Private Health Insurance Demand in China: Considering the Nonlinear Impact of Income

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Abstract

Against the background of fast economic growth during the past decades, the demand for private health insurance (PHI) is of particular interest for both private insurance sector and public policy makers in China. According to the previous literature, the nonlinear relationship between income and PHI demand might exist. The threshold effect of disposable income on PHI demand is tested with data from 30 provinces in China employing Panel Smooth Transition Regression (PSTR) model. Empirical results show that the sample data is found to scatter within two distinctive demand regimes with smooth switching process. The significant determinants for PHI demand change accordingly in different regime. Our research results imply that, when trying to promote the PHI in various regions, the governments and the insurance firms should take different strategies and policies.

Keywords: Threshold effect; Disposable income; Private health insurance demand; Panel Smooth Transition Regression

JEL Classifications: G15, I11, C23

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1. Introduction

Health is the most important asset of human. Poor health not only affects people's well-being, but lowers the productivity of labor and adversely affects the entire economy. It is commonly recognized that financial capability is the key determinant for utilization of health services. To ease the burden of possible catastrophic medical bills and promote the utilization of health services, most nations across the world set up tax-financed public health insurance plans. At the same time, private health insurance (PHI) is also an alternative or complement to public health insurance plans and helps to finance the medical expenses to various degree. With PHI coverage, healthcare services is more accessible for the people insured and households can be shielded against impoverishment due to catastrophic health care expenditures (Asfaw and Jütting, 2007). Though private health insurance can be employed to strengthen the insured's financial capability, the decision of purchasing private health insurance may be constrained by the policyholder's income, and other factors as well. As is discovered in some literature, the demand for PHI may vary at different income level. This paper aims to probe the nonlinear relationship, if any, between PHI demand and individual income in China and depict a better image of PHI demand. Understanding the demand for PHI in China is of great interest because Chinese governments have being trying to promote involvement of PHI into health care financing since its marketization process from 1978.

This article will unfold as following: Section II briefly introduce the development of public/PHI in China; Section III presents literature review; Section IV describes the design of research and the Panel Smooth Transition Regression (PSTR) model employed in this study; Section V presents the data and shows empirical results; Section VI discusses economic and policy implications; Section VII concludes the study.

2. Health Insurance Development in China

There are three major public insurance plans in China at present, i.e. the Urban Employee Basic Medical Insurance (UEBMI), the New Rural Cooperative Medical Scheme (NCMS), and the Urban Resident Basic Medical Insurance (URBMI), launched in 1998, 2003, and 2007, respectively, covering over 95% of the entire population in China. However, there are still many people not enrolled in any of the public health insurance plans, more are not fully covered against devastating medical bills. Some of these people resort to private insurance for better health risk management. PHI has been seen a rapid development for the past decade due to imperfect coverage provided through public health insurance plans. Among others, there are three main drives.

First, migrant workers from rural area to big cities may lost public insurance protection due to the non-portability of the public health insurance, thus purchasing PHI is their priority to reimburse the medical expenses. The public health insurance system itself have been fragmented rather than integrated up to now, aforementioned three public insurance plans are designed according to the permanent residence registration system ("Hukou" system) and/or the person's employment status and are supposed to target different populations. According to current administrative regulations, health services received out of the local area where the insured is registered are possibly not reimbursed by local public insurance plans. However, with the rapid progress of urbanization, more and more rural residents rush into the big cities, who will later find that they become uninsured at new places. PHI will help them to alleviate the burden of medical expenses.

Second, even though the enrollees can get reimbursement from the public health insurance plans, due to coinsurance rates and other factors, the out-of-pocket payments (OOPs) may still be enormous and beyond their financial capability. UEBMI and NCMS reimburse both outpatient and inpatient care, whereas URBMI mainly provides reimbursement for inpatient care (Yip *et al.*, 2012). The reimbursement rates for inpatient care reached 50.1%, 53.6% and 68.8%, respectively, for NCMS, URBMI and UEBMI in 2013 (Center for Health Statistics and Information, 2013), rest part of the medical cost is on the insured. Moreover, preventive care services and certain high-cost medical services are not reimbursed through any of these three public insurance schemes (Ramesh *et al.*, 2014). Thus precautionary savings or other financial risk transfer tools, like PHI, are needed by many public health insurance enrollees.

