Estimating the Stochastic Sickness Effect on Employment, Worktime and Saving Decisions

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This paper aims to study labor supply and saving decisions as a result of health uncertainty. O'Donnell (1995) suggested a theoretical positive relationship between working hours (or saving rate) and the perceived health uncertainty. That is, for risk-averse individuals, there exists a precaution motion to work harder and save more when facing the uncertainty for the health condition. We test this hypothetical relationship by applying the 2003-2005 data from the Panel Study of Family Dynamics (PSFD) in Taiwan. Following Hughes and Maguire's approach (2003), our estimation result indicates that a stochastic sickness has positive effects on the decisions of working time and saving rate.

Keywords: Health; Uncertainty; Labor Supply; Saving

JEL Classification: D14; I12; J22

1. Introduction

The relationship between health condition and consequently working time has long drawn the attention from various disciples of scholarship to seek for an accurate explanation. Numerous speculations, drawn from various disciplines, have sought to explain the relationship between health and labor outcomes consequences such as labor participation, working hours, and wage. Early studies focus on the link between human capital and labor market outcomes. Although Mushkin (1962), Becker (1964) and Fuchs (1966) has pointed out that health capital is one of the key components of human capital[3], the following studies mostly focused only on the effect of education in the labor market and fewer have concerned the health effect to the labor input.

Among all the previous efforts, Grossman (1972a, 1972b) has a significant, ground-breaking contribution in the health economic literature regarding to this issue. Grossman argues that the benefit of investment in health is to increase time available for productive activities. Thus, any effort to improve a person's health condition is expected to yield a positive effect on the quantity of labor supply for this person. In principle, the change of health capital depends on health depreciation due to aging, investments in the health improvement (e.g., preventive medicine) and the decisions of time allocations (e.g., exercise). In Grossman's model, health capital is viewed as

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[3] In his Nobel lecture (1992), Becker assumes individuals make investment decisions of human capital by weighting the benefits and costs based on their education, training, additional knowledge, medical care, and health condition.

an endogenously determined variable that affects the hours of labor input. In reality, the uncertainty over the health condition is a common issue even for the most developed parts of the world. Therefore, can we assume health is endogenous? Regardless the impressive improvement in the modern medical technique for the past century, an explicit degree of uncertainty over human's health condition still exists. Therefore, we are interested in finding out whether people would include this uncertainty over health condition into their labor supply and saving decisions. If so, in what way do people adjust their behaviors due to their perspectives of the uncertainty over health? Few researches of labor economics have taken into account this aspect of uncertainty and none have applied it into empirical studies.

O'Donnell's (1995) have incorporated the impact of stochastic sickness on labor supply and saving decision, while also recognizing that an increase in the degree of uncertainty over sickness time can create a positive effect on labor supply and saving. According to O'Donnell's theoretical model, a risk-aversion individual tends to work harder and save more on a regular base in order to avoid the decrease of future consumption if the unpredicted health problems happen. Although we agree O'Donnell's theoretical model and conclusion, there is no empirical effort in the literature to support his argument. Therefore, the main purpose of this paper is to empirically investigate whether health uncertainty affects people's hours of work and saving behaviors. We adopt O'Donnell's argument and presume each individual make the ex ante decisions to allocate working hours and the amount of savings based on his forecast of future health status. We also assume health status is randomly distributed with a known probability density function. Under the assumption that the distribution of perceived future health is a function of previous health condition with one and two time lag, we assume the uncertainty of sickness is captured by employing a residual estimate of forecast health model.

This paper is organized as follows. Section 2 describes the empirical framework regarding the estimated function of the uncertainty for sickness. The estimated uncertainty is then incorporated into our labor supply and saving models to examine whether stochastic sickness affects the decisions of labor supply and saving. Section 3 outlines data source and variables used in the empirical investigation. Section 4 presents and explains our empirical results. Finally, Section 5 concludes our study and provides policy implication.

