Moral Hazard Model of Health Insurance

Vardan Adibekyan

1 Introduction

Moral hazard is widely recognized as one of the most important distortions in health care and insurance markets, which leads to excess consumption. While most of the literature provides experimental evidence of moral hazard in health insurance, it's also interesting to provide theoretical framework for it.

The crucial point in moral hazard analysis is how this study identifies it in case of health insurance. Most of the papers analyzing this issue identify moral hazard by measuring the changes in people's medical visits' frequencies once they get insurance. This paper provides an alternative approach to this identification issue. The paper constructs probabilistic model of household's consumption-investment problem with no assets. Here term "investment" is not used in its standard meaning. Under the investment people's efforts exerted to protect and improve their health are assumed. Under the model's framework there is an inter-temporal choice between investing in future health (choosing the level of health protecting effort) at the expense of current dis-utility and obtaining high levels of current utility from consumption at the expense of future poor health. Here the change in health protecting behavior of individuals with different initial health levels is estimated, once the individuals get insurance. We also want to compare health protecting behavior of insured individuals with different initial health levels.

2 The Model

In this section, we build a consumption - 'investment in health' model with no assets. We try to capture the change in the behavior of 20[1] years and elder individuals after health insurance implementation.

Individuals maximize their lifetime[2] expected utility with an inter-temporal discount factor β for discrete time t (in 5-year periods). There are continuum of individuals with stocks of health $h_t \in [0, 1]$ at period t. At time t individuals receive

[1]The insurance program is designed for the employees only, thus we consider an average age of an individual entering job market.

[2]For individuals' lifetime average life expectancy data for both men and women are taken based on the "World Development Indicators" data source.

wh_t wage conditional that they survive until that period [3] Individuals consume consumption goods c_t and decide level of health investment a_t each period.

Timing: The sequence of events for a living individual is the following: an individual observes his/her current state of the health, receives income and pays premiums for the insurance. Based on the current health an individual consumes and decides how much to invest in health, then health shock is realised. His/her health state evolves to the next period, and then the same cycle continues again.

Utility function: The utility function of living individual at period t depends on the consumption c_t and effort level a_t (level of health investment), as well as the current state of health h_t. The utility of individual with $h_t = 0$ is 0. Utility function is given by (we have omitted subscript t for simplicity):

$$u(c, a; h) = \begin{cases} \ln c + \mu h - \frac{1}{2}\alpha a^2, & \text{if } h_t \in (0, 1] \\ 0, & \text{if } h_t = 0 \end{cases} \tag{1}$$

Individual derives utility from the consumption, which depends on health level, directly from the health level and derives a dis-utility from health investments, which is costly effort consisting from the both preventive and curative care.

Health state evolution: The next period health depends on the current health level, age, health investment and the mortality rate. If an individual survives given the age-specific mortality rates[4] the subsequent health state is obtained from the distribution of next period health levels. Health evolution is given by:

$$h_{t+1} = \begin{cases} max(0, min(1, \hat{h}_{t+1})), & \text{if } \Theta_t \leq \bar{\Theta}, h_t > 0 \\ 0, & \text{otherwise.} \end{cases} \tag{2}$$

$$\begin{aligned} \hat{h}_{t+1} = (\gamma_0 + \gamma_{a1} age + \gamma_{a2} age^2 + \gamma_{h1} h_t + \gamma_{h2} h_t^2 \\ + exp(\gamma_{m1} + \gamma_{m2}(1 - h_t))[ln(a_t + exp(\gamma_{m0})) - \gamma_{m0}]) * \epsilon_t^h (1 + m) \end{aligned} \tag{3}$$

If the age specific mortality is higher then particular threshold or an individual is already dead, then the next period health is also 0. The health shock is distributed by Beta distribution with parameters $\alpha = \frac{1}{1-h_t}$ and $\beta = \frac{1}{h_t}$:

$$\epsilon_t(\frac{1}{1 - h_t}, \frac{1}{h_t}) \tag{4}$$

The Beta form in (4) is motivated from the following fact: given how much health an individual in the previous period had and the health investment for the current period, health shock wears out some part of the expected next period health. This

[3] Here w is the productivity of an agent, with unitary level of health.

