Modelling optimal asset allocation when households experience health shocks

Jiapeng Liu, Rui Lu, Ronghua Yi, and Ting Zhang*

Abstract

Health status is an important factor affecting household portfolio decisions. In this study we develop a theoretical framework to examine how China's rural households make optimal asset allocation decisions in response to health risks. Our two- and three-asset models both suggest that the maximum utility is derived when households allocate the majority of their assets to human capital. When households experience acute illness shocks, their welfare and portfolio value reduce, and they need to increase their investment in human capital. When households experience chronic illness shocks such as cancer, the optimal decision for asset-rich households is to undertake medical treatment, whereas the optimal decision for asset-poor households is to forgo treatment. Finally, public financial assistance is particularly needed to help asset-poor households to invest in human capital.

Keyword: Rural households, health shocks, asset allocation, human capital, public assistance

JEL Codes: E2, G1, I1, I3

* Liu is an associate professor of finance at China Jiliang University, Hangzhou, China. Lu is an associate professor of finance at Lingnan College (University), Sun Yat-sen University, Guangzhou, China. Yi is a professor of finance at China Jiliang University, Hangzhou, China. Zhang is an assistant professor of finance at University of Dayton, Dayton, OH, 45469 USA. Corresponding author: Ting Zhang. Phone: 1-937-229-3428; fax: 1-937-229-2427; email: tzhang1@udayton.edu. Comments are welcome.

1. Introduction

Unanticipated health shocks, particularly severe illness shocks such as cancer and other chronic illnesses, frequently strike China's rural households. These shocks can have devastating effects on households, and cause significant loss of income/welfare and considerable economic hardship for rural households. For example, China's Ministry of Health (2008) estimated that the total economic cost from cancer was 86.85 billion RMB (or US$10 billion) in 2003. [1] Health shocks are the ones most likely to impoverish China's rural households. According to a World Bank report (Wagstaff, 2006, 2007), the large or "catastrophic" out-of-pocket medical spending for rural households due to severe illnesses has pushed more than 4.5 million people in China below poverty line in 2006.[2]

In this study we aim to provide a theoretical framework for the optimal asset allocation for Chinese rural households and the availability of public financial assistance in response to health shocks, such as cancer and other chronic (severe) illnesses. We are particularly motivated by previous studies that have found health risk to be an important factor affecting household portfolio decisions. Households are sensitive to health-related risks because they impose both direct (heath care) and indirect costs (loss of income or other opportunities) (Atella et al., 2011). When a health shock occurs, such as a household member suffering from an unexpected acute or chronic illness, households need to change their allocation of financial resources. Several studies provide empirical evidence on the effect of health conditions on household portfolios, including Pratt and Zeckhauser (1987), Gollier and Pratt (1996), Rosen and Wu (2004), and Goldman and Maestas, 2007). But the theoretical framework remains scarce.

[1] In comparison, the total cost of cancers in the US in 2005 was estimated to be US$209.9 billion.
[2] In particular, Wagstaff (2006, 2007) reports that in China, the headcount below poverty line would have been 2.6 percentage points lower or nearly 15% lower (13.7% compared to 16.2%) in the absence of out-of-pocket medical spending.

Based on Becker's household economics and asset allocation theories (Becker, 1965, 1974, 1975), we develop a theoretical framework of household portfolio choices in response to health shocks. In our model, human capital, fixed assets, financial assets, and other working capital constitute the major assets of a rural household's portfolio. Human capital inputs and outputs are primarily related to household members' education and the accumulation of knowledge. Health is an important factor influencing the quality of human capital (Barro and Barro, 1996). The health of household members and their ability to recover from illness greatly affect human capital, which consequently affects the household's portfolio value and well-being. Therefore, optimizing the household portfolio in response to health shocks and the deterioration in a household member's health condition becomes an important investment decision for a household.

We first create a two-asset (fixed assets and human capital) and a three-asset (fixed assets, human capital, and financial assets) model and solve for the optimal asset allocation for a household. Next, we include health shocks in the model and examine the change in the optimal portfolio asset allocation and household utility in response to shocks. We also examine how public financial assistance affects human capital and household portfolio asset allocation. More specifically, we classify health shocks into two types depending on whether human capital is recoverable: (1) acute illness shocks, in which human capital can be fully, or at least partially, recovered; and (2) cancer and other chronic illness shocks, in which human capital cannot be recovered. We then investigate the effect of these two types of shocks on household portfolio optimization and the choice of public financial assistance.

We summarize the major findings as follows. First, the two- and three-asset models both suggest that the maximum utility is derived when rural households allocate a majority of their assets to human capital. Second, as a result of acute illness shocks, a household's welfare becomes lower and the value of its portfolio reduces. The original asset allocation between human capital and other household assets becomes sub-optimal. Our solution indicates that a household needs to increase its investment in human capital as a response to illness shocks. Third, when a household member suffers from cancer and other severe, chronic illnesses, our solution again indicates that the household needs to increase its investment in human capital. However, as cancer becomes more severe and medical treatment expenses grow, the welfare of the household continues to fall. For asset-rich households, the optimal decision is to undertake medical treatment, whereas for asset-poor households, giving up treatment becomes the optimal decision. Finally, when a household suffers a shock from cancer or other chronic illness, it becomes more likely that the household will exhaust its fixed and financial assets and will lose all of its human capital. Therefore, public financial assistance is particularly needed for poor rural households, such as medical expense reimbursement and insurance. We suggest that public financial assistance should be used for human capital investment, such as providing financial support for the education of the *next* generation in rural households. This will help to minimize the household loss and maximize the benefit of public financial support.

