating to the benefit design and the time-limited nature of the HIPAA discouraged insurers from marketing MSAs and employers and Medicare beneficiaries from seeking them. Since December 21, 2005, MSAs can no longer be opened.[2]

Health Savings Accounts. The Medicare Prescription Drug, Improvement, and Modernization Act of 2003 (Public Law 108-173 Dec. 8, 2003) considerable expanded on MSAs, so that the new Health Savings Accounts (HSAs) are available to about 250 million non-elderly Americans since January 1, 2004. An HSA is a special account owned by an individual where pre-tax contributions to the account are to pay for current and future medical expenses. HSAs are used in conjunction with a qualified High Deductible Health Plan (HDHP).

Any individual who is covered by an HDHP, not covered by other health insurance, not enrolled in Medicare and not claimed as a dependent on someone else's tax return is eligible for an HSA. Examples of other coverage that causes ineligibility include participation in a health care flexible spending account (FSA), a spouse's FSA, a spouse's family enrollment in an HMO, and other non-high deductible insurance plans like TRICARE and Medicare. Additional plans for disability, dental, vision, and long-term care insurance are allowed. If the policyholder ends participation in the HDHP, he or she loses eligibility to deposit further funds, but funds already in the HSA remain available for use. If a person ceases to remain an eligible individual, the extra amount contributed in that year is included in income and subject to an additional 10% tax.[3]

A qualified HDHP must have at least a $\$1,100$ deductible for an individual ($\$2,200$ for a family). The maximum deductible of a qualified HDHP plan is $\$5,500$ for an individual ($\$11,000$ for a family) after which the plan pays 100% of the cost of covered

[1] A similar summary can be found in Schreyogg (2002).

[2] See Fuchs and James (2005) for more details.

[3] See Revenue Procedure 2006-53, November 9, 2006 at http://www.treas.gov/offices/public-affairs/hsa/07IndexedAmounts.shtml

services. These limits include deductibles and coinsurance for "in-network" providers. HDHPs must also apply costs of prescription drugs to the annual deductible.

Preventive care services may be exempted from the deductible requirement, but coverage of most other services, including prescription drugs, is subject to the deductible. The IRS definition of preventive care includes periodic health evaluations, including tests and diagnostic procedures ordered in connection with routine examinations, routine prenatal and child care, immunizations, tobacco cessation programs, obesity weight-loss programs, and various screening services (compare (GAO, 2006, p. 8)).

The maximum annual contribution is $2,850 for an individual ($5,650 for a family).[4] Account holders who are 55 and older may make "catch-up" contributions of $500 in 2004, increasing the amount by $100 each year until $1000 in 2009. Contributions must stop once an individual is enrolled in Medicare. If HSAs exist for less then a year then the total amount of contributions to an HSA is based on the number of months that the individual is covered that year. The contributions can be made by the employer, by the employee, or by an individual opening the account. Employer contributions are excluded from income, employee contributions can be made via a salary reduction arrangement through a cafeteria plan (120 plan), and individual contributions are tax deductible. Contributions to an HSA may be invested at the discretion of the account owner, but they may not be invested in life insurance contracts. Earnings in the account accumulate tax free. The funds must be in a trust administered by a bank, insurance company, or other approved administrator.

Distribution of the funds is tax-free if taken for "qualified medical expenses" (which now includes over-the-counter drugs). Funds cannot be used tax-free to pay premiums of health insurance, except for COBRA continuation premiums, paid while unemployed, qualified long-term care insurance premiums, and Medicare premiums (Part A,B,C, and D, but not Medigap). Funds withdrawn for non-medical purposes are subject to a 10% penalty tax (except in cases of death, disability, or Medicare eligibility) and regular income tax. After the account holder turns 65, the 10% tax penalty no longer applies. In case of death the HSA can be transferred tax-free to a spouse. If the recipient is not the spouse, income tax has to be paid.[5]

Proposals towards improving the performance of HSAs include (*i*) increasing the maximum amount that can be contributed to an HSA to match total out-of-pocket expenses,[6] (*ii*) allowing employers to make larger contributions to chronically ill workers, finally (*iii*) allow workers who purchase an HSA qualifying high deductible health insurance plan to use their HSA to pay their premium. The latter has been proposed in the Affordability in the Individual Market Act (S.2554) (see Owcharenko (2006)).

Goals of HSAs. In general, Health Savings Accounts (HSAs) have four objectives: (*i*) reduce health care costs, (*ii*) lower premiums and increase the number of insured agents, (*iii*) change the structure of health care into a fully funded system where high savings rates increase growth rates, and (*iv*) put the patient into the center of the health

[4] The maximum annual contribution used to be the lesser of the HDHP deductible amount or $2,850 for an individual ($5,650 for a family). This has been changed by the Revenue Procedure 2006-53. See also: http://www.treas.gov/offices/public-affairs/hsa/07IndexedAmounts.shtml

[5] For various summaries on HSAs see *All About HSAs* (2005), Nahata, Ostaszewski and Sahoo (2005), or the website of the U.S. Office of Personnel Management at http://www.opm.gov/hsa/faq.asp

[6] For HSAs started in 2007 the maximum contribution per year is $2,850 for individuals, even if their deductible is lower than that. See the IRS issued Revenue Procedure 2006-53, issued on November 9, 2006 (http://www.treas.gov/offices/public-affairs/hsa/07IndexedAmounts.shtml).

care decision making process.

The first aim of HSAs is to reduce health care costs. The high deductible health care plans encourage individuals to be more prudent consumers of health care, because they will be responsible for the cost of health care below the deductible and thus will be more likely to limit health care use to necessary, cost-effective services. As a consequence, the moral hazard problem of traditional insurance contracts is partially alleviated.[7] In addition, the consumer is expected to "shop" for the best offer available in the market (e.g. buy generic drugs instead of brand names, compare prices for certain health procedures, etc.), as stated in Goodman (2004). HSAs therefore control low-cost routine expenses, something that managed care does not do very well, according to Scandlen (2001). However, according to GAO (2006) participants in HSAs understood the main aspects of HSAs (e.g. employer and employees can contribute, accounts are portable, savings accumulate tax free over time, and the maximum contribution limit) but expressed confusion about certain other features of HSA eligible plans and accounts. This of course has to do with the relative novelty of such plans so that market participants need some time to learn the new plan.[8]

Whether or not HSAs reduce costs is controversial. Although Nahata, Ostaszewski and Sahoo (2005) and Buntin, Damberg, Haviland, Kapur, Lurie, McDevitt and Marquis (2006) conclude that HSAs may be able to reduce some of the distortions introduced by traditional health insurance and have a moderate effect on preventing cost increases, Keeler, Malkin, Goldman and Buchanan (1996) show that changes in health care expenditures after the introduction of MSAs range from a 1% increase to a 2% decrease. Ozanna (1996), on the other hand, found a decrease between 2% to 8% in health spending after the introduction of HSAs. Watanabe (2005) shows in a highly stylized partial equilibrium model that an HSA is a tax-preferred account that itself encourages health care consumption by lowering the effective price of health care. The cost-containment effect, in contrast, comes from the high deductible of the attached catastrophic insurance plan. The overall effect of the HSA program is ambiguous and depends on the relative strength of these opposing forces. Park, Greenstein and Friedman (2006) even warn that the "overfunding" of HSAs may encourage individuals to obtain additional elective health care services and increase total health expenditures. This has to do with the fact that funds held in HSAs may be used to pay for practically any medical expense, including services that typically are not covered by health insurance plans.

Remler and Glied (2006) conclude that due to the large amount of cost sharing that is already present in today's health insurance policies (e.g. flexible spending accounts (FSAs) or health reimbursements accounts (HRAs)), the estimation results of older studies overpredict the potential cost savings of HSAs. Heffley and Miceli (1997) show that MSAs have the potential to induce socially efficient levels of health activities and preventive care, raising the expected wealth of consumers without reducing

[7] See also **?** on how cost sharing affects the demand for medical servics. The RAND experiment shows that catastrophic insurance plans with copayments can reduce health expenditures significantly.

[8] Confusion concerned mostly which preventive services were included in the plan, whether the services were provided by an in- or out-of-network provider and what medical expenses qualified for payment using their HSAs. GAO (2006) found further that few participants in HSAs researched the cost of services before obtaining care, although many researched the cost of presecription drugs. Many participants also expressed unease to negotiate a price with their doctor and felt they did not initially understand the extent to which they needed to manage and take responsibility for their heath care as consumers. Participants also noted that physicians did not always know the cost of services and that this information was generally handled through a billing office.

insurers' profits. Their model is a partial equilibrium model. Zabinski, Selden, Moeller and Banthin (1999) use a microsimulation (MEDISIM) to show that a MSA combined with catastrophic health insurance will tend to crowd out comprehensive coverage due to the tax deductions offered for the funds that go into the health accounts. This results in premium spirals in the comprehensive coverage markets, since the insurance pool of these markets erodes. Aggregate effects from the reform might be positive, although there is increased exposure to risk. This raises equity concerns because health care systems that are based on individual savings will naturally lead to less equity.

Zabinski et al. (1999) further show that poorer families and families with children lose the most from the reform. They report evidence of low-risk families self selecting into the MSA system, which leaves the high-risk families with the choice of paying higher premiums in the comprehensive plans or joining the MSA system. In both cases, high-risk families lose compared to their pre-reform coverage.

Hoffman and Schwartz (2006) report that low income families, people with chronic conditions, disabilities, and others with high-cost medical needs may face even greater out-of-pocket costs under HSA-qualified plans. A study by the Government Accountability Office in 2006 finds that HSA holders are satisfied with their health insurance but would not recommend the same plan to individuals with chronic conditions, have children, or may not have the funds to meet the high deductible.[9]

Eichner, McClellan and Wise (1996) analyze longitudinal health insurance claims data from a large firm (with $300,000$ employees) over a three-year period ($1989 - 1991$) and find that about 80% of retirees are left with at least 50% of total HSA contributions, whereas 5% have less than 20% of their contributions left. In their simulation, the authors do not account for any behavioral responses of employees that can be expected due to alleviating moral hazard. This leads them to underestimate the amount left in the HSAs.