2. Theoretical framework and empirical specification

We will construct the labor supply and saving function for individuals who face stochastic bad health conditions in this section. While there has been a great deal of empirical attention devoted to the effect of health on various labor outcome consequences such as labor force participation and earnings (e.g., Luft, 1972; Bartel and Taubman, 1979; Dwyer, and Mitchell, 1999; Pelkowski and Berger, 2004), there are relatively few empirical efforts can be found on the relationship between health condition and hours of work (e.g., Haveman et al., 1989; Pelkowski and Berger, 2004). Existing empirical studies mostly treat health status as known to the individuals so to omit health uncertainty from the model building process. Therefore, we distinguish our study by including health uncertainty consideration into our labor supply and saving decision functions. To accomplish this goal, the model building process is constructed by two steps.

The first step is to model people's conceptual uncertainty of future health condition. We adopt O'Donnell's model (O'Donnell 1995) and assume any unforeseen sickness time is considered at the expense of consumption from the loss of salary. For a risk-averse agent, uncertainty over sickness provides a precaution motivation to decide the amount of saving and hours of work. Therefore, saving and labor supply behaviors are predicted to rise when facing a greater uncertainty of future health condition.

We adopt Hughes and McGuire's approach (2003) to model the function of conceptual uncertainty over sickness. Considering that hospitals face an uncertain demand environment, Hughes and McGuire assumes the distribution of demand for the hospital impatience service is conditional on realizations of previous periods. Following their methodology, we employ a simple estimating function indicating the current exception of bad health is related to prior bad health experience as shown in equation (1):[4]

$$BadHealth_t = \alpha_0 + \alpha_1 BadHeath_{t-1} + \alpha_2 BadHealth_{t-2} + a_3 X + \varepsilon \quad (1)$$

where $BadHealth$ is a self evaluated health status ranging 1 to 5; t indicates time period. Vector X contains selected demographic variables including gender, age, education, and region of residence.

The squared value of residual from Equation (1) is used as a proxy for health uncertainty (denotes $StochasticSickness$) for modeling labor supply and saving decision for the next step.[5] The bad health is estimated by two lagged bad health and personal characteristics. The next step is to incorporate the information generated from equation (1) to our labor supply and saving decision functions.

Given Emp is a dummy variable indicating the decision to participle in the labor market, the participation decision is a latent regression function as shown in equation

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[4] In Eqn. (1), bad health is treated as a continuous dependent variable. We conducted an ordered Probit model by treating bad health as a categorical dependent variable, but the model failed to reach convergence in estimation well.

[5] Hughes and McGuire (2003) use the residual from the forecast demand equation as the unpredicted demand indicator. However, we argue the magnitude of uncertainty should not be affected by the sign of the residual based on the theoretical specification. Instead, this study employs the squared value of the residual.

(2):

$$Emp^* = \beta_0 + \beta_1 BadHealth_{t-1} + \beta_2 StochasticSickenss + \beta_3 X_1 + V \qquad (2)$$

where X_1 contains a set of exogenous variables that we assume would affect the decision to participate in labor market such as gender, age, education, martial status, and number of children.

Labor supply theory states that workers make the optimal hours of work decision by comparing the marginal rate of substitution between leisure and work (so as the consumption) to the wage rate (Borjas 2005). A rational individual will only participate in labor market if the marginal rate of substitution is bigger than the wage rate. To be specific, we assume

$Emp = 1$ (in labor force) if $Emp^* > 0$

$Emp = 0$ (not in labor force) if $Emp^* \leq 0$

Therefore, if $Emp_i = 1$, then the function of hours-of-work is estimated as:

$$WorkTime_t = \gamma_0 + \gamma_1 BadHealth_{t-1} + \gamma_2 StochasticSickness_t + \gamma_3 E_t + u \qquad (3)$$

Where $WorkTime$ is weekly work hours; E_t contains a set of exogenous variables controlling workers characteristics such as gender, age, education, martial status, number of children and job factors. The health variable is given one period time lag to reflect the dependence of labor market outcomes on the prior health status as suggested by Luft (1971), Grossman and Benham (1974), Bartel and Taubman (1979) and Haveman (1989). Considering the correlation (ρ) between the error terms of equations (2) and (3), Heckman's two-step method (1979) is employed to carry out the estimates of the labor market models. Basically, the existence of the correlation in the error terms between equation (2) and (3) suggests that these two equations should be evaluated together as a simultaneous equation model. However, if ρ is zero, we can just use single equation approaches to estimate equations (2) and (3).