This study makes several contributions to the literature. It provides a theoretical framework to investigate optimal asset allocation for rural households by incorporating health risk into the model, an important factor that affects household portfolio decisions. Our framework considers the optimal mix of four different assets: human capital, fixed assets, financial assets, and other production materials. This sets contrasts with previous studies which generally do not consider human capital in their analysis (e.g., Rosen and Wu, 2004; Goldman and Maestas, 2007). Our result highlights the important role of human capital in deriving the maximum level of household well-being. This finding has important implications for rural households and suggests that the majority of household assets, as well as public financial assistance, should be allocated to develop human capital. Finally, although we focus on the effect of health shocks on household portfolio decisions in this study, our framework can be easily extended to other types of shocks or disasters that could strike a household in rural areas, such as earthquakes, weather events, and agriculture- and food-related epidemics.

2. Household asset allocation: theoretical background

2.1. Basic theory

Household portfolio asset allocation theory deals with the optimal mix of human capital, fixed assets, and financial assets that maximizes household utility. The theory helps to explain how households consume and make investments in education, health care, and other human capital, as well as how households make choices between fixed assets and financial assets. The theory also considers asset rebalances and changes, and focuses on a dynamic process of portfolio optimization.

According to Becker's household economics model (Becker, 1965, 1974, 1975), a household's utility can be defined as follows:

$$U = U(h, g, f, p) \qquad (1)$$

where h is human capital, g is a house and other fixed assets, f is cash and other financial assets, and p is land and other production materials (e.g., livestock). Our objective is to maximize the household utility:

$$\begin{aligned} &max: \quad U = U(h, g, f, p) \\ &s.t. \quad F(h, g, f, p) = w_0 \end{aligned} \qquad (2)$$

where w_0 is the distribution of the original assets.

Note that for the household utility function, the marginal utility of the four asset categories (*h*, *g*, *f*, and *p*) is generally increasing; that is, its first-order partial derivative is positive: $\frac{\partial U}{\partial \square} > 0$. However, the second-order derivative varies for these four asset classes. In particular, houses and other fixed assets (*g*) have a diminishing marginal utility ($\frac{\partial^2 U}{\partial g^2} < 0$). Financial assets (*f*) are generally liquid and easily converted into other assets; they can also generate interest income. Hence, we assume a constant marginal utility for financial assets, or $\frac{\partial^2 U}{\partial f^2} = 0$. Land and other production materials (*p*) enjoy economies of scale, or $\frac{\partial^2 U}{\partial p^2} > 0$, but are subject to the effective function of human capital. After reaching a certain level, the marginal utility of land and other assets starts to decrease, i.e., $\frac{\partial^2 U}{\partial p^2} < 0$. Finally, we assume the marginal utility for human capital (*h*) to be increasing ($\frac{\partial^2 U}{\partial h^2} > 0$), primarily for the following reasons. First, the improvement in human capital is conditional on education, while education is an externality (as part of the cost of education is borne by society). Second, the level of human capital imposes a constraint on the use of a household's other assets. Third, human capital is scarce, grows slowly, and has a maximum potential level (for both intelligence and physical development).

Figure 1 shows the two types of marginal utility curves for the four asset categories: (1) human capital, and (2) other assets, including house and other fixed assets, cash and other financial assets, and land and other production materials.

2.2. Two-asset model

We start with a basic two-asset model and assume that a household has two assets: human capital (*h*), and a house and other fixed assets (*g*). Thus, the household utility function is

$$U = U(h, g) \tag{3}$$

2.2.1. Additive utility function

We assume the following utility equation:

$$U(h, g) = ah^n + bg^{1/m} \tag{4}$$

where *n* and *m* are factors, denoted as positive integers greater than 1. Now our objective function is to maximize the following household utility:

$$\begin{aligned} max: \quad & U = U(h, g) = ah^n + bg^{1/m} \\ s.t. \quad & h + g = 1 \end{aligned} \tag{5}$$

Assume that *n* =2 and *m* =2 and we have

$$\begin{aligned} max: \quad & U = U(h, g) = h^2 + g^{1/2} \\ s.t. \quad & h + g = 1 \end{aligned}$$

Using the Lagrange multiplier we have

$$L(h, r, \lambda) = h^2 + g^{1/2} + \lambda(1 - h - g)$$

$$\frac{\partial L}{\partial h} = 2h - \lambda = 0$$

$$\frac{\partial L}{\partial r} = {1/2}\, g^{-1/2} - \lambda = 0$$

$$\frac{\partial L}{\partial \lambda} = 1 - h - g = 0$$

We obtain the solution as

$$4h = g^{-1/2} \tag{6}$$

Given that g = 1–h, we have

$$16h^2 = 1/(1-h) \tag{7}$$

Now our maximization function becomes

$$16h^3 - 16h^2 + 1 = 0 \quad (8)$$

Based on the discriminant analysis, we have

$$D = \left(\frac{q}{2}\right)^2 + \left(\frac{p}{3}\right)^3 = \frac{5^2 - 2^{10}}{3^6 \cdot 2^{10}} < 0$$