The second goal of HSAs is concerned with increasing the number of individuals with health insurance. This is important in the U.S. context, with roughly 45 million uninsured Americans. HSAs promise to decrease premiums so that more people can afford health insurance. HSA are also attractive to employers who cannot afford to offer standard low deductible health insurance to its workers due to rising premiums. Glied and Remler (2005) estimate that the tax savings via HSAs will increase the number of newly insured adults by fewer than $100,000$, or about 0.3% of the current adult uninsured population. This small number is the result of the relatively low response rate of low income adults to buy insurance with additional income from tax savings.[10] Low income adults have the smallest gains from tax exemptions but are the largest group within the uninsured population (compare Hoffman and Schwartz (2006)).

The third objective of HSAs addresses population aging. Since HSAs and MSAs are fully funded systems, they are less exposed to demographic trends since each generation pays for its own services directly. This goal requires a high coverage rate, which makes implementation difficult. The only country so far that has reached an almost universal coverage rate with MSAs is Singapore, where MSAs are mandated by law.

Finally, HSAs put patients back in the center of the health care decision making process. Patients influence the entire process of their medical treatments, which can also

[9] For more information see GAO (2006).

[10] Hoffman and Tolbert (2006) calculate that the tax benefit from contributing any amount to an HSA of a family of four with an income of $\$20,000$ is nil, whereas the tax benefit of a family of four making $\$120,000$ would accrue \$620 in tax savings from contributing $\$2,000$ to an HSA. They conclude that because of the limited ability of low income families to save money, HSAs do not offer any real financial benefits for these families and are therefore not attractive to the low income uninsured population.

reduce the risk of ex-post moral hazard. Supporters of HSAs claim that incentives for prevention are inherent in these accounts, although critics state the opposite. The notion that individuals will have an incentive to adopt healthier lifestyles in order to limit their health care expenses is unsupported by any evidence so far, according to Laditka (2001).

Who Enrolls in HSAs. The number of enrollees covered by an HSA-eligible plan was about 438,000 in September 2004. It increased to 1 million in March 2005 and to about 3 million in January 2006[11] according to America's Health Insurance Plans, an industry group as cited in Dash (2006). This report also estimates that 31% of HSA-qualified policies sold in the individual market were purchased by individuals who were previously uninsured. In the small group market, 33% of businesses who have HSA-qualified high-deductible policies previously did not offer coverage to their workers (Owcharenko (2006a)). An analysis by eHealthInsurance, a national online health insurance broker, found that 45% of individuals purchasing a HSA-qualified high-deductible plan earned less than \$50,000 a year. Both studies found that HSAs were purchased by all age groups. GAO (2006) finds that in 2004 and 2005, more than half of the individuals having a HSA purchased that plan in the individual insurance market. Preliminary data for 2006 suggests that the number of HSA-eligible plan enrollees in the employer provided insurance or group market is growing faster than in the individual market.

On the other hand, a report by the Kaiser Foundation found that as of spring 2006 only an estimated 2.7 million workers were enrolled in high deductible plans that is roughly 4% of workers with health insurance, essentially the same percentage as 2005. Moreover, only 6% of firms said they were very likely to adopt high-deductible health plans in the future. According to this survey a typical HSA of an individual is combined with a \$2,011 deductible. The average deductible for families is \$4,008. Consumers who have selected high-deductible health plans thus far have tended to be better educated people with higher-than-average earnings, according to Jon Gabel, vice president of the Center for Studying Health System Change (see Snowbeck (2006)).

According to GAO (2006) higher income households are more likely to have HSAs. The same study did not find a pattern on which age cohorts are more likely to hold HSA-eligible plans. In addition, HSAs are used as tax-shelters (see also Park, Greenstein and Friedman (2006)). The GAO study used Internal Revenue Service data on tax filers who made HSA contributions in 2004. This is the first income data available on actual HSA use throughout the U.S. The GAO found that only 18% of tax filers under age 65 had incomes exceeding \$75,000, but 51% of tax filers making HSA contributions did. also, the average income of HSA users was \$133,000 in 2004 compared to \$51,000 for all non-elderly tax filers. The GAO also found a positive correlation between income and contributions made to HSAs. The average HSA contribution of households with incomes exceeding \$200,000 was twice as large as the average contributions made by households with incomes below \$50,000. Finally, the GAO study seems to indicate that HSAs are used as tax shelters, since the majority of people did not withdraw any money from HSAs in 2004 and participants in the focus groups spoke of using their HSAs for tax sheltering purposes.

Another study by Greene, Hibbard, Dixon and Tusler (2006) on employer provided HSAs finds that enrollees in high deductible health plans are on average substantially

[11] Hoffman and Tolbert (2006) finds that in 2006, about 1.4 million emplyees are enrolled in HSA-qualified HDHPs offered by their employers; and at least another 855,000 people are covered in the nongroup market.

healthier and have higher educational attainment than Preferred Provider organizations (PPO) enrollees.

The lack of enthusiasm for HSAs has also been attributed to their relative complexity (compare Fronstin and Collins (2006)). Finally, the point that HSAs will inspire people to become smarter shoppers (see Goodman (2004)[12]) and therefore help reduce costs has come under criticism because doctors and hospitals are not prepared to give consumers good information about the actual cost of services (see Snowbeck (2006) and the discussion on consumer confusion in GAO (2006)).

Alternatives to Health Savings Accounts. We briefly present the main alternatives. Park, Greenstein and Friedman (2006) also give a critical assessment on the likely interaction effects of HSAs with other forms of tax sheltered "savings" accounts.

Flexible spending accounts (FSAs) were introduced in 1984 under section 125 of the Internal Revenue Code. Unlike HSAs, any unused balance remaining at the end of the year is forfeited. According to Glied and Remler (2005) by 1999 between 15 and 28 percent of the workforce had some form of FSA. Health Reimbursement Accounts (HRAs) are savings accounts attached to high-deductible plans that are similar in a number of aspects to HSAs but do not have the same tax advantages. Only employers may contribute to such accounts, balances can be carried over into subsequent years, but employees do not retain the HSAs if they leave their employer. The main difference between HSAs and IRAs is that although contributions to IRAs are tax-deductible and earnings on IRAs accrue tax-free, withdrawals in retirement are treated as ordinary income and are subject to income tax. Funds held in HSAs are never taxed if used for qualified health expenses (compare discussion in Park, Greenstein and Friedman (2006)). Also, there is no income limit for contributors to HSAs. Under Roth IRAs, accumulations and withdrawals are not subject to tax, but contributions must be made out of post-tax income. Provisions that would allow one time transfers from FSAs, HRA and IRAs into HSA would lead to forgone tax income and worsen the federal fiscal deficit (compare criticism in Glied and Remler (2005)).

1.2 Singapore

Singapore's low health expenditure has been attributed to its early use of MSAs. Singapore spends less than 4% of its GDP on health care (Massaro and Wong (1995)). In comparison Kotlikoff and Hagist (2005) report that health expenditures in 2004 were 8.6% of GDP for Canada, 16.6% for the U.S. and 10.9% for Germany (see also Hagist, Klusen, Plate and Raffelhueschen (2005)).

The low health expenditure in Singapore is partly explained by the low percentage of Singaporeans above 65 (about 7.3% compared to Europe's 14%). However, assuming a 14% share of elderly above 65, projections still only arrive at costs of up to 5.8% of GDP, which is far lower than the figures for the U.S. and Europe. Since Singapore does not follow OECD standards in measuring health expenditures and the government does not release any health figures, it is difficult to say how efficient the system really is as noted by Barr (2001). Chia and Tsui (2004) and Schreyogg and Kin (2004) discuss MSAs in Singapore in more detail. The accounts are compulsory in Singapore and therefore a large fraction of the workforce is using them.

[12] Compare also the publications at the National Center for Policy Analysis (NCPA) at http://www.ncpa.org/pub/ba/ba464/

A more critical view on Singapore is presented in Hsiao (1995), Hsiao (2001) and Barr (2001). These authors claim that the accounts were not able to curb health expenditures and that the government in Singapore had to abandon its reliance on price competition and to impose direct control on supply and prices of medical services.

1.3 China

In 1998 China extended a pilot project that introduced MSAs in some cities to the 50 largest cities. MSAs led to cost reductions of up to 24.6% in the participating cities, whereas neighboring cities that did not have the MSAs experienced growth rates of medical expenditures between $35-40\%$ (Gratzer (2002) and Yip and Hsiao (1997)). MSAs are financed by employers (6% of gross wages) and employees (2% of gross wages). The amount of 3.8% goes towards MSAs whereas the residual 4.2% go to social security.

A problem with the implementation in China was that employers could not be forced to pay their share into the MSAs for their workers which left many workers out of the system. Another peculiarity of the Chinese system is that the funds do not earn interest, however, they can be transferred after death (Schreyogg (2002)).

Whether the MSA experiments led to savings in health expenditures is not clear since there is not enough data available. According to Yip and Hsiao (1997) there have been accounts of reduced usage of expensive high-tech diagnostic machines and a substitution of generic drugs for high priced drugs. However, it is unclear whether this happened due to demand side effects since the government also put limitations on access to health care services. Also, some undesirable effects have been documented such as risk selection, cost shifting, and reduction in equity. Yip and Hsiao (1997) concludes that in order to be an effective cost reducing system, MSAs have to be coupled with supply side restrictions to health services.