[4] Age-specific mortality rates are taken from the database of Armenian National Institute of Health.

means the error term is a distribution on $[0, 1]$ support. The healthier an individual the higher α parameter, and the closer to 1 β parameter. This means that after the shock the next period health will be closer to the expected next period health. In turn, the lower the previous health, the closer α parameter to 1, and the higher β parameter. This would imply that the health shock realizations will be closer to 0 with higher probability.

The first line of (3) is the mean of the next period health conditional on the previous health and age. For the sake of simplicity we set parameters γ_{a1} and γ_{a2} to 0, which means we disregard age dependency in health evolution.[5] The second line of (3) represents the build-up of the next period health level due to the health investments. First parentheses show the efficacy of health investments at current period. $(\gamma_{m1} - \gamma_{m0})$ is the base efficacy and γ_{m2} is the differential efficacy of curative care relative to preventive care[6]. γ_{m0} allows to control for the curvature health investments: lower values of γ_{m0} mean that marginal returns to health investment decrease more rapidly.

The m stands for the restoration of health, if an individual has insurance. The no insurance case corresponds to $m = 0$.

Budget constraint:

$$c = \begin{cases} wh(1-\tau), & \text{for "working age" period} \\ TR, & \text{for "retirement" period} \end{cases} \tag{5}$$

Here τ is the rate of taxation or insurance premium imposed by the government or insurance company.

Individual's problem: The individual's problem at each period is to maximize the lifetime utility choosing optimal level of health investments a and subject to budget constraint on consumption level. This implies that an individual has to balance between immediate utility from the current consumption and future payoff from health investments.

Every individual at period t faces the following problem:

$$V_t(h_t) = \max_{c_t, a_t} u(c_t, a_t; h_t) + \beta \Bigg((1 - \Phi(\Theta_t)) \int_{-\infty}^{\infty} V_{t+1}(h_{t+1}) d\Phi(\epsilon^h) + \Phi(\Theta_t) V_{dead} \Bigg) \\ s.t. (2), (3), (5). \tag{6}$$

3 Results

We rank individuals by their initial health levels from 0 to 1 and observe 5 different groups based on their behavior. (See Fig. 1)

[5] We can include age dependency in health evolution so that health depreciation is faster for elder individuals.

[6] The parameters are calibrated based on the database of Armenian National Institute of Health.

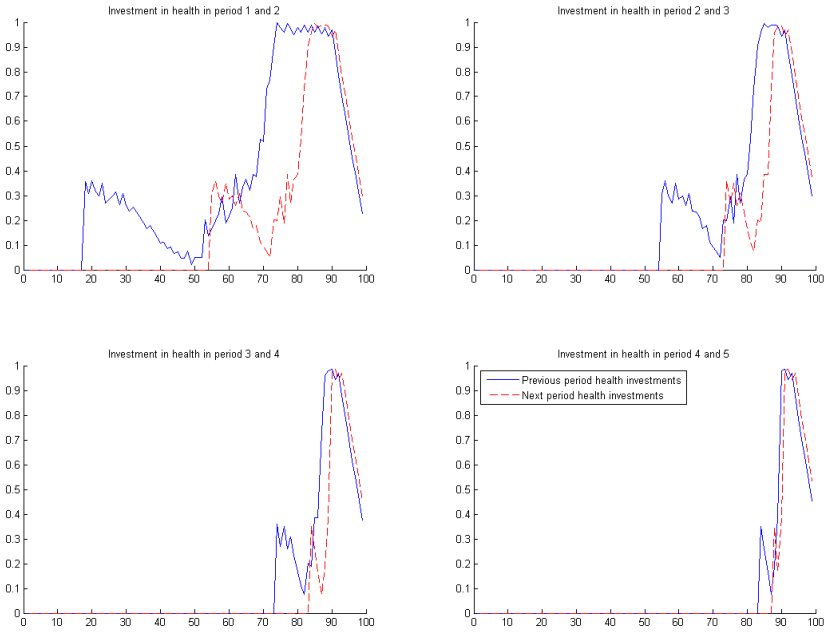

Figure 1: Health investment behavior

The lowest $18th$ percentile of the population with different initial health levels is the share of people that doesn't invest in health and dies right away.