We obtain the following solutions:

$$h_1 = 0.9273$$

$$h_2 = 0.2985$$

$$h_3 = -0.2258 \quad (9)$$

We exclude $h_3 = -0.2258$ and the final solutions are

$$h_1 = 0.9273$$

$$h_2 = 0.2985 \quad (10)$$

Figure 2 shows the relationship between household utility and human capital investment. The maximum utility is achieved when h_1=0.9273 and the minimum utility is achieved when h_2=0.2985. This suggests that a household should allocate a majority of its assets to human capital.

2.2.2. Multiplier utility function

We assume the following utility equation:

$$U = U(h, g) = ah^n g^{1/m} \quad (11)$$

where *n* and *m* are factors, denoted as positive integers greater than 1. Our objective function is to maximize the following household utility:

$$\begin{aligned} max: &\quad U = U(h, g) = ah^n g^{1/m} \\ s.t. &\quad h + g = 1 \end{aligned} \quad (12)$$

Figure 3 depicts the relationship between household utility, human capital, and other asset allocation. It can be seen that an optimal solution exists in the decision space. Using the

Lagrange multiplier we have

$$L(h,g,\lambda)=ah^n g^{1/m}+\lambda(1-h-g)$$

$$\frac{\partial L}{\partial h}=anh^{n-1}g^{1/m}-\lambda=0$$

$$\frac{\partial L}{\partial g}=a(1/m)h^n g^{1/m-1}-\lambda=0$$

$$\frac{\partial L}{\partial \lambda}=1-h-g=0$$

We obtain the solution

$$h=mng \tag{13}$$

Given that g = 1–h, we have

$$h=\frac{mn}{mn+1}$$

$$g=\frac{1}{mn+1}$$

Assuming that n =2 and m =2, we have

$$h = 0.8$$

$$g = 0.2 \tag{14}$$

Figure 4 shows the relationship between household utility and human capital investment. The maximum utility is achieved when h=0.8 and g=0.2.

2.3. Three-asset model

We now extend our basic two-asset model to a three-asset model, and assume that a household has three assets: human capital (h), a house and other fixed assets (g), and financial assets (f). The household utility function then becomes

$$U=U(h,g,f) \tag{15}$$

We assume the following utility equation:

$$U(h,g,f)=ah^n+bg^{1/m}+cf \tag{16}$$

where *n* and *m* are factors, denoted as positive integers greater than 1. Now our objective function is to maximize the following household utility:

$$max: \quad U = U(h, g, f) = ah^n + bg^{1/m} + cf$$
$$s.t. \quad h + g + f = 1 \tag{17}$$

Assume that *n* =2 and *m* =2, *a*=1, *b*=1, and *c*=1, then we have

$$max: \quad U = U(h, g, m) = h^2 + g^{1/2} + f$$
$$s.t. \quad h + g + f = 1 \tag{18}$$

Applying the Lagrange multiplier,

$$L(h, g, f, \lambda) = h^2 + g^{1/2} + f + \lambda(1 - h - g - f)$$

$$\frac{\partial L}{\partial h} = 2h - \lambda = 0$$

$$\frac{\partial L}{\partial g} = 1/2\, g^{-1/2} - \lambda = 0$$

$$\frac{\partial L}{\partial f} = 1 - \lambda = 0$$

$$\frac{\partial L}{\partial \lambda} = 1 - h - g - f = 0$$

we obtain

$$h = 1/2$$

$$g = 1/4$$

$$f = 1/4 \tag{19}$$

The results suggest that the maximum utility is achieved with the following asset allocation in a household: human capital (*h*) = 50%, house and other fixed assets (*g*) = 25%, and financial assets (*f*) = 25%. Human capital investment remains the largest allocation in a household portfolio.

3. Health shocks and household asset allocation changes

In this section we examine the effect of health shocks on a household's portfolio asset allocation. Based on the theoretical models discussed in the previous section, we model the loss of human capital due to heath shocks and how a household portfolio should be changed to minimize the loss of human capital and maximize well-being. We further study how public financial assistance (i.e., medical expense reimbursement and insurance) can be used to help recover human capital loss and increase household utility. In particular, we focus on two types of health shocks: (1) acute illness shocks, and (2) cancer and other chronic illness shocks, and investigate the effect of such shocks on household portfolio optimization and the choice of public financial assistance.

Again, we define a household's utility as follows:

$$U = U(h, g, f, p) \tag{20}$$

where h is human capital, g is a house and other fixed assets, f is cash and other financial assets, and p is land and other production materials. Our objective is to maximize household utility:

$$\begin{aligned} &max: \quad U = U(h, g, f, p) \\ &s.t. \quad F(h, g, f, p) = w_0 - w_- + w_+ \end{aligned} \tag{21}$$

w_0 is the distribution of original assets, $w\_$ is the asset loss due to illness shocks, and w_+ is public financial assistance.