1.4 South Africa

MSAs emerged in the 1990s in Nelson Mandela's South Africa and have captured about two thirds of the market for private health insurance in South Africa in 2005 which insures roughly 20% of the population, that is 4.6 million people (see Matisonn (2000), Goodman (2004), and Goodman (2005)). The other 80% are insured by a public system plagued with long waiting lines and a deteriorating quality (Shortt (2002)).

Supporters of MSAs see this as a success story and point out that MSAs in South Africa work under less stringent conditions than in the U.S. and are therefore more successful. They claim that once MSAs can compete on an equal basis (South Africa places very few restrictions on MSAs) with other insurance forms like health maintenance organizations (HMOs), they will be accepted by the population.

The implementation in South Africa was criticized as being primarily attractive for the young and healthy population (Soderlund and Hansl (2000)) and would lead to adverse selection. Matisonn (2000) and Matisson (2002) claims that this was not the case.

2 The Model

2.1 Preferences

An alternative way of formulating the preferences and reducing the state space would be to let total health expenditure m_j enter the utility function directly. We only model discretionary health expenditures (see next section for a discussion on health expenditures). Depending on the realization of the health state ε_j, the relative weight in the utility function of discretionary health expenditures m_j changes, so that

$$u(c_j, m_j) = \frac{\left(c_j^{\gamma_1} m_j^{\gamma_2(\varepsilon_j)}\right)^{1-\sigma}}{1-\sigma},$$

where $\gamma_2(\varepsilon_j)$ is a decreasing function in the health status variable ε_j. As the health state worsens, the consumer puts more weight on health expenditures in her utility function. Another way of thinking about this is health maintenance. If health deteriorates, the health maintenance costs are higher and therefore the consumer is willing to spend more on health care which establishes new relative rates of marginal utilities between consumption and health expenditures.

2.2 Production of Health

One method to include non-discretionary health expenditure is to allow the consumer to freely decide on how much to spend on discretionary health expenditures m_j (e.g. preventive health check-ups, upgrades in hospitals, etc.) when she incurs non-discretionary health expenditures $\bar{m}(\varepsilon_j)$ at the same time. The latter are a function of her health shock ε_j (e.g. hospital visits due to serious health problems, emergency health care, etc.). The total health expenditure would then be denoted

$$p_m \bar{m}(z_j) + p_m m_j.$$

2.3 Health Insurance and Out-of-Pocket Medical Expenses

Cutler and Wise (2003) report that about two thirds of the population younger than 65 is covered by some form of private insurance. The majority of these contracts is offered via employment contracts and premiums paid are thus tax deductible. Only 10% of these contracts are bought directly from insurance companies by the households. Premiums for these contracts are not tax deductible.

According to MEPS data from 2003, only 1.35% of the population older than 65 is not covered by Medicare. The same survey finds that 10.13% have Medicaid and Medicare, 54.95% have Medicare and private insurance combined (62.97% of those have private group insurance whereas 36.89% have private individual insurance, the rest have some other form of private insurance combined with Medicare), and 33.57% have only Medicare. (Available at: http://www.meps.ahrq.gov/mepsweb/data_stats/download_data/pufs/pmep04/pmep04_

3 Solving the Model

We solve the model backwards discretizing along a, a^m, 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

$$h_j = \phi_j m_j^{\xi} + (1 - \delta(h_j))\, h_{j-1} + \varepsilon_j. \tag{1}$$

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

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

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 health state h_j. We solve the model backwards using a grid search over all states $\{a,\ a^m\ , h\ , age\ , ins,\ \varepsilon\}$. The algorithm follows the steps given below

1. Discretize $\Theta = \{a,\ a^m\ , h\ , age\ , ins,\ \varepsilon\}$ according to

   - $a = [0, ..., 20]_{1\times 80}$
   - $a^m = [0, ..., 12]_{1\times 14}$
   - $h = [0.01, ..., 5]_{1\times 16}$
   - $age = [20, ..., 92]_{1\times 8}$
   - $ins = \{1, 2, 3\}$
   - $\varepsilon_j = \{\varepsilon_1, \varepsilon_2, \varepsilon_3, \varepsilon_4, \varepsilon_5\}$, where $j = \{1, ..., 8\}$

2. Guess prices w, R, p, p', p^{Med}, tax rates τ^{Med}, τ^{Soc}, and an initial capital stock K^{old}

3. Solve model backwards for optimal policy functions $a^*(\Theta), a^{m*}(\Theta), c^*(\Theta), m^*(\Theta)$, and $in^*(\Theta)$ 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 zero asset holdings at the beginning of their economic life at age 20 and store the distribution in an array Muw and Mur, for workers and retirees respectively (does not allow us to track individual agent histories)

5. Calculate aggregate asset holdings K^{new} using Muw and Mur

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

7. Calculate new prices 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 allows us to condition policies on agent income histories, a feature that is not captured by the current solution method.

4 Calibration

4.1 Insurance Premiums, Coinsurance Rates and Deductibles

The average deductible for the low deductible insurance is around \$305 as reported in Fronstin and Collins (2006), whereas the average deductible for high deductible plans is around $\$2,330$.[13] Since the data in Fronstin and Collins (2006) is highly aggregated we view the \$305 deductible for the low deductible insurances as a lower bound. The average deductible for Medicare plans is around $\$1,076$ according to the U.S. Department of Health and Human Services.[14] We then get the following ratios: $\frac{\rho}{\rho'} = \frac{305}{2{,}330} = 0.13$ and $\frac{\rho}{\rho^{Med}} = \frac{305}{1{,}076} = 0.28$.

In the next step we try to relate the deductibles and the insurance premiums to median income. According to data from the U.S. Census real median household income in the United States reached $\$46,326$ in 2005. Factoring in the average household size of 2.6 in 2005 we get a median per capita income of $\$46,326/2.6 = 17,817$ which results in ratios of: $\frac{\rho}{med(income)} = \frac{305}{17{,}817} = 0.017$, $\frac{\rho'}{med(income)} = \frac{2{,}330}{17{,}817} = 0.13$, $\frac{\rho^{Med}}{med(income)} = \frac{1{,}076}{17{,}817} = 0.0604$, $\frac{\sum_j \mu_j p_j}{med(income)} = \frac{\$1{,}203}{\$46{,}326/2.6} = 0.07$, and $\frac{\sum_j \mu_j p_j}{med(income)} = \frac{\$4{,}100}{\$46{,}326/2.6} = 0.2301$.[15]

Finally, we relate the deductibles themselves to the average premiums paid. We get the following deductible vs. average premium ratios for the low deductible plan $\frac{\rho}{\sum_j \mu_j p_j} = \frac{305}{4{,}100} = 0.076$ and $\frac{\rho}{\sum_j \mu_j p_j} = \frac{305}{1{,}203} = 0.25$. For the high deductible plan we have $\frac{\rho'}{\sum_j \mu_j p'_j} = \frac{2{,}330}{3{,}500} = 0.66$ and $\frac{\rho'}{\sum_j \mu_j p'_j} = \frac{2{,}330}{2{,}027} = 1.15$, and for Medicare it is $\frac{\rho^{Med}}{\sum_j \mu_j p^{Med}} = \frac{1{,}076}{1{,}062} = 1$.

4.2 Price of Medical Services

In order to pin down the relative price of consumption goods vs. medical care goods, we use the average ratio of the consumer price index (CPI) and the Medical CPI between 1992 and 2006. We calculate the relative price to be $p_m = 1.52$.[16]

The price of medical services for uninsured agents is higher than for insured agents. Various studies have pointed to the fact that uninsured individuals pay up to 50% (and more) higher prices for prescription drugs as well as hospital services (see *Playing Fair, State Action to Lower Prescription Drug Prices* (2000)). The national average is a markup of around 60% for the uninsured population (Brown (2006)).[17]

[13] A 2005 national employer health benefits survey (as reported inGAO (2006)) found that employers' HSA-eligible plan deductibles were, on average, nearly six times greater than those for employers' traditional plans. This is very close to the ratio we use here.

[14] Compare: http://www.cms.hhs.gov/apps/media/press/release.asp?Counter=1557

[15] For the U.S. Census data compare: http://www.census.gov/Press-Release/www/releases/archives/income_wealth/007419.html
and
http://factfinder.census.gov/servlet/ACSSAFFFacts?_submenuId=factsheet_0&_sse=on

[16] Compare: http://data.bls.gov/cgi-bin/surveymost?cu

[17] Kaiser (2000) of the Kaiser Foundation reports that the uninsured pay 14.6% higher prescription drug prices (not counting promotions for insurers). Their summaries are based on a study by the U.S. Department of Health and Human Services (see *Prescription Drug Coverage, Spending, Utilization, and Prices: Report to the President* (2000)). Anderson (2007) finds that the uninsured pay up to 2.5 times the amount that insured patients pay when hospital services are included. Finally, Brown (2006) finds that uninsured consumers in California pay 65% more for common prescription drugs than the federal government does for the same medications.

We therefore pick a markup factor of 1.6 so that $p_{m,nIns} = 1.6 \times p_{m,Ins}$. According to the U.S. Census 2004, the fraction of the population without insurance is roughly 15.7%.[18] Using all this information we solve the following system of equations for the relative prices that the insured and uninsured pay for medical services

$$\begin{cases} 1.52 = 0.843 \times p_{m,Ins} + 0.157 \times p_{m,nIns}, \\ p_{m,nIns} = 1.6 \times p_{m,Ins}, \end{cases}$$

which results in $p_{m,nIns} = 2.2226$ and $p_{m,Ins} = 1.3891$. This assumes that the overall price difference between consumption and health services is a weighted average of the prices that the insured and uninsured pay for health services.

4.3 Estimating Markov Transition Probabilities between Health Shocks

We use the Rand-HRS data to estimate transition probabilities between shocks to health ε_j as expressed in equation (1). We denote this Markov transition matrix $P(\varepsilon_j|\varepsilon_{j-1})$.