Third, with the improvement of medical treatment quality (usually means higher costs), as well as the personal demand for better health condition, the total expenditure on medical and healthcare has been seen to soar in the past decades, given the structure of sharing the medical expenses, individual's OOPs would grow substantially, PHI could be utilized to ease the financial burden for the individual.

PHI plays an increasingly critical role to fill the coverage gap and meet various health care needs of the population in China. In 2009, along with a national healthcare system reform, the Chinese governments encouraged the private insurance companies to provide various insurance products, especially for the elderly, disabled and those with catastrophic diseases, and individuals are also encouraged to purchase these insurance products. There are more than 100 private insurers offering over 1500 health insurance products in 2016. The premium of PHI had increased from 3.6 billion to 404.2 billion RMB, and its share of the total health care expenditures also increased from 0.9% to 9.6% during 1999-2016. PHI is available in both rural and urban China, targeting mainly the high-income population.

With the rise of swelling middle class with stronger consuming capability, PHI will be demanded even more. Besides, the philosophy of nation governance has changed dramatically for central government of China these years, not only the individuals are encouraged to buy PHI by offering tax exemption and other favors, but the public-private cooperation in insurance sector is strengthened so that government can transfer the surplus risk to or take the advantages of better services from the private insurance companies. Hence the development of PHI is no longer negligible and deserve in-depth observation. This paper focuses on the impact of individual income growth on the PHI given that income growth is the direct results of rapid economic growth in China in the past decades and the rise of income level has comprehensive impacts on PHI demand and other economic and social variables related to health insurance demand.

3. Literature Review

Cost of health services is identified to increase faster when income grows (Schieber, 1990; Gerdtham *et al.*, 1992; Getzen and Poullier, 1992; Getzen, 2000). Along with the soaring total healthcare expenditure, the out-of-pocket expenditure on healthcare also grow fast, which already results in serious social and economic consequences across the world, especially in developing countries. It is found that the growing out-of-pocket expenditure on healthcare has led to 24% of all hospitalized Indians falling below the poverty line as a result of these costs (Ahuja, 2004). In China, the beneficial effect of public health insurance weakens over time due to increases in the coinsurance rates of public health insurances, the poorer are less beneficial from the public insurance program and are still exposed to various health risks (Jung and Streeter, 2015). PHI is usually employed as a vital complement to public health insurance plans to alleviate the devastating financial burden caused by critical illness. However, due to different institutional and economic circumstances, PHI demand may have particular determinants for each specific country.

Following Arrow (1963), many literature hold that demand factors of health insurance include consumers' disposable income, price of health insurance products, fiscal and taxation policies, risk attitude, social medical and health conditions, etc. (Gertler and Sturm, 1997; Holmer, 1984; Liljas, 1998; Manning and Marquis, 1996; Short and Taylor, 1989; Strombom *et al.*, 2002; Thomasson, 2003; Gruber, 2005; Wang, 2009; Dekker and Wilms, 2010; Bardey *et al.*, 2016). Willcox (1991) suggests that three main considerations in the decision-making process about PHI are health status, cost and inadequacy of the public health insurance coverage.

Among the previous studies, some researchers notice the nonlinear relationship between insurance demand and income and other determinants as well. Enz (2000) identifies the demand for insurance become less sensitive to the growth of income when income level is higher, and the relationship between demand for insurance and income takes on a 'S' shape. Zheng *et al.*, (2008) use macro data of 95 countries and find a 'S' curve relationship existing for insurance development and economic growth. Truett and Truett (1990) find that income elasticity of demand for life insurance differ for low- and high-income populations. Anderson and Nevin (1975) find that middle-income couples show weaker demand for life insurance than low- and high-income couples. Hammond *et al.*, (1967) discover that the income elasticity of insurance demand for middle-income people is much higher than that of low- and high-income group.