3.1. Acute illness shocks

Assume that the illness causes a human capital loss of θ (50%), then we have

$$\begin{aligned} h &= (1-\theta)h_0 \\ g &= g_0 \end{aligned} \tag{22}$$

The total household assets become

$$(1-\theta)h_0 + g_0 \tag{23}$$

Under the condition that human capital is recoverable, a household needs to change the allocation of its assets to obtain the maximum utility:

$$max: \quad U = U(h, g) = ah^n g^{1/m}$$
$$s.t. \quad h + g = (1-\theta)h_0 + g_0 \qquad (24)$$

h_0, g_0 are the values for the household's human capital, house and other fixed assets before the shock occurs.

Recall that the original maximization function for a household utility is

$$max: \quad U = U(h, g) = ah^n g^{1/m}$$
$$s.t. \quad h + g = 1 \qquad (25)$$

Considering that a household's portfolio of assets needs to be changed, we have the following maximization equation:

$$max: \quad U = U(h, g) = ah^n g^{1/m}$$
$$s.t. \quad h + g = \frac{1}{mn+1} + \frac{(1-\theta)mn}{mn+1} \qquad (26)$$

Solving for the solution, we have

$$h = \frac{mn}{mn+1}\left(\frac{1}{mn+1} + \frac{(1-\theta)mn}{mn+1}\right)$$
$$g = \frac{1}{mn+1}\left(\frac{1}{mn+1} + \frac{(1-\theta)mn}{mn+1}\right) \qquad (27)$$

Assuming that $n = 2$, $m = 2$, and $\theta = 50\%$, we have

$$h = 0.48$$
$$g = 0.12 \qquad (28)$$

Figure 5 shows the change in the portfolio asset allocation after an acute illness shock occurs. The blue curve indicates the original relationship between household utility and human capital investment; the maximum utility is achieved when investment in human capital accounts for 80% and investment in other assets accounts for 20%. When a household member suffers from an acute illness shock and we assume the loss of human capital to be 50% (i.e., human capital investment accounts for 40%), then the household utility falls off, as shown by the red arrow①. The dotted red curve shows the new relationship between household utility and human capital investment. Apparently, the original asset allocation between human capital and other household assets becomes sub-optimal. Our solution in Eq. (28) indicates that a household needs to increase its investment in human capital to 48% from 40% as a response to illness shocks②. In addition, Figure 5 shows that increasing human capital investment can improve household utility, but household utility can never be restored to its previously observed level. Therefore, public financial assistance such as insurance and medical expense reimbursement is needed to restore a household's utility to its previous level③.

3.2. Cancer and other chronic illness shocks

In this section, we examine the effect of cancer and other chronic illness shocks on a household's portfolio asset allocation. Cancer has been found to be the second-leading cause of death in China behind cardiovascular disease. According to a report by the National Central Cancer Registry of China (NCCRC, 2013), 244,366 incidences of cancer were registered in China in 2009, a crude incidence rate of 285.91 per 100,000 population. The incidence rates for urban and rural areas were 174,418 and 69,948 cases, respectively. There were 154,310 deaths from cancer in China in 2009, a crude mortality rate of 180.54 per 100,000 population. In urban and rural areas, 104,551 and 49,759 people died from cancer, respectively. A cancer epidemic has hit China "after decades of pollution sparked a boom in disease" (Simpson, 2013). Environmental pollution has spawned a string of toxic "cancer villages" in China's rural areas (Simpson, 2013). Although the overall cancer incidence in rural areas is lower than in urban areas, mortality is higher, primarily due to the limited medical resources, low levels of cancer diagnosis and treatment, and a lack of health education in rural areas (NCCRC, 2013). Such severe cancer shocks can cause considerable economic hardship and significant loss of income/welfare for rural households. Therefore, we model a household portfolio asset allocation when facing cancer shocks in this section.

An important difference between acute and chronic illness shocks is that human capital is not recoverable under chronic illness shocks, but is (at least) partially recoverable under acute illness shocks. In addition, cancer and other chronic illnesses are difficult to cure, medical treatment for them is costly, and they can cause considerable economic hardship for rural households. First, assuming that cancer causes a human capital initial loss of θ (25%), we have

$$\begin{aligned} h &= (1-\theta)h_0 \\ g &= g_0 \end{aligned} \tag{29}$$

The total household assets become

$$(1-\theta)h_0 + g_0 \tag{30}$$

Cancer is not curable, so we assume that human capital continuously decays at $(1-\delta)^t$ where $0<\delta<1$ and obtain

$$h = (1-\theta)h_0(1-\delta)^t \tag{31}$$

We assume that other assets are continuously used to cure cancer:

$$g = g_0 - \rho t \tag{32}$$

We further assume there is a certain relationship between δ^t and ρt , as follows:

$$\delta = \frac{1}{\rho + c} \tag{33}$$

To maximize a household utility, we have:

$$\begin{aligned} & max: \quad U = U(\delta,\rho) = ah^n g^{1/m} \\ s.t. \quad & h = (1-\theta)h_0(1-\delta)^t \\ & g = g_0 - \rho t \\ & \delta = \frac{1}{\rho + c} \end{aligned} \tag{34}$$