In order to estimate the residuals of equation (1) we use two different approaches. The first approach uses an ordered logit estimator, the second approach uses a panel robust estimator that accounts for AR(1) error in the residuals. We describe method one first.

1. Method one uses an ordered logit specification on a simplified law of motion for health (1), that we denote

$$h^*_{ij} = \beta_0 + \beta h_{ij-2} + x_{it}\beta_{kj} + \varepsilon_{ij}, \tag{2}$$

where we assume that health states can only obtain five possible outcomes that correspond to the HRS variable on health states. This variable is coded as: excellent $(h_{ij} = 1)$, very good $(h_{ij} = 2)$, good $(h_{ij} = 3)$, fair $(h_{ij} = 4)$, or poor $(h_{ij} = 5)$. We allow health states to vary with lagged health states h_{it-2} and a vector of explanatory variables x_{ij} that contains measures for age (age, age^2), out-of-pocket health expenditures ($oopHealthExp$, $\frac{oopHealthExp^2}{1000}$), total health expenditures ($totHealthExp$, $\frac{totHealthExp^2}{1000}$), measures for the body mass index (bmi, bmi^2), and dummy variables for being female ($female$), being employed ($employed$), doing physical exercise ($exercise$), as well as smoking ($smoke$). Expression (2) is a linear "approximation" to (1) and results in estimated residuals denoted $\hat{\varepsilon}_{ij}$.

2. We next estimate an $AR(1)$ process for the residuals

$$\hat{\varepsilon}_{ij} = \rho_0 + \rho\hat{\varepsilon}_{ij-1} + u_j, \tag{3}$$

and get an estimator $\hat{\rho}$ and an estimated standard deviation $\hat{\sigma}_u$. We assume $u_j \tilde{} N\left(0, \sigma_u^2\right)$.

3. We use 20 starting values for $\varepsilon_{i,20}$ and simulate 10,000 draws of $u_{i,,22} \tilde{} N\left(0, \hat{\sigma}_u^2\right)$. We then run expression (3) forward to age 98, using $\hat{\rho}$ and repeated draws of $u_{i,,22} \tilde{} N\left(0, \hat{\sigma}_u^2\right)$. This results in a series of simulated residuals $\tilde{\varepsilon}_{ij}$ for $j = \{20, 22, ..., 98\}$.

4. We next calculate eight age-group means of residuals that roughly correspond to the age groups in our model. The age group averages in the data are over 8 years,

[18] http://www.census.gov/hhes/www/hlthins/hlthin04/hlth04asc.html

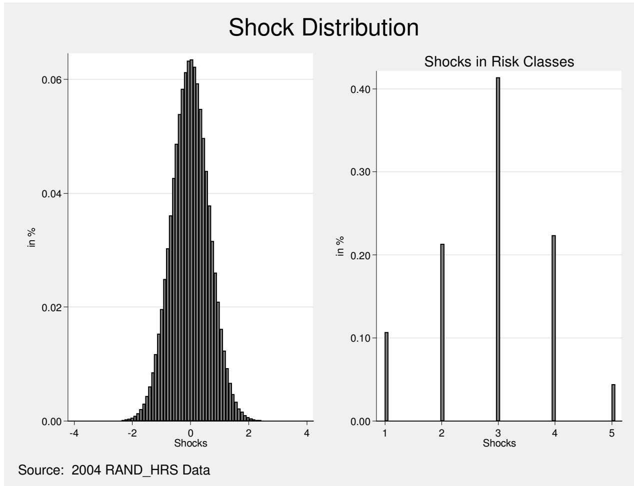

Figure 1: Ordered logit estimator.

whereas one model period is 9 years. We think this is a good approximation. Means are denoted $\bar{\varepsilon}_{ig}$, where $g = \{1, ..., 8\}$ denotes the age groups in the eight periods of the model. So for an individual i in age group one the mean is $\bar{\varepsilon}_{i1} = \frac{1}{5}\sum_{j=20}^{28} \tilde{\varepsilon}_{ij}$ since we have data every two years only. We interpret $\bar{\varepsilon}_{i1}$ as the average health shock of individual i in her first period of life.

5. We next group the average health shocks into five risk categories according to

$$\varepsilon_{ig} = \begin{cases} 1 \text{ if } & 1 < \bar{\varepsilon}_{ig}, \\ 2 \text{ if } & 0 < \bar{\varepsilon}_{ig} \leq 1, \\ 3 \text{ if } & -1 < \bar{\varepsilon}_{ig} \leq 0, \\ 4 \text{ if } & -1.5 < \bar{\varepsilon}_{ig} \leq -1, \\ 5 \text{ if } & \bar{\varepsilon}_{ig} < -1.5. \end{cases}$$

   The following histogram shows the residuals in panel one and the shocks grouped into risk classes in panel two.

6. Finally we count how many agents are in category $1, 2, ..5$ in period $g+1$ given they were in category 1 in period g. We denote this as the transition probability $P_{g=1}(\varepsilon_j = h|\varepsilon_{j-1} = 1)$ for $h = \{1, 2, ..., 5\}$. We count the transition probabilities of the other periods $g = \{2, 3, ...8\}$ in a similar way. This will result in 7 transition matrices. Since we model 8 periods we assume that the first transition matrix $P_{g=1}$ is identical for the first two age groups in the model. Table 1 reports the estimated Markov transition matrices for all age groups.

The second method uses a panel robust estimator that explicitly accounts for the AR(1) error structure in (2).[19] This procedure gives us an estimator for $\hat{\rho}$ directly. The rest of the procedure follows step $3-6$ from above. We changed the risk groups slightly

[19] Stata's `xtregar` command.

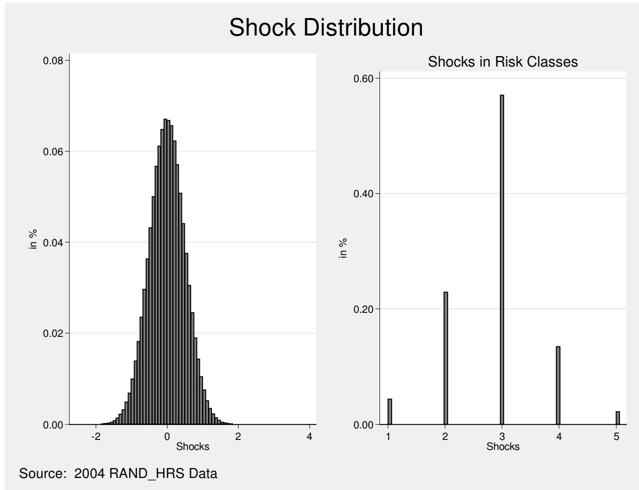

Figure 2: Panel robust estimator accounting for AR(1) structure in errors.

to accommodate for the smaller variance in simulated shocks. We use

$$\varepsilon_{ig} = \begin{cases} 1 \text{ if} & 0.85 < \bar{\varepsilon}_{ig}, \\ 2 \text{ if} & 0.3 < \bar{\varepsilon}_{ig} \leq 0.85, \\ 3 \text{ if} & -0.5 < \bar{\varepsilon}_{ig} \leq 0.3, \\ 4 \text{ if} & -1 < \bar{\varepsilon}_{ig} \leq -0.5, \\ 5 \text{ if} & \bar{\varepsilon}_{ig} < -1, \end{cases}$$

which results in the following histograms for shocks.The reported results are obtained using the Markov transition probabilities from method two. The small probability of the very bad health shock (shock 5) allows us to model an insurance take-up ratio that is close to what we observe in the data without unduly overshooting the fraction of aggregate expenditures in percent of GDP of 16%.

4.4 Human Capital Profile and Health Productivity

There is a growing empirical literature documenting the relationship between medical services, health, and productivity (or growth) that can be divided into two branches The first consists of microeconomic literature that examines the effects of various health inputs on health outcomes. Two of the most important inputs are food and medical services (e.g. Behrman, Hoddinott, Maluccio, Martorell, Quisumbing and Stein (2003), Maccini and Yang (2005), Alderman and Kinsey (2006) for food and Grossman (1972), Stratmann (1999) and Grossman (2000) for medical services). Medical services do have a positive impact on health outcome measures after controlling for endogeneity. The second branch of the literature concentrates on the effect of health on productivity and income (e.g. Bloom, Canning and Sevilla (2004), Jamison and Wang (2005), and Schultz (2005)) Most of this literature is concentrated on developing countries and finds a significant effect of health on output. The evidence in richer countries is less conclusive (see Cawley (2004), Greve (2007), and Weil (2007)) but still indicates a positive relationship.

The following expression presents their human capital production function,

$$e_j = \overbrace{h_j^s \times h_j^e}^{\left(e^{\beta_0+\beta_1 j+\beta_2 j^2}\right)^{\chi}} \times \overbrace{h_j^h}^{\left(h_{j-1}^{\theta}\right)^{1-\chi}}, \text{ for } j = \{1, ..., J_1\}, \tag{4}$$

where h^s is the portion of human capital from schooling (education), h^e is human capital from experience on the job, and h^h is human capital that comes from health. The expressions in brackets above equation (4) are the functional forms that we use in our model in expression (**??**).

In our model we do not distinguish between the contributions of schooling and experience on the job to the formation of human capital, but rather summarize both of these using an exogenous component that is determined by age only (see expression (**??**)). Ashraf, Lester and Weil (2007) use similar polynomials to parameterize h^s and h^e.