Let $Save$ be yearly saving rate[6], the saving function is written as:

$$Save_t = \alpha_0 + \alpha_1 BadHealth_{t-1} + \alpha_2 StochasticSickness_t + \alpha_3 E_t + e \qquad (4)$$

Based on O'Donnell's prediction (1995), the coefficients for $StochasticSickmess$ in equations (3) and (4) are expected to be positive and statistically significant. However, there is no theoretical prediction in O'Donnell 's paper regarding the effect of stochastic sickness on labor participation due to the fact

[6] If a specific respondent is unmarried, we calculate save rate by dividing this person's saving over personal income in the previous year. For married respondents, save rate is calculated by the couple's total saving over total income in the previous year.

that O'Donnell's effort is focused on deriving the interior solution of hours of work only.

3. Data and Variables

The data for this study is adopted from the Panel Study of Family Dynamics 2003-2005 (PSFD). The mission for the PSFD is to provide researchers detail information to study the socio-economic issues such as economic, social, psychological structures and custom evolution in Taiwan. The key reason we select PSFD data in this study is because PSFD is the only panel data available in Taiwan that provides self-evaluated health condition across different time periods. The PSFD comprises multi-year panel survey starting from 1999 but questionnaires are not identical over the years. The survey has been conducted yearly since 1999. In years of 1999, 2000, 2003, and 2004, a new sample age cohort was added, in addition to the previous included cohorts. Once a specific interviewee is included in the survey, PSFD will update this respondent's information whenever a new survey is conducted. Table 1 shows the year and age cohorts for the PSFD. (Table 1: The Year and Age Cohorts of the PSFD

Survey Period	Conduction Year	Age Cohorts Included
1	1999	1953-1964
2	2000	1935-1954, 1953-1964
5	2003	1935-1954, 1953-1964, 1964-1976.
7	2004	1935-1954, 1953-1964, 1964-1976, 1976-1979

Our research focuses on the 2005 data while 2003 and 2004 are used to estimate 2005 health indictor. The 2005 PSFD sample contains four cohorts (age groups) of respondents who were born in 1935-1954, 1953-1964, 1964-1976 and 1976-1979.[7] However, the age cohort 1976-1979 is not included in our study because the lack of time-lag data for our study purpose. The 2005 PSFD sample contains four cohorts (age groups) of respondents who were born in 1935-1954, 1953-1964, 1964-1976 and 1976-1979.

The completed data included in this paper contains 2389 out of total 3319 observations. It is noted that 635 observations choose not to respond to the question regarding the saving rate. We create a dummy variable "$Not\_response$" to indicate this fact and assign the value of zero for these observations.[8] All variables included in our model are listed and defined in Table 2. The descriptive statistics of these variables are shown in table 3.

[7] The questionnaire, and the detail of the survey are available at http://psfd.sinica.edu.tw/check.htm

[8] I also attempt to delete non-response observations and reconstruct the completed data without missing value. The estimated results for saving decision model are virtually unchanged.

The corresponding means of self-evaluated health condition ($BadHealth$) from 2003 to 2005 are 2.39, 2.53, and 2.62. The decrease in numbers as the year goes on implies that the health status deteriorates as an individual ages. Moreover, our sample observations are mostly married, middle-aged and elder adults due to the fact that PSFD only records the heads of selected households. The education level for our sample is relatively low because Taiwan's education reform that provides subsidies to citizens for the access to cheap junior high school education (equivalent to lower secondary education) did not start before 1968. Furthermore, Taiwan's government education policy did not emphasize on increasing the number of higher education before 1988. Therefore, most of our samples were too old to enjoy the benefit of education reform. On the other hand, as the main household financial supporter, the rate of labor force participation respondents in our sample, 0.6784, is pretty high. By contrast, the ratio of self-employed workers is only 0.0127.