The second group constitutes the next 30% of the population. We can think of it as a marginal group between poorest and middle class individuals. People in this group have bad health, but still invest in their health to be able to survive 1 additional period.

The third group accounts for 22% of population and, by analogy, this group represents middle class individuals. People in this group care more about their future health, since they have real chances to increase their quality of life making additional investments in health.

The fourth group constitutes 25% of population and consists of relatively healthy and wealthy people (we directly link wealth to health: the healthier you are the more is your wealth), who nevertheless find it beneficial to invest in their health, since they can afford to incur utility losses from very high levels of health investments in order to increase their healthy life expectancy.

And finally, the last fifth group composes 5% of population and represents idealistic case, when people at age 20 (starting point of the model) have an incredibly high levels of health (which is usually not reported in Armenian Household Survey). This people can be described as elite of the society, since both their health and wealth levels are very high, and they do not have to think about high levels of health investments: they just enjoy their healthy and prosperous life.

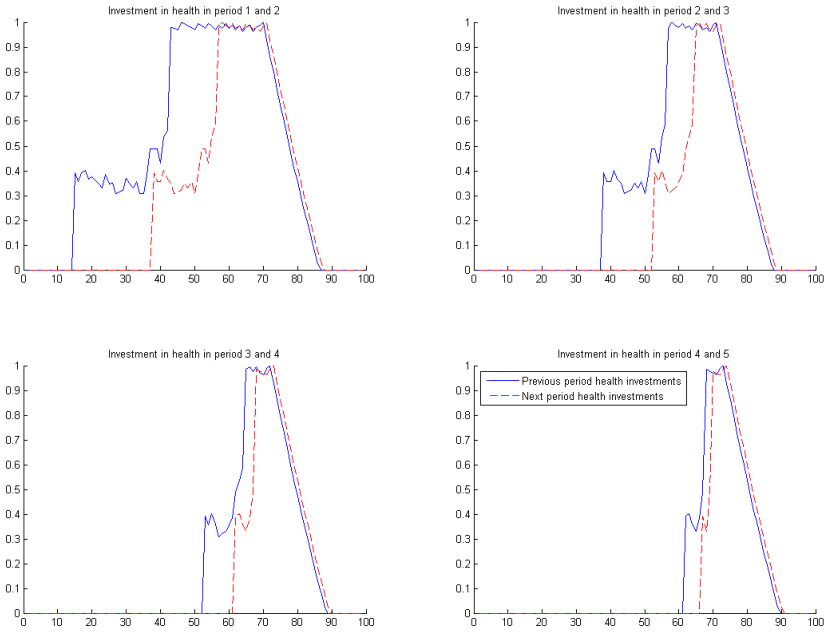

Figure 2: Health investment behavior

After health insurance implementation [7] we observe drastic change in the behavior of $4th$ and $5th$ groups. The upper $30th$ percentile of population maintains higher health level during their life, while their health investments dramatically decreases. This is an indication of moral hazard behavior.

Middle class, in turn, takes an advantage of health insurance, which decreases their health shocks and increases their health levels. This implies that now they can achieve much healthier life exerting more effort than before. (See Fig. 2)

4 Conclusion

The paper provides an alternative way of thinking about moral hazard issue. In our framework moral hazard can be represented as the careless attitude of people towards their health, once they get health insurance. We have found that not all the individuals are exposed to moral hazard after being insurance. Particularly, we have found that moral hazard is specific to more prosperous and healthier part of population. Moreover, those who still feel an urgent need to improve their health will behave quite the opposite: they'll have more incentives to care about their health once they get insurance, since it increases the efficiency of health investments.

Another issue this paper addresses is health protecting behavior of individuals with different initial health levels. The results show that there is non linear correla-

[7] The insurance target group is considered middle and upper part of population distribution according to their initial health levels

tion between health level and health investment. Moreover, the sign of correlation differs depending on health level. For the first group of the society with the poorest health level the health investment level is fixed to 0. For the second group of the society the correlation is negative: the higher the health level the lower the level of health investment. For the third group of the society the sign of the correlation becomes positive. Then the fourth group is indifferent to the initial health level, having constant level of investments in their health. And finally, the last fifth group exhibits different behavior: negative correlation between the level of health and health investment.