However, the parameterization they use for the health component of human capital is different from ours and is written as

$$h_j^h = \begin{cases} e^{(1-\eta)\rho ASR+\eta\rho ASR'} & \text{if } t-j < T, \\ e^{\rho ASR'} & \text{if } T \leq t-j. \end{cases} \tag{5}$$

Ashraf, Lester and Weil (2007) distinguish the health process before and after a health intervention takes place at time T. Before the intervention, the adult survival rate is expressed as ASR and after the intervention they denote it as ASR'. Parameter ρ measures the effect of the ASR on worker productivity as estimated by Weil (2007), and $\eta \in [0, 1]$ captures the importance of the contemporaneous health environment in affecting worker productivity. A value of $\eta = 1$ implies that health improvements are immediately translated into increased productivity, whereas $\eta = 0$ implies that improved health has no immediate effect on worker productivity; only workers born after the intervention have higher productivity ASR'.

This is an interesting interpretation of parameter η as it can be related to the interpretation of our health productivity parameter θ. What this formulation suggests is that there eventually is a positive effect of better health on productivity, so that $\theta > 0$ is again confirmed. What the authors also state is that there is no solid ground for estimating the value of η. They use $\eta = 0.5$ as base value for their simulation and conduct sensitivity analysis.

We have to point out that the definition of the health component of human capital h^h in Ashraf, Lester and Weil (2007) is different from the definition of health capital in our model. Variable h^h measures the productive component of health, whereas health in our model has a wider definition as it also enters preferences as consumption good. If we were to compare the two we would need to write

$$h_j = \varphi h^h,$$

where $\varphi > 1$ which captures the consumption value of health.[20]

Based on the existing literature we think that a conservative estimate would exhibit a θ that is closer to zero than to one. Parameter values of θ closer to one have the potential to overstate the effect of health on aggregate production. We start with $\theta = 1$

[20] E.g. better health results in more healthy workdays. Variable h^h only measures the increase in healthy workdays, whereas health h (from our model) measures the total of health capital which carries additional consumption value.

for our benchmark calibration, but conduct extensive sensitivity analysis on the value of θ in section **??**.

5 Results

5.1 A Snapshot Experiment

In this experiment we describe the effect of introducing HSAs into an economy with health productivity $\theta = 1$ in more detail. This will be an example of an economy where health is very productive. As a result, HSAs will cause a strong decrease in human capital that cannot be offset by an increase in physical capital. As a result individuals will spend less on health services, but the decline in aggregate income will erode household income enough so that many households decide to opt out of health insurance. The calibration allows us to get quantitative results for this particular level of health productivity. Table 2 reports steady state outcomes for our policy experiment. The steady state results of the benchmark economy are presented in column one of table 2. We then introduce $HSAs$ and examine the effects on key aggregate variables, market prices, number of insured individuals savings, and total health expenditure (see column 2). Finally, we analyze the effect of partially fixed prices and compare it to the general equilibrium case.

5.1.1 Aggregate Health Expenditures

The introduction of HSAs (2nd column in table 2) decreases aggregate health expenditures as a fraction of GDP from 17.6% to 14.4%. At the same time, the total fraction of insured individuals decreases from 80% to 75%.

With the introduction of HSAs agents shift savings from standard assets into their HSAs. Total savings increase by 1.2% compared to the benchmark model. Aggregate health capital decreases as a consequence of the lower expenditure on health services (decrease in health capital of 5.5%). The overall effect of the increase in physical capital and the decrease in health capital is a 3% decrease in output. This will lower the income of the households. On the other hand, households buy more into high deductible insurances which reduces moral hazard. As a consequence agents demand fewer of the discretionary health services. This effect decreases total health expenditures.

HSAs increase the average price of discretionary health services relative to consumption. Therefore, consumption increases by 7% as consumers shift their expenditures from health services into consumption. Another consequence of this change in the relative price is that 52% of all retirees spend money saved in HSAs on non-health related consumption which forces them to pay the forgone income tax. Agents seem to "oversave" in HSAs, so that when they retire they have excess funds to spend. This is consistent with findings in GAO (2006) that state that only half of the owners of HSAs have actually withdrawn funds in 2004 to pay for their health treatments. Finally, government tax revenue decreases due to the tax preferred treatment of savings in HSAs. We therefore observe an adverse effect on government spending, a decrease from around 20% of GDP to 15% of GDP. HSAs are therefore very likely to add to fiscal deficits (see Park, Greenstein and Friedman (2006)).

5.1.2 Insurance

The insurance landscape changes dramatically. The fraction of agents buying the low deductible insurance decreases from 73% to 11%, whereas the fraction of agents buying the high deductible insurance increases from 3.6% in the benchmark economy to 59%. The introduction of HSAs decreases the average insurance premiums of both, the low and the high deductible insurance. This has to do with some of the high risk agents moving out of the low deductible insurance into the high deductible insurance, so that the premiums for low deductible insurances drop. Overall the decrease in the insurance premiums is not enough to compensate for the loss of income from the lower output, so that overall the number of uninsured individuals increases.

The Medicare premium increases drastically by 29%. This has to do with the lower health states of all agents which increases the marginal utility of health at higher ages. Since we force all agents older than 65 into Medicare, these agents then use the insurance to "replenish" their low health especially in the context of the larger health shocks at higher ages. The increase in the Medicare premium is then the direct effect of the requirement that the program has to satisfy the Medicare budget constraint.

The Gini coefficient decreases slightly from 0.728 to 0.713 and welfare increases moderately from -100 to -97.

5.1.3 Shifts in the Number of Insured Workers

Figure 4 shows the fraction of insured workers (low deductible insurance or high deductible insurance) for regime [1] and regime [2]. We track the number of insured workers per age group, income quintile, and health capital status and compare how the insured population changes when we introduce HSAs. From panel 1 we see that the very young lose their insurance coverage after the introduction of HSAs whereas the group of the middle aged gains coverage. Panel 2 indicates that no particular income group stands to lose insurance coverage disproportionately. Panel 3 shows that HSAs increase coverage of the "sicker" population with lower health capital, whereas coverage of the high health capital group drops. This is contrary to the findings in Greene et al. (2006) who report that healthier individuals are more likely to have HSAs. The discrepancy can be explained by the full information structure of our model and the long run equilibrium result of our solution. Greene et al. (2006) results are based on 2004 data and reflect the short experience of their survey participants with HSAs. Finally, in panel 4 we illustrate the change in health capital holdings per age group before and after the introduction of HSAs. We see that the drop in health capital predominantly affects middle age workers. Health capital over age does not follow a hump shape pattern. When Medicare becomes available, agents have access to relatively cheap health services and start replenishing their health stocks at higher ages. This effect becomes more extreme with the introduction of HSAs because HSAs kept the health capital at lower levels than in the benchmark economy.

5.1.4 Who Saves in HSAs?

Panel 1 in figure 5 reports the average percentage of asset holdings in HSAs by age together with the fraction of the population having HSAs. We find that there is a nonlinear relationship. The young and the old hold more of their assets in the form of funds in HSAs, whereas the middle-aged have a smaller fraction of their assets invested in

HSAs. However, the middle aged are more likely to have HSAs. The fact that none of the 30 year old agents buy the high deductible insurance is consistent with the argument made by Hoffman and Tolbert (2006). They claim that low income families do not get any additional income from tax shelters, so that HSAs, especially together with the high deductibles, are unattractive to them. Also, the model does not indicate a clear pattern of which age cohorts are more likely to have HSAs which confirms the findings in GAO (2006).

Panel 2 graphs the percentage of asset holdings in HSAs and the percentage of the population with HSAs per income quintile. We find that the annual contribution limit ensures that the higher income households cannot shift a larger proportion of their income into HSAs. In fact, they hold less of their assets in HSAs. Holdings in HSAs as a fraction of annual household income is a decreasing function of the income status of the household. However, richer households are more likely to have HSAs. This is consistent with the results in GAO (2006) that HSA plan enrollees have higher income than households in comparison groups.

Panel 3 illustrates the percentage of assets holdings in HSAs and the fraction of the population with HSAs by health capital status. We see that the "sickest" population is less likely to have HSAs and if they do, the percentage of assets in HSAs is small. From panel 4 in figure 5 we already saw that the cohort around age 30 is the one with the lowest health capital. This is also the group that is least likely to have insurance. This is a direct result of the income age profile. This age group has relatively low income and faces small health shocks. Therefore, this age group does not buy health insurance. The high price of health services without health insurance keeps them from investing in their health capital. However, this only holds for the lowest health capital group. The next highest group has already almost 50% of all assets invested in HSAs. Also, it turns out that the group with the smallest amount of health capital is already fully invested into Medicare as can be seen in panel 4.

Panel 4 depicts health insurance take-up ratios by health capital status. The most striking feature is that individuals with relatively low health states are buying the high deductible insurances. This does not confirm the findings in Zabinski et al. (1999). The difference between our result and theirs is largely explained by the health capital accumulation process. From panel 4 in figure 4 we have seen that middle aged workers have relatively low health capital. However, this is the cohort that is most likely to invest into HSAs because for them the tax free savings that comes with HSAs is attractive.