Table 2 Variable definition

Variable definition	
Dependent Variables	
WorkTime	Weekly hours of work
Save	Yearly saving rate If respondent is unmarried, Save is measured by personal saving rate If respondent is married, Save is measured by couples' saving rate
Demographic Characteristics	
Age	Age
Male	Gender of the respondent Male =1 if male; Male=0 otherwise
Married	Marital status Married =1 if married Married =0 if single, divorced, or widowed
High School	Whether the respondent has at least a high school degree High school=1 if yes, and High school=0 if no
College	Whether the respondent has at least a college degree College=1 if yes, and College=0 if no
North	Whether the respondent lives in northern Taiwan North=1 if yes, and North=0 if No
South	Whether the respondent lives in southern Taiwan South=1 if yes, and South=0 if No
East	Whether the respondent lives in eastern Taiwan East=1 if yes, and East=0 if No
Central	Whether the respondent lives in central Taiwan Central=1 if yes, and Central=0 if No
Child	Number of children
Job Characteristics	
Self Employed	Whether a respondent is self-employed Self Employed =1 if yes; Self Employed=0 otherwise
Wage	Hourly Wage Rate
Employment	Whether or not the respondent is employed Employment =1 if yes; Employment=0 otherwise

Health Variables	
Bad health	A respondent's self evaluated health status. Possible answers are: Bad health=1 if very good; Bad health=2 if good; Bad health=3 if just ok Bad health=4 if not very good; Bad health=5 if very poor

Table 3 Descriptive statistics

	Mean	S.D.
Dependent Variables		
WorkTime	32.2071	27.5115
Save	0.1143	0.3542
Demographic Characteristics		
Age	50.4060	11.7050
Male	0.4965	
Married	0.9791	
High School	0.4711	
College	0.1135	
North	0.4109	
Central	0.2294	
South	0.3089	
East	0.0508	
Child	2.4713	1.4713
Job Characteristics		
Wage	142.7799	231.7016
Employment	0.6784	

Self Employed	0.0127	
Health Variables		
Bad Health (2005)	2.6223	0.9170
Bad Health (2004)	2.5326	0.9683
Bad Health (2003)	2.3933	0.9836
Number of Observations	2389	

4. Results

Our estimated results are reported in Tables 4 and 5. Before examining the effect of perceived stochastic sickness on the working hours and saving decisions, the health forecast result from equation (1) is examined first. Prior health variables have a significant and positive effect on current health. Moreover, gender, age, education, and the region of residence affect health status. The F-statistics of 130.08 implies a well-fitted forecasting model in our case. The estimate values are listed in Appendix 1.

Table 4 shows that the inverse Mill's ratio is statistically significant, which implies the existence of sample selection bias in Equation (3). Our result from the correlation coefficient, ρ , in the simultaneous equation system also suggests that the decision of labor participation is related to the decision of hours of work. Therefore, Heckman's two-step approach is an appropriate estimated method for labor market outcomes regarding labor force participation and hours of work.

The result shown in Tables 4 indicates that stochastic sickness noticeably affects the labor market consequences. As expected, the coefficients on $StochasicSickness$ are significant and positive in the both equations (2) and (3), which coincides with O'Donnell's argument (1995) stating that a higher uncertainty over sickness leads to more working hours. However, our data also indicates that stochastic sickness has a significant but negative effect on the labor force participation decision. This implies the fact that although the uncertainty over the health condition discourages people from participating labor market, for those who still manage to participate in the labor market will put more working hours for the reason of future consumption.

Our study result points out what O'Donnell is missing when the concern is switched to those workers whose uncertainty of health condition is so high that they simply just cannot participate or refuse to join the labor force. The characteristics of those workers deserve when developing any government program aims to stabilize labor market and reduce social welfare problems.