However, to our limited knowledge, research has never been conducted particularly on the nonlinear impact of the determinants on the demand for PHI up to date. This study aims to investigate the nonlinear impact of disposable income on demand for PHI in China by employing the method of Panel Smooth Transition Regression (PSTR) developed by González *et al.* (2005).

4. Design of Research and Methodology

In our study, PHI premiums per capita (health insurance density, HID) is set as the dependent variable, the explanatory variables are selected social-economic determinants, including disposable income per capita (DIS), urbanization rate (URB), social security expenditure per capita (SSE), dependency ratio (DER), out-of-pocket medical expense per capita (MCE), and education level (EDU). Thus a basic model is constructed as:

$$\mathrm{HID}_{it} = \mu_i + \beta_0 X_{it} + \varepsilon_{it}, \quad (1)$$

where HID_{it} is a scalar, X_{it} is a K-dimension vector, X_{it} = (DIS, URB, SSE, DER, MCE, EDU), β_0 is the coefficient vector, μ_i represents the fixed individual effect and ε_{it} are the errors.

The independent variables are carefully chosen, related previous studies are referred to, more importantly, it is based on a behavior model as Figure 1. As is shown in Figure 1, we use annual medical expenses per capita to proxy for the burden of medical cost of the residents, and urbanization ratio to proxy for the frequency of possible losses. We believe the occurred medical expenses can make the patients more aware of how much is needed to pay for an accident or illness, thus motivate them to buy insurance. Meanwhile, as some literature indicate, urbanization progress usually goes with increasing accidents and more serious health problems which resulted from deteriorating air quality, more accidental injuries, etc. and contribute to higher demand for medical services. When a health expenditure occur, it assumes an outflow of wealth for the patient and his/her family. There are several channels for the patient to cover the expenses. Typically, public health insurance, if any, will cover part of the expenses, and there will be out-of-pocket payment. Income is another source to financing the medical bill. During this process, PHI can be utilized to fill the budget gap, as long as the patient is insured. Even though the material need for extra PHI exist, the purchasing decision may still be affected by some other factors. One of them is dependent ratio which reflects the future financial obligation the prospective insured has, another one is education level which is usually used to proxy for the awareness of risk and insurance. Detailed introduction about the variables used in our model is as follows.