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6 Extra Tables and Figures

Table 1: Transition Probabilities between Health Shocks by Age Groups

	to	Shock 1	Shock 2	Shock 3	Shock 4	Shock 5	Sum	N
20 to 29	.	.	.	.	.	.	.	.
from	.	.	.	.	.	.	.	.
Shock 1	.	0.111	0.337	0.481	0.065	0.006	1.000	5810.000
Shock 2	.	0.067	0.286	0.539	0.095	0.012	1.000	41097.000
Shock 3	.	0.040	0.221	0.575	0.141	0.024	1.000	1.09e+05
Shock 4	.	0.021	0.155	0.578	0.204	0.042	1.000	21393.000
Shock 5	.	0.012	0.118	0.557	0.248	0.065	1.000	2347.000
29 to 38	.	.	.	.	.	.	.	.
from	.	.	.	.	.	.	.	.
Shock 1	.	0.111	0.337	0.481	0.065	0.006	1.000	5810.000
Shock 2	.	0.067	0.286	0.539	0.095	0.012	1.000	41097.000
Shock 3	.	0.040	0.221	0.575	0.141	0.024	1.000	1.09e+05
Shock 4	.	0.021	0.155	0.578	0.204	0.042	1.000	21393.000
Shock 5	.	0.012	0.118	0.557	0.248	0.065	1.000	2347.000
38 to 47	.	.	.	.	.	.	.	.
from	.	.	.	.	.	.	.	.
Shock 1	.	0.099	0.326	0.498	0.069	0.008	1.000	8228.000
Shock 2	.	0.064	0.274	0.545	0.102	0.014	1.000	41463.000
Shock 3	.	0.040	0.222	0.573	0.141	0.024	1.000	1.01e+05
Shock 4	.	0.023	0.169	0.580	0.187	0.041	1.000	24672.000
Shock 5	.	0.012	0.127	0.566	0.234	0.062	1.000	4169.000
47 to 56	.	.	.	.	.	.	.	.
from	.	.	.	.	.	.	.	.
Shock 1	.	0.101	0.329	0.495	0.068	0.007	1.000	8176.000
Shock 2	.	0.066	0.279	0.539	0.103	0.013	1.000	41282.000
Shock 3	.	0.041	0.221	0.578	0.139	0.022	1.000	1.01e+05
Shock 4	.	0.023	0.168	0.580	0.190	0.038	1.000	24725.000
Shock 5	.	0.013	0.137	0.552	0.237	0.061	1.000	4329.000
56 to 65	.	.	.	.	.	.	.	.
from	.	.	.	.	.	.	.	.
Shock 1	.	0.089	0.326	0.502	0.075	0.008	1.000	8329.000
Shock 2	.	0.065	0.279	0.543	0.099	0.013	1.000	41376.000
Shock 3	.	0.040	0.220	0.578	0.139	0.023	1.000	1.02e+05
Shock 4	.	0.023	0.171	0.577	0.190	0.039	1.000	24651.000
Shock 5	.	0.019	0.131	0.577	0.218	0.056	1.000	3995.000
65 to 74	.	.	.	.	.	.	.	.
from	.	.	.	.	.	.	.	.
Shock 1	.	0.094	0.325	0.500	0.073	0.008	1.000	8169.000
Shock 2	.	0.064	0.277	0.547	0.100	0.013	1.000	41337.000
Shock 3	.	0.040	0.223	0.573	0.141	0.023	1.000	1.02e+05
Shock 4	.	0.022	0.166	0.585	0.190	0.036	1.000	24455.000
Shock 5	.	0.016	0.132	0.562	0.234	0.056	1.000	4089.000
74 to 83	.	.	.	.	.	.	.	.
from	.	.	.	.	.	.	.	.
Shock 1	.	0.090	0.327	0.506	0.070	0.008	1.000	8071.000
Shock 2	.	0.066	0.276	0.544	0.101	0.014	1.000	41396.000
Shock 3	.	0.039	0.219	0.576	0.142	0.023	1.000	1.02e+05
Shock 4	.	0.024	0.161	0.582	0.195	0.038	1.000	24746.000
Shock 5	.	0.014	0.133	0.575	0.219	0.058	1.000	4058.000
83 to 92	.	.	.	.	.	.	.	.
from	.	.	.	.	.	.	.	.
Shock 1	.	0.094	0.319	0.510	0.069	0.009	1.000	8113.000
Shock 2	.	0.064	0.276	0.548	0.099	0.013	1.000	40904.000
Shock 3	.	0.040	0.224	0.574	0.139	0.023	1.000	1.02e+05
Shock 4	.	0.023	0.167	0.578	0.192	0.040	1.000	24896.000
Shock 5	.	0.016	0.134	0.563	0.227	0.061	1.000	4201.000

	[1] Benchmark	[2] HSA
Health Expense (in % of GDP):	17.642	14.367
All Insured (in %):	80.136	75.033
Output Y :	100.000	97.017
Capital K :	100.000	101.172
Health Capital H :	100.000	84.521
K/Y :	2.662	2.776
H/Y :	5.280	4.600
Assets a :	1.258	0.683
Assets in HSA a^m :	0.000	0.622
Consumption C :	100.000	107.236
C/Y:	0.319	0.353
Interest Rate $R = 1 + r$:	1.046	1.043
Social Security Tax τ^{Soc} :	0.102	0.108
Avge. Marg. Income Tax: τ:	0.109	0.099
% of Workers paying Penalty:	0.000	0.000
% of Retirees paying Penalty:	0.000	52.414
T^{SI} Worker (in %):	0.319	0.445
T^{SI} Retiree (in %):	0.022	0.019
Insured Workers Low (in %):	72.955	11.107
Insured Workers High(in %):	3.594	59.387
Insured Workers (in %):	76.549	70.494
Insured Retirees (in %):	99.714	99.805
All Insured (in %):	80.136	75.033
Average Insurance Premium p^{Low}:	100.000	73.935
Average Insurance Premium p^{High}:	100.000	87.388
Medicare Premium p^{Med} :	100.000	128.750
Government Size G/Y (in %):	20.277	15.404
Aggregate Welfare:	-100.000	-96.776
Gini Coefficient:	0.728	0.713

Table 2: Policy Experiment with Health Productivity $\theta = 1$: [1] *Benchmark* two insurance types witout HSAs and [2] two insurance types with HSAs.

	[1 Benchmark]	[2]	[3]	[4]	[5]	[6]
Output Y :	4.194	4.069	4.056	4.156	4.239	3.690
Capital K :	1.240	1.255	1.224	1.290	1.277	0.989
K/Y :	2.662	2.776	2.715	2.793	2.712	2.412
Assets a :	1.258	0.683	0.974	0.651	1.299	0.986
Assets in HSA-a^m :	0.000	0.622	0.258	0.669	0.000	0.000
Health Capital H :	2.461	2.080	2.117	2.214	2.424	1.633
H/Y:	5.280	4.600	4.698	4.794	5.146	3.984
Health Expenditures $p_m M$:	0.740	0.585	0.613	0.686	0.738	0.407
$p_m M/Y$:	0.176	0.144	0.151	0.165	0.174	0.110
Consumption C :	1.340	1.437	1.442	1.404	1.358	1.603
C/Y:	0.319	0.353	0.356	0.338	0.320	0.434
Human Capital Hk :	0.965	0.917	0.924	0.934	0.967	0.891
Interest Rate $R(J)$:	1.503	1.457	1.481	1.451	1.483	1.619
Interest Rate $R = 1 + r$:	1.046	1.043	1.045	1.042	1.045	1.055
Wages w :	2.911	2.972	2.940	2.981	2.938	2.773
Social Security Tax-τ^{Soc} :	0.102	0.108	0.108	0.109	0.102	0.105
Avge. Marg. Income Tax: τ:	0.109	0.099	0.099	0.100	0.110	0.105
Total Income Tax Income:	0.893	0.652	0.676	0.699	0.902	0.767
% of Workers paying Penalty:	0.000	0.000	0.000	0.000	0.000	0.000
% of Retirees paying Penalty:	0.000	52.414	11.426	33.934	0.000	0.000
Social Insurance Transfers T^{SI}:	0.042	0.025	0.025	0.015	0.039	0.344
T^{SI} Worker:	0.042	0.025	0.025	0.014	0.038	0.273
T^{SI} Retirees:	0.000	0.000	0.000	0.001	0.000	0.071
T^{SI} Worker in %:	0.319	0.445	0.394	0.314	9.178	1.623
T^{SI} Retiree in %:	0.022	0.019	0.019	1.074	0.021	2.290
Insured Workers-Low(in%):	72.955	11.107	18.808	23.952	59.309	0.000
Insured Workers High(in%):	3.594	59.387	54.092	54.775	2.644	0.000
Insured Workers (in %):	76.549	70.494	72.900	78.728	77.246	0.000
Insured Retirees Low(in%):	0.000	0.000	0.000	0.438	0.000	0.000
InsuredRetirees-High(in%):	0.000	0.000	0.000	99.089	0.000	0.000
Insured Retirees (in %):	99.714	99.805	99.810	99.527	99.752	0.000
All Insured(in%):	80.136	75.033	77.068	81.949	81.503	0.000
Insurance Premium p^{Low}:	0.597	0.597	0.608	0.606	0.608	0.000
Insurance Premium p^{High}:	0.627	0.634	0.642	0.590	0.628	0.000
Average Insurance Premium p^{Low}:	0.876	0.648	0.681	0.686	0.789	0.000
Average Insurance Premium p^{High}:	1.215	1.062	1.100	1.332	1.093	0.000
Medicare Premium p^{Med} :	0.720	0.927	0.756	0.000	0.740	0.000
Accidental Bequests $TBeq$:	0.049	0.050	0.049	0.048	0.050	0.039
Profits Low Insurance:	0.000	0.000	0.000	0.000	0.000	0.000
Profits High Insurance:	0.000	0.000	0.000	0.000	0.000	0.000
Government Consumption G:	0.850	0.627	0.650	0.684	0.863	0.423
G/Y :	0.203	0.154	0.160	0.165	0.204	0.115
Agg. Welfare:	-5.010	-4.848	-4.842	-4.850	-4.983	-6.217
Gini Coefficient:	0.728	0.713	0.721	0.732	0.728	0.748
Error in %	0.001	0.004	0.001	0.002	0.002	0.000
overrun Iter2w	0.000	0.000	0.000	0.000	0.000	0.000
overrun Iter2r	0.000	0.000	0.000	0.000	0.000	0.000

Table 3: Six Regimes: [1 *Benchmark*] two insurance types witout HSAs, [2] two insurance types with HSAs, [3] HSAs funds can be used to pay health care premiums , [4] HSAs without Medicare, [5] workers can buy into Medicare, and [6] no insurance. In regime [1], [2], [3], [4], and [5] agents can choose between low and high deductible insurances. In regime [1], [5] and [6] HSAs are not available. In regime [2], [3] and [4] the high deductible insurance can be linked to an HSA.