The estimated coefficients of *BadHealth* are significant in the working hours model but not in the saving decision model. The coefficient value for the labor participation is negative as expected because the capability of work usually decreases as the health condition gets worsen. However, our study result also shows a positive relationship between hours of work and bad health. One possible explanation is that bad health condition may have a dominate effect on encouraging workers to increase hours of work, due to a less cautious attitude toward the potentially harmful effect on working overtime.[9] We also suspect maybe there exits some hidden relationship between the health condition and length of working hour in Taiwan's job market.

The effects of demographics of respondents are not consistent between the decisions of labor participation and hours of work. For example, gender, age, and martial status are apparently important to explain labor force participation but not worktime. These coefficient values of these variables seem to indicate that being a younger, married male in Taiwan tends to create a higher willingness to participate the labor market. This finding leads us to the unique relationship between wage and hours of work in our data. Our data indicates that higher wage actually reduces working time in Taiwan's labor market, which implies that income effect dominates substitute effect in the trade-off between hours of work and leisure time, according to Neo-Classical labor theory. Does this result imply Taiwanese prefer leisure over extra income? A possible explanation may come from Taiwan's constantly long hours of work in the labor market. Because Taiwan's average working hour has already been one of the longest in the world, we suspect majority of Taiwanese may already reach their upper physical limitations that substitute effect cannot affect the hour input decision anymore. On the other hand, Taiwan does not have a well-developed regulation to prevent employers from forcing employees to work over time, especially for those low-paid and low-skilled industries. We suspect that higher wages are available only in better working environment or relatively high-skilled industries, which labor efficiency is higher. Because available data in Taiwan cannot provide enough information to explain the dominated income effect, we believe the institutional approach should be included in the future to search for socio-economic reasons behind the statistic data.

We also find that having a college degree exhibits a positive effect on the decision to participate in labor market but has a negative effect on hours of work. This

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[9] According to the 2003 World Competitiveness Report issued by the IMD in Switzerland, an average Taiwanese worker worked 2282 hours per year, which raked on the topic of the world.

result supports the argument of human capital theory: education enhances productivity, so educated people have competitive advantage in the labor market. Moreover, empirical evidence suggests that self-employed status is commonly related with freely allocated work hours, and hours in the insufficient norm.

The evidence in table 5 supports our hypothesis that stochastic sickness has a positive and significant effect on the decision of saving. That is, the rate of saving will increase as a response to the higher uncertainty over health condition. On the other hand, a negative coefficient (although not significant) value of *BadHealth* in the saving equation (4) may result from the fact that Taiwan has the National Health Insurance (NNI) system that reduces the necessity to save for the sake of bad health [10]. The demographic variables in equation (4) also show an interesting pattern. We find that age and education exhibit positive relationship with the saving rate. It is likely that older and better-educated people have a stronger tendency to save. The number of children, as an indication for the necessary, inevitable household consumption, has a negative effect on saving. This also implies the fact that traditional Chinese culture expects children to financially take care of their parents once their parents' health conditions prevent them from working. Household residing in northern or southern Taiwan save less than those who live in the other parts of Taiwan, this is due to the fact that the most modern and westernized cities are located in these two areas.

5. Conclusion

In this paper, we have investigated the relationship between the uncertainty over health condition and the decisions of labor supply and saving. We derived labor supply and saving functions and estimated the parameter values to analyze this relationship by applying the survey data from the Panel Study of Family Dynamics for the years 2003-2005. We conclude that stochastic sickness has a positive effect on the hours of work and saving rate.