Alternatively,

$$\begin{aligned} &max: \ U = U(\lambda,\delta) = a[(1-\theta)h_0(1-\delta)^t]^n[g_0-\rho t]^{1/m} \\ &s.t. \quad \delta = \frac{1}{\rho + c} \end{aligned} \tag{35}$$

Plugging $\rho = \frac{1}{\delta} - c$ into the maximization functions yields

$$max: \ U = U(\lambda,\delta) = a[(1-\theta)h_0(1-\delta)^t]^n[g_0 - (\frac{1}{\delta}-c)t]^{1/m} \tag{36}$$

Solving for the first-order partial derivative, we have

$$\begin{aligned} \frac{\partial U}{\partial \delta} &= -an[(1-\theta)(1-\delta)^t h_0]^{n-1} t[(1-\theta)h_0](1-\delta)^{t-1}[g_0-(\frac{1}{\delta}-c)t]^{1/m} \\ &+a[(1-\theta)(1-\delta)^t h_0]^n \frac{1}{m}[g_0-(\frac{1}{\delta}-c)t]^{\frac{1}{m}-1}\frac{t}{\delta^2} = 0 \end{aligned} \tag{37}$$

That is,

$$\begin{aligned} \frac{\partial U}{\partial \delta} &= -an[(1-\theta)(1-\delta)^t h_0]^{n-1} t[(1-\theta)h_0](1-\delta)^{t-1}[g_0-(\frac{1}{\delta}-c)t]^{1/m} \\ &\quad +a[(1-\theta)(1-\delta)^t h_0]^n \frac{1}{m}[g_0-(\frac{1}{\delta}-c)t]^{\frac{1}{m}-1}\frac{t}{\delta^2} \\ &= at[(1-\theta)(1-\delta)^t h_0]^n[g_0-(\frac{1}{\delta}-c)t]^{\frac{1}{m}}\left[-n(1-\delta)^{t-2}+\frac{1}{m\delta^2}[g_0-(\frac{1}{\delta}-c)t]^{-1}\right] \\ &= at[(1-\theta)(1-\delta)^t h_0]^n[g_0-(\frac{1}{\delta}-c)t]^{\frac{1}{m}}\left[-n(1-\delta)^{t-2}+\frac{1}{m\delta^2[g_0-(\frac{1}{\delta}-c)t]}\right] \\ &= 0 \end{aligned} \tag{38}$$

Note that $at[(1-\theta)(1-\delta)^t h_0]^n$ cannot be zero, so we have

$$[g_0-(\frac{1}{\delta}-c)t]^{\frac{1}{m}} = 0 \tag{39}$$

or

$$\left[-n(1-\delta)^{t-2}+\frac{1}{m\delta^2[g_0-(\frac{1}{\delta}-c)t]}\right] = 0$$

If

$$[g_0-(\frac{1}{\delta}-c)t]^{\frac{1}{m}}=0$$

then we have

$$g_0=(\frac{1}{\delta}-c)t \quad (40)$$

Therefore $g_0=\rho t$. This indicates that a household needs to use all of its assets to cure cancer, which is not an optimal decision as a household eventually exhausts its other assets and experiences a complete loss of its human capital.

Now we solve the following equation for the optimal decision:

$$\left[-n(1-\delta)^{t-2}+\frac{1}{m\delta^2[g_0-(\frac{1}{\delta}-c)t]}\right]=0 \quad (41)$$

This is a complicated equation so we consider a special case; that is, the first period after the shock occurs, or $t = 1$.

Assuming n=2, m=2, c=2, and $g_0 = 0.5$ we have

$$\delta=0.5 \quad (42)$$

Given that $\delta=\frac{1}{\rho+c}$, we have $\rho = 0$. This solution indicates that an optimal decision for rural households is to give up treatment in response to cancer shocks. However, when $g_0>0.5$ the treatment should be undertaken; and when $g<0.5$ the treatment should be given up。

The interpretation of this result is that when rural households experience cancer and other chronic illness shocks, the house and other fixed assets exert a constraint on whether medical treatment should be undertaken. Generally, for asset-rich households, the optimal decision is to undertake medical treatment. For asset-poor households, giving up treatment becomes the optimal decision. Therefore, public financial assistance is particularly needed for poor rural households when they experience cancer and other chronic illnesses.

Figure 6 shows the portfolio asset allocation after the cancer shock occurs. The blue curve shows the original relationship between the household utility and human capital investment; that is, the maximum utility is achieved when human capital investment accounts for 80% and other asset investment accounts for 20%. When a household member suffers from cancer and we assume the initial loss of human capital to be 25% (i.e., human capital investment accounts for 60%), then the household utility falls off, as shown by the red arrow①. The dotted red curve shows the new relationship between household utility and human capital investment. The original asset allocation between human capital and other household assets becomes sub-optimal. Our solution above indicates that a household needs to increase its investment in human capital, but as the illness becomes more severe and medical treatment expenses grow, the welfare of the household continues to fall.