	[1 Benchmark]	[2]	no G.E. Effects
Output Y :	4.194	4.069	4.194
Capital K :	1.240	1.255	1.277
K/Y :	2.662	2.776	2.740
Assets a :	1.258	0.683	0.669
Assets in HSA-a^m :	0.000	0.622	0.644
Health Capital H :	2.461	2.080	2.059
H/Y:	5.280	4.600	4.419
Health Expenditures $p_m M$:	0.740	0.585	0.588
$p_m M/Y$:	0.176	0.144	0.140
Consumption C :	1.340	1.437	1.479
C/Y:	0.319	0.353	0.353
Human Capital Hk :	0.965	0.917	0.914
Interest Rate $R(J)$:	1.503	1.457	1.503
Interest Rate $R = 1 + r$:	1.046	1.043	1.046
Wages w :	2.911	2.972	2.911
Social Security Tax-τ^{Soc} :	0.102	0.108	0.102
Avge. Marg. Income Tax: τ:	0.109	0.099	0.098
Total Income Tax Income:	0.893	0.652	0.651
% of Workers paying Penalty:	0.000	0.000	0.000
% of Retirees paying Penalty:	0.000	52.414	77.615
Social Insurance Transfers T^{SI}:	0.042	0.025	0.026
T^{SI} Worker:	0.042	0.025	0.025
T^{SI} Retirees:	0.000	0.000	0.000
T^{SI} Worker in %:	0.319	0.445	0.485
T^{SI} Retiree in %:	0.022	0.019	0.018
Insured Workers-Low(in%):	72.955	11.107	7.676
Insured Workers High(in%):	3.594	59.387	60.863
Insured Workers (in %):	76.549	70.494	68.538
Insured Retirees Low(in%):	0.000	0.000	0.000
InsuredRetirees-High(in%):	0.000	0.000	0.000
Insured Retirees (in %):	99.714	99.805	99.821
All Insured(in%):	80.136	75.033	73.383
Insurance Premium p^{Low}:	0.597	0.597	0.597
Insurance Premium p^{High}:	0.627	0.634	0.627
Average Insurance Premium p^{Low}:	0.876	0.648	0.638
Average Insurance Premium p^{High}:	1.215	1.062	1.045
Medicare Premium p^{Med} :	0.720	0.927	0.720
Accidental Bequests $TBeq$:	0.049	0.050	0.049
Profits Low Insurance:	0.000	0.000	0.000
Profits High Insurance:	0.000	0.000	0.000
Government Consumption G:	0.850	0.627	0.626
G/Y :	0.203	0.154	0.149
Agg. Welfare:	-5.010	-4.848	-4.781
Gini Coefficient:	0.728	0.713	0.709
Error in %	0.001	0.004	2.932
overrun Iter2w	0.000	0.000	0.000
overrun Iter2r	0.000	0.000	0.000

Table 4: Four Regimes: [1 *Benchmark*] two insurance types witout HSAs, [2] two insurance types with HSAs, [*no G.E. Effects*] two insurance types with HSAs and fixed w and R.

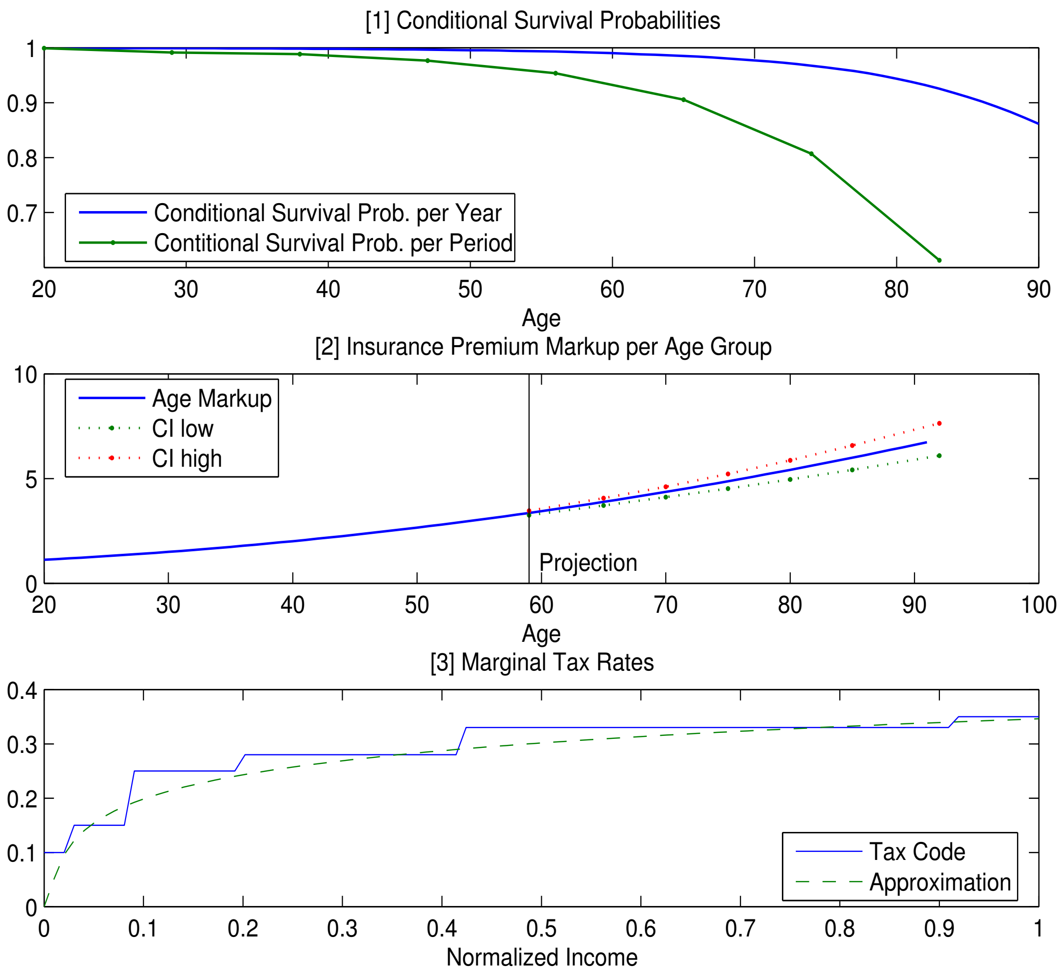

Figure 3: Panel (1): Conditional Survival Probabilities from U.S. Life-Tables 2003. Panel (2): Premium Markup per Age Group. Source: 2005 Data from www.ehealthinsurance.com. Panel (3): Income Tax Function Approximation.

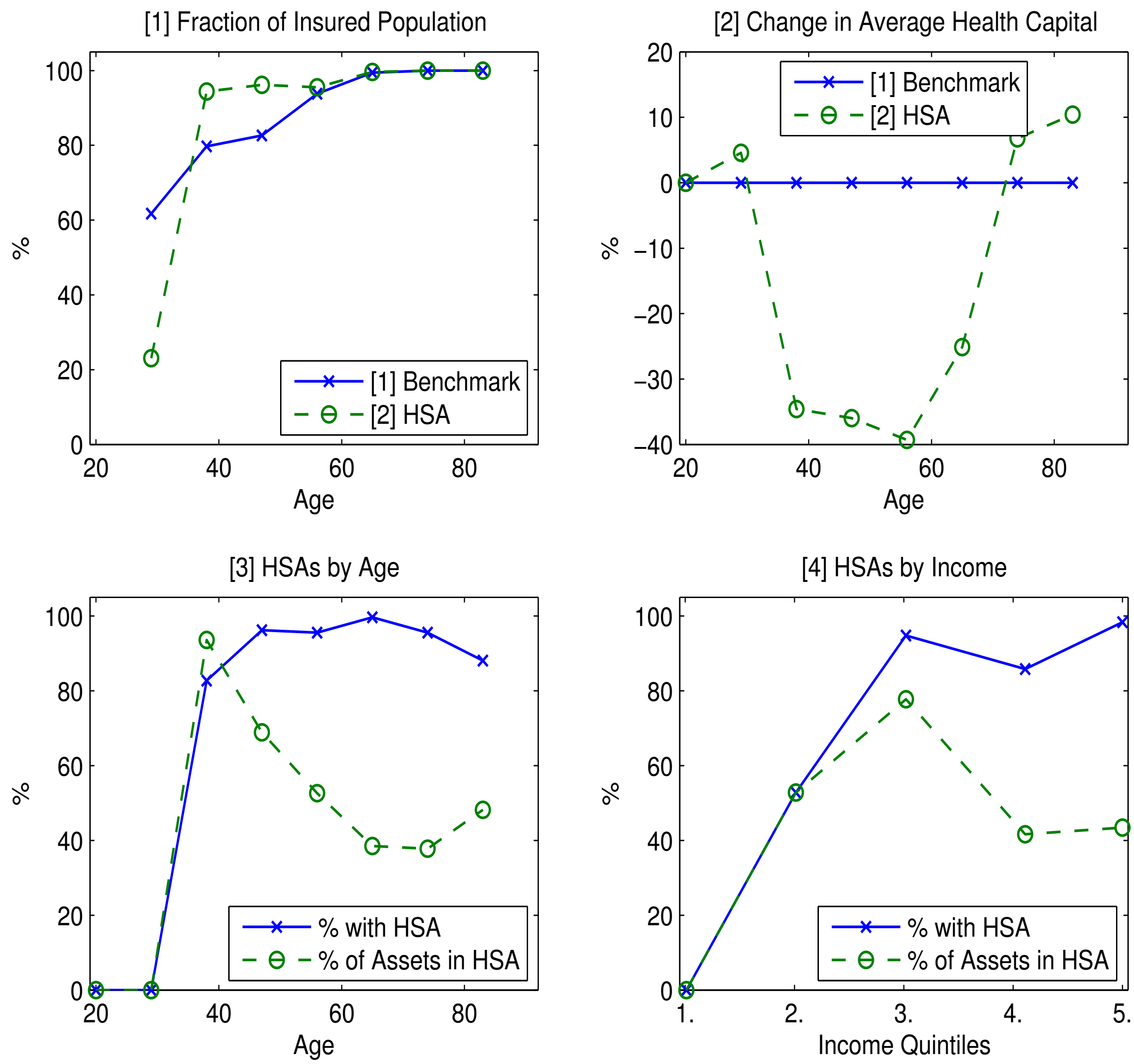

Figure 4: Fraction of insured workers before and after the policy experiment of introducing HSAs. Panel (1): Percentage of insured workers per age group. Panel (2): Percentage of insured workers per income quintile. Panel (3): Percentage of insured workers per health capital state. Panel (4): Average health capital per age group.