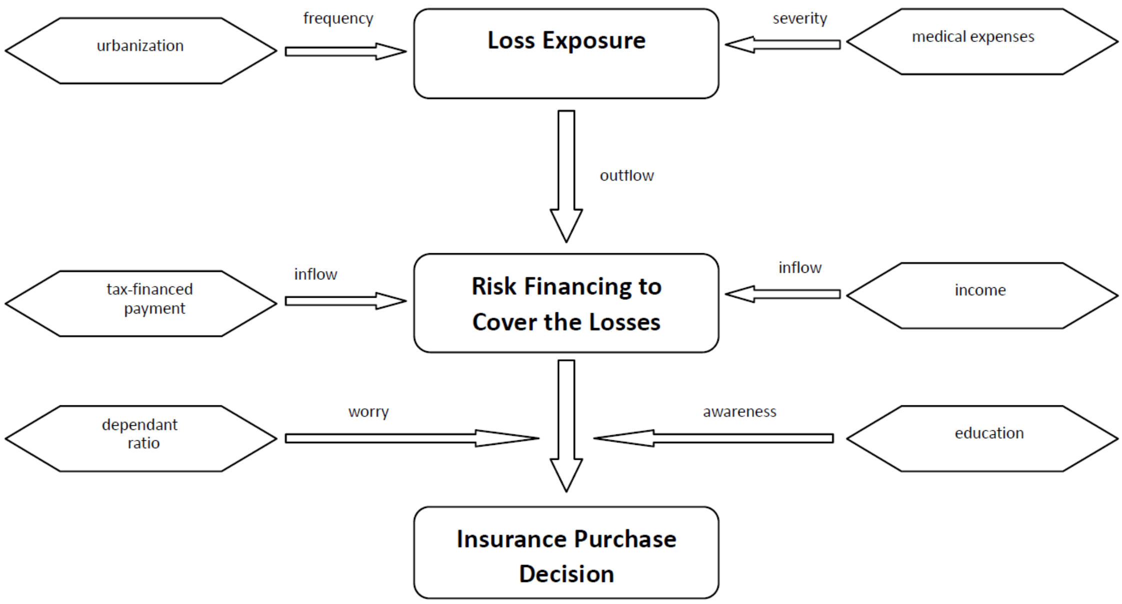

Figure 1: Factors Affecting the PHI Purchase Decision

4.1 Private Health Insurance Premiums

Premiums are used to proxy for the demand for PHI in this study as many literature do. During the past decade, with the increasingly intense competition in urban areas, more and more private health insurers extended their business to vast rural areas, making PHI more available to the people all around the country, thus premiums are appropriate to represent the effective demand for PHI.

4.2 Disposable Income

Income is a core variable in PHI demand models. Most literature studying the relationship between PHI demand and income generally find that income growth is positively correlated to insurance demand (e.g. Dushi and Honig, 2003; Hofter, 2006). However, we note that insurance is not the only source to finance the losses, other techniques like risk retention (self-insurance), by which losses are reimbursed with self-owned capital or income, are not rare to see in the real world. When income grows, people may face the tradeoff between transferring the risk to insurers with a sacrifice of expense loading in insurance premium and retaining the risk to him/herself, sometimes risk retention is more attractive as the losses can be indemnified with the attained (or prospective) income and the loading incorporated in the premiums is avoided. Thus the aggregate effect of disposable income on PHI demand is not obvious to us, it is interesting to examine whether the impact of income on PHI undergoes structural change(s).

Empirically, we identify that nonlinear relationship between PHI demand and disposable income level may exist according to the scatter plot (Figure 2). In Figure 2 the PHI accelerates when average disposable income level increases for the sample provinces.

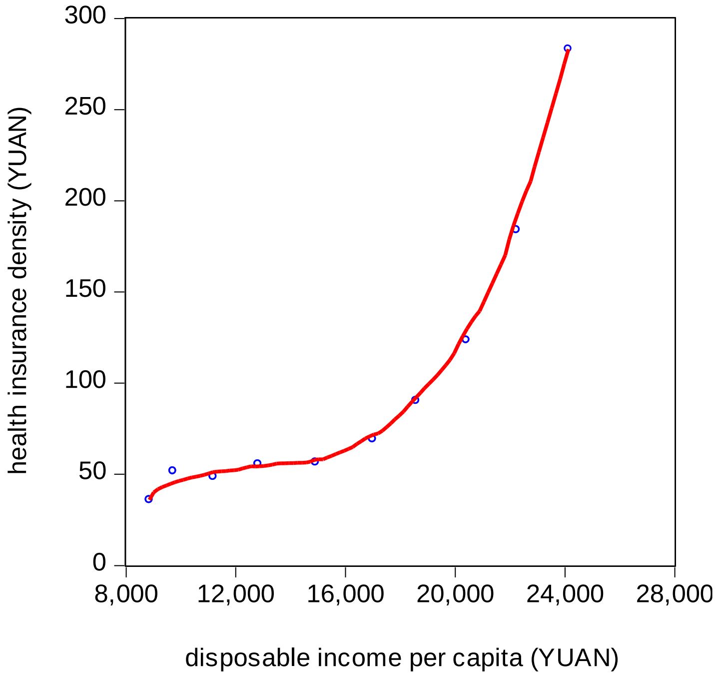

Figure 2: Scatter Plot of Health Insurance Density and Disposable Income per Capita

Considering the possible nonlinear relationship, we employ disposable income as a transition variable to examine the PHI demand against the disposable income and try to capture the nonlinear effect of