When a household suffers from cancer and other chronic illness shocks, it is likely that it will deplete its fixed and financial assets, as well as experiencing a complete loss of human capital. Considering the significant effect of these shocks on human capital and household portfolios, we suggest that public financial assistance should be used for human capital investment, such as providing financial support for the education of the *next* generation in the household②. This will help to minimize the household loss and maximize the benefits of public finance support.

4. Policy implications and conclusions

Human capital represents an important component of a household's portfolio. The health of household members and their ability to recover from severe illness greatly affect human capital, which consequently affects the household's portfolio value and welfare. Unanticipated events, particularly severe illness shocks such as cancer, frequently occur in rural households in

China. Cancer has become the second-leading cause of death in China. Due to the limited medical resources, low levels of cancer diagnosis and treatment, and a lack of health education in rural areas (NCCRC, 2013), the overall cancer mortality rate is higher in rural than in urban areas. Cancer causes considerable economic hardship and a significant loss of income/welfare for rural households.

In this study, we develop a model to examine the optimal asset allocation for Chinese rural households in response to household members' health shocks. Our model is based on Becker's household economics and asset allocation theories (Becker, 1965, 1974, 1975). Our two- and three-asset models both suggest that the maximum utility is derived when households allocate a majority of their assets to human capital. In examining household portfolio changes in response to acute illness shocks, we show that the original asset allocation between human capital and other household assets becomes sub-optimal. A household needs to increase its investment in human capital in response to illness shocks. The optimal decision for asset-rich households is to undertake medical treatment, whereas giving up treatment is the optimal decision for asset-poor households. As it is likely that a household will exhaust its fixed and financial assets and will experience a complete loss of human capital, we suggest that public financial assistance should be used for human capital investment, such as medical expense reimbursement and insurance. One feasible way is to encourage households to use financial assistance to make investment in human capital of the next generation. Overall, our results highlight the important role of human capital in deriving the maximum level of utility for China's rural households when they experience health shocks.

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Figure 1: Two types of marginal utility for household assets

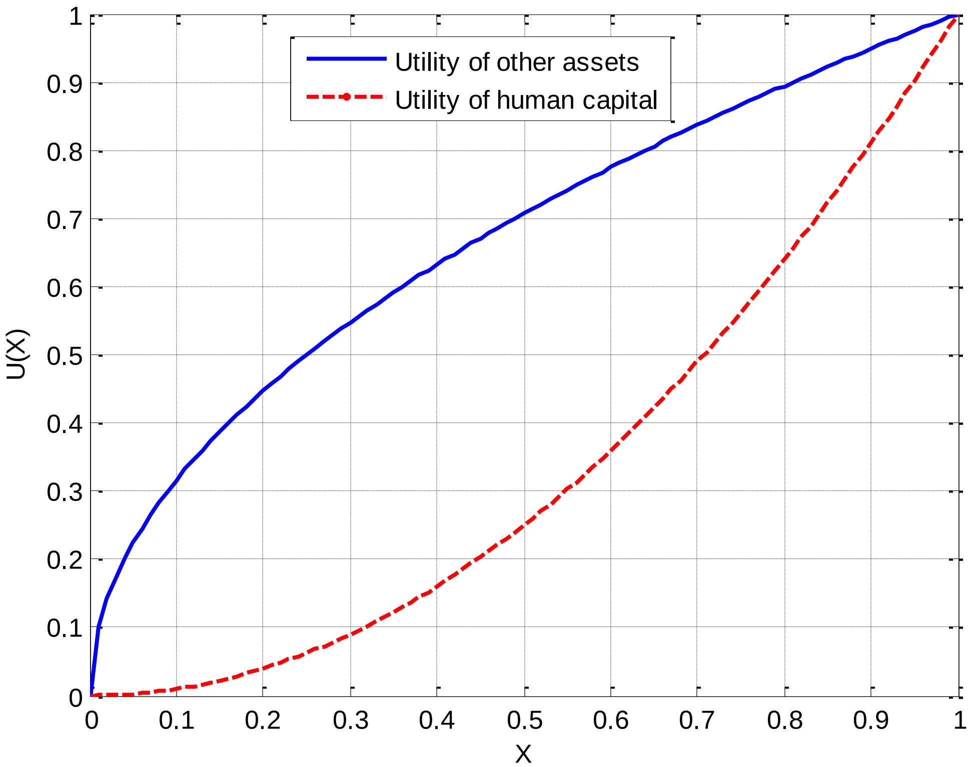


Figure 2: The relationship between household utility and human capital investment