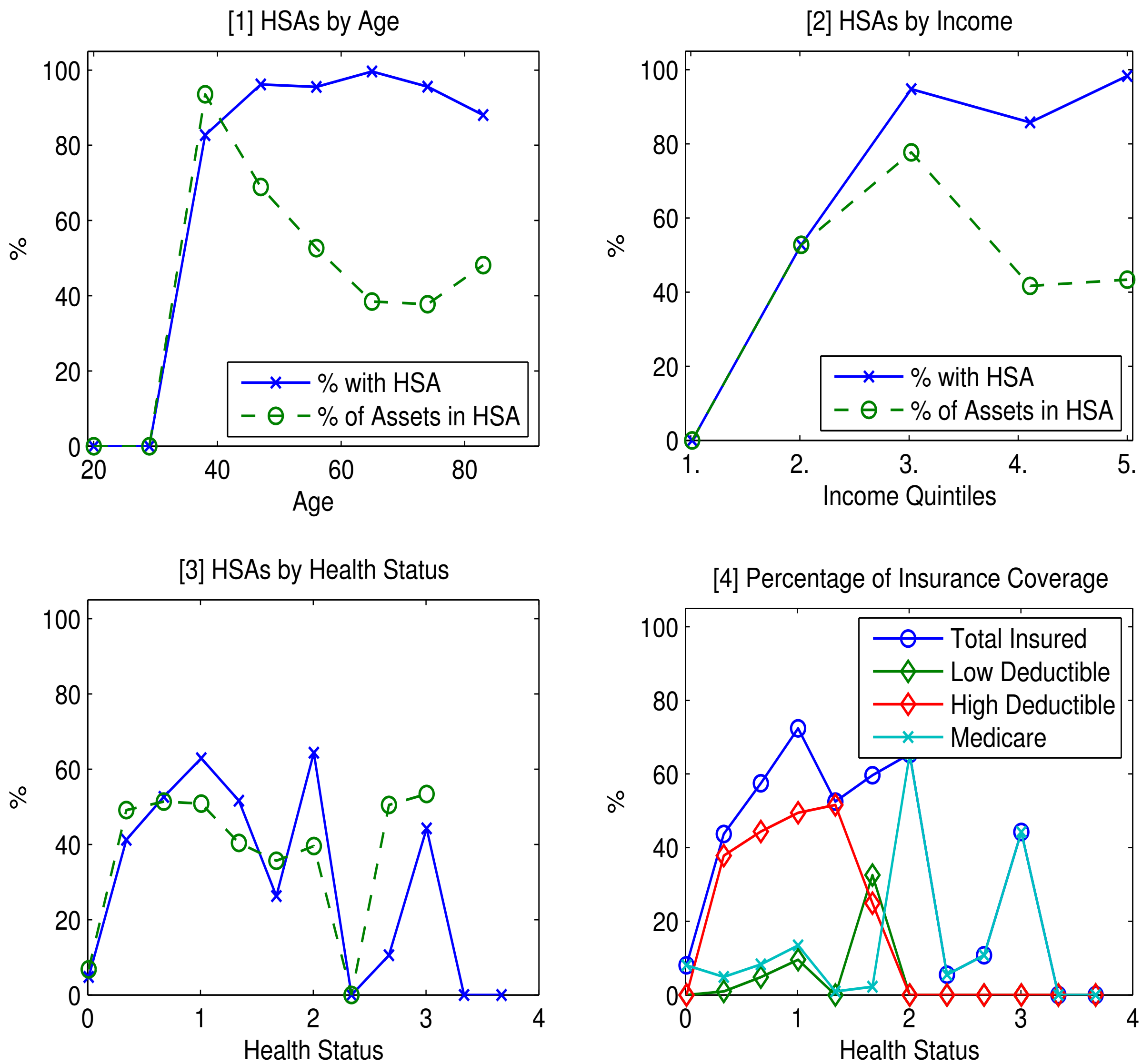

Figure 5: Panel (1): Percentage of assets held in the form of funds in HSAs by age group and percentage of the population with HSAs per age group. Panel (2): Percentage of assets held in the form of funds in HSAs by income quintile and percentage of the population with HSAs by income quinitile. Panel (3): Percent of assets in HSAs by health state and percent of the population with HSAs by health state. Panel (4): Percentage of insurance coverage type by health state. All results are for regime [2], the model with two insurance types and HSAs.

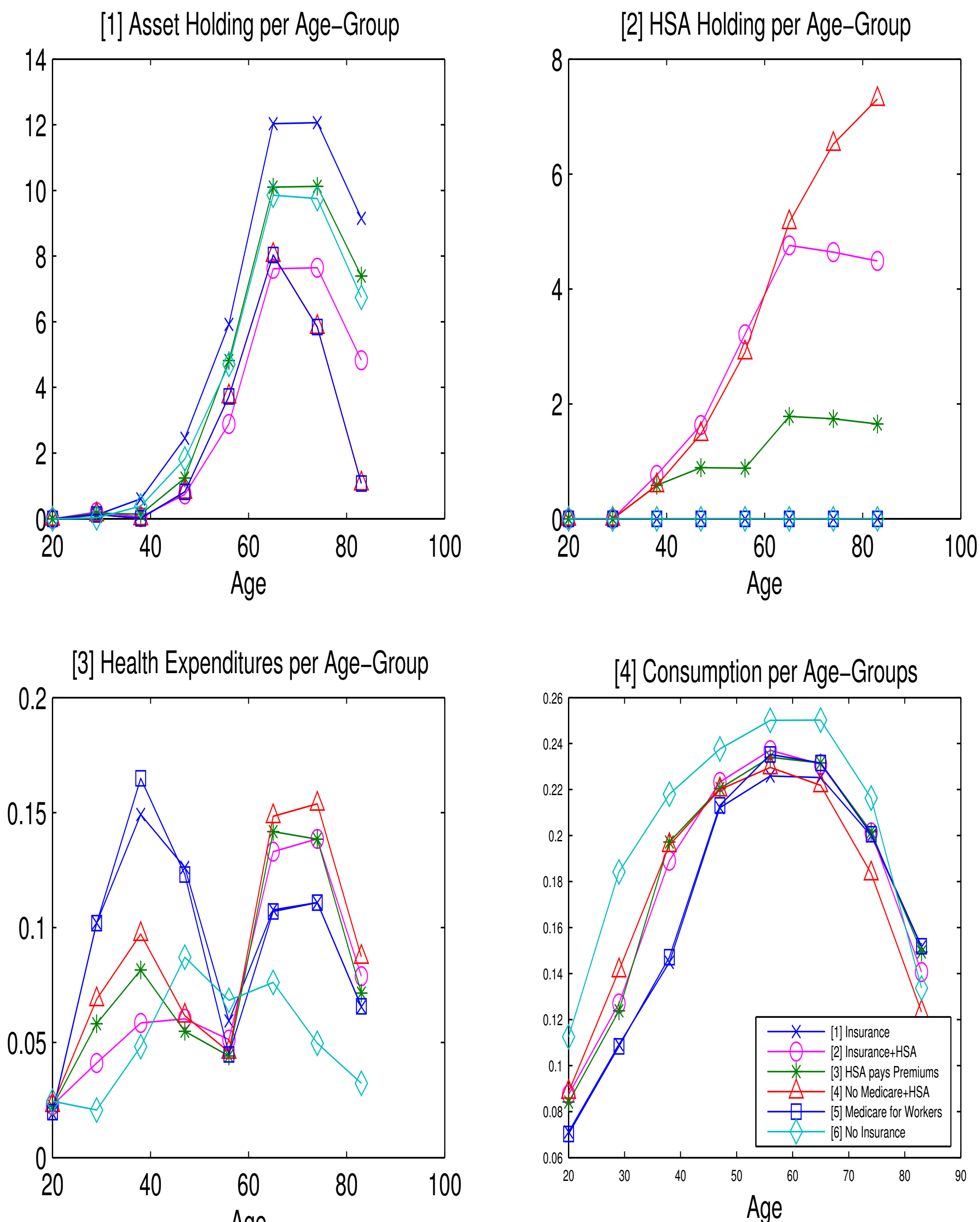

Figure 6: Aggregate Variables for Six Regimes. Panel (1) aggregate asset holdings, panel (2) aggregate holdings in HSAs, panel (3) aggregate medical expenditures, and panel (4) aggregate consumption. The regimes are: [1 *Benchmark*] two insurance types witout HSAs, [2] two insurance types with HSAs, [3] HSAs funds can be used to pay health care premiums , [4] HSAs without Medicare, [5] workers can buy into Medicare, and [6] no insurance.