Our empirical study result confirms the hypothesis that the prospect of future ill-health actually has significant effect on the people when deciding on their hours of working. Moreover, such uncertainty over future health condition is also associated with macroeconomic activities through saving behavior. An understanding of stochastic sickness effects thus has important policy implication in evaluating cost and effectiveness of public health programs. For example, preventive medical programs such as free screening for some preventable illness, free flu shot, etc, not only can improve citizens' health conditions but also would be a useful mechanism to

[10] Taiwan's National Health Insurance (NNI) system started in 1995 and the percentage of the population covered by the health insurance has increased significantly from 50% in 1995 to nearly 98% in 2007. Moreover, more than 95% of medical care providers were contacted with the National Insurance Bureau.

reduce the uncertainty over health condition. Traditional policy analyses put attention mostly on the direct effect of improving physical condition for the citizens. Our paper points out that if policymakers ignore the impacts of stochastic sickness, the uncertainty over health condition, on people's working and saving decisions, some biases over cost and benefit may be expected when the governments try to evaluate and weight different social welfare programs. Accordingly, we recommend policymakers divert more resources to create efficient preventive medical programs. A more stable labor market and less precaution savings, as a consequence of a better social preventive health programs, can definitely create positive multiple effects for the whole society.

For those who have very high uncertainty over health and bad current health condition at the same time, we suspect they soon will be unable to continue working. Our empirical result also suggests that there may be a specific amount of workers in Taiwan whose deteriorating health condition forces them to put more hours at work, which can accelerate the process of deterioration in health. We urge policy makers to recognize the need of these workers and develop a well-designed social welfare system to protect their physical and financial risk after they lose the capability to work.

Taiwan's labor market system and social welfare programs are both in their early stages to find the optimal path for the sustainable future. Its nature of combining of traditional Asian and modern Western culture also resembles numerable emerging eastern Asian economies that we believe our finding in Taiwan's case would be contributive to not only Taiwan but other similar economies in the world.

Table 4 The Heckman two-step estimates for labor supply model

Dependent Variable	Labor force Participation	Hours of Work
Intercept	-0.0779	60.3830
	(8.48)***	(12.8)***
BadHealth	-0.0502	1.2639
	(-1.64)***	(2.42)**
StochasticSickness	-0.0779	1.3236
	(-2.35)**	(2.03)**
Wage	-	-0.0210
		(-10.44)***
Male	0.6987	2.2609
	(11.42)***	(1.14)
Age	-0.0521	-0.0756
	(-14.71)***	(-0.54)
Married	0.5188	-4.7191
	(2.42)**	(-1.26)
High School	0.2144	-1.1414
	(2.82)***	(-0.8)

College	0.2950	-2.6956
	(2.39)**	(-1.68)*
Child	0.0066	0.4440
	(0.27)	(1)
Self Employed	-	-6.5163
		(-1.66)*
Inverse Mill's Ratio	-12.831	
	(-2.18)**	
ρ	-0.6298	

***significant at 1% confidence level; **significance at 5 % confidence level; *significant level at 10%

Table 5 The estimates from the saving model

Dependent Variable	Save	
	Coefficients	t statistics
Intercept	0.0604	(1.33)
BadHealth	-0.0059	(-0.9)
StochasticSickness	0.0133	(1.8)*
Wage	0.0000	(0.59)
Age	0.0017	(2.27)**
Married	-0.0618	(-1.43)
High School	0.0435	(2.67)***
College	0.0623	(2.86)***
Child	-0.0168	(-3.15)***
Employment	0.0105	(0.55)
North	-0.0299	(-1.84)*
South	-0.0535	(-3.11)***
East	-0.0301	(-0.99)
Not_response	-0.0870	(-4.53)***
R Squared	0.0535	
F test	11.18 (P value<0.01)	

***significant at 1% confidence level; **significance at 5 % confidence level; *significant level at 10%

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Appendix 1: The estimate result of forecasting health condition

Dependent Variable	BadHealth (2005)
Intercept	1.2703
	(12.294)***
BadHealth (2003)	0.1888
	(10.353)***
BadHealth (2004)	0.3588
	(19.819)***
Male	-0.0644
	(-2.078)**
Age	0.0028
	(1.726)*
High School	-0.1351
	(-3.4)***
College	-0.0633
	(-1.213)
North	-0.1180
	(-2.943)***
South	0.0304

	(0.712)
East	-0.1221
	(-1.613)
R Squared	0.3250
F test	130.0800

***significant at 1% confidence level; **significance at 5 % confidence level; *significant level at 10%