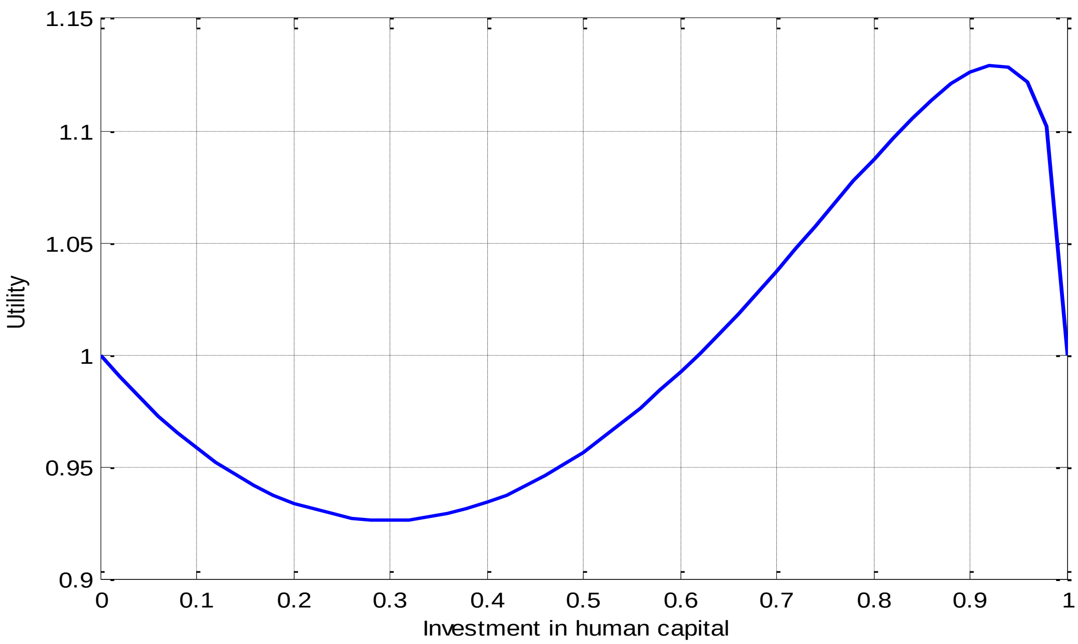


Figure 3: The relationship between household utility and investment in human capital and other assets

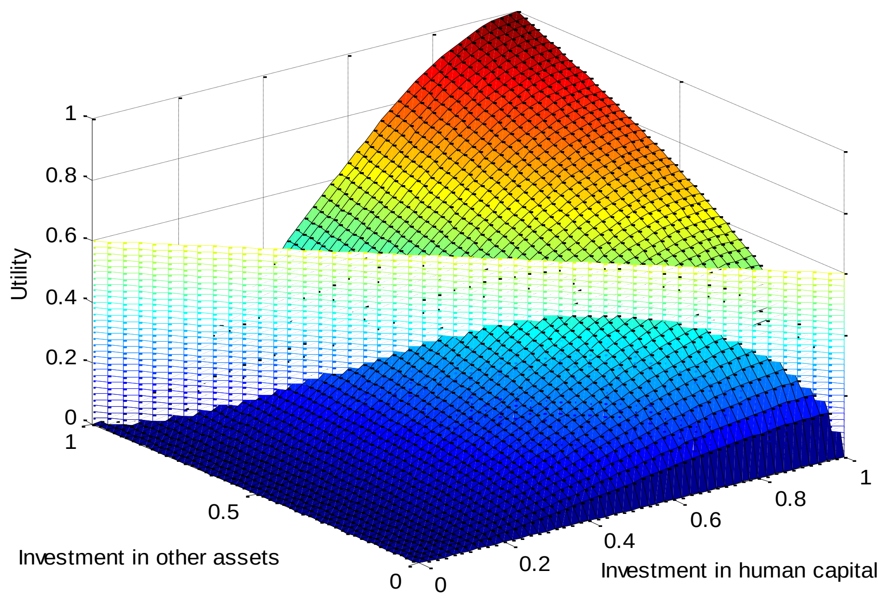


Figure 4: The relationship between household utility and human capital investment

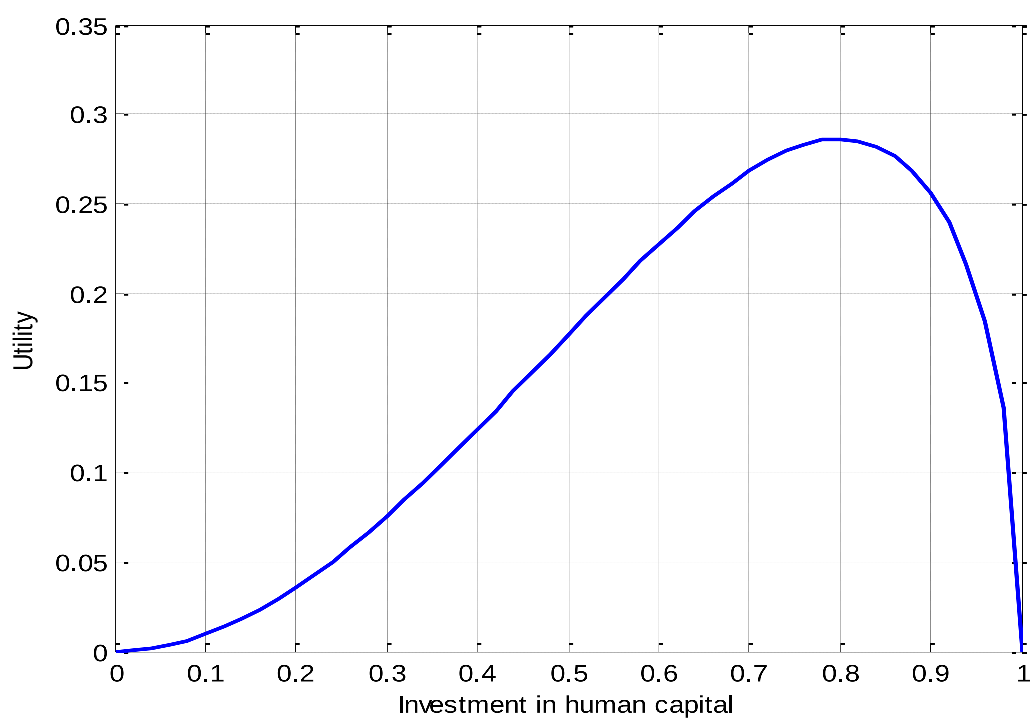
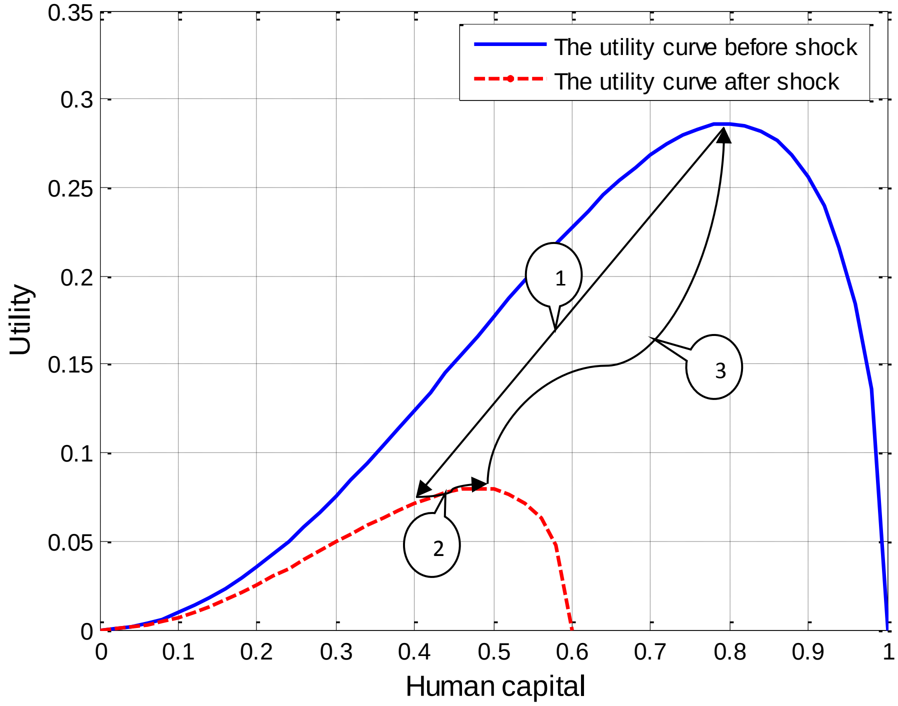


Figure 5: Change in asset allocation when acute illness shocks occur

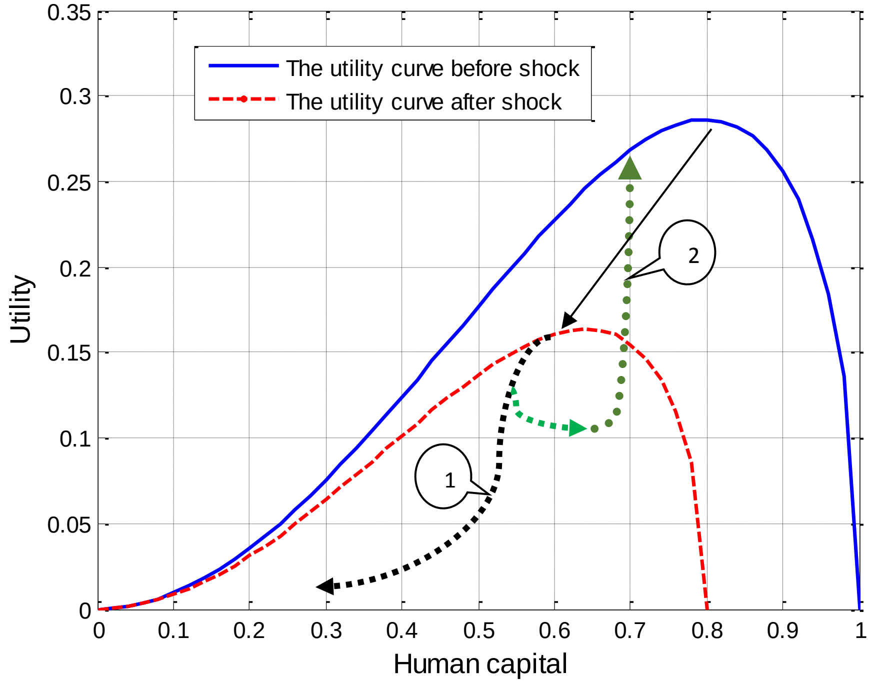


① Acute illness shock path

② Change in household asset allocation path

③ Public financial assistance path

Figure 6: Change in asset allocation when cancer and other chronic illness shocks occur



①Household wealth falls off the path

②Public financial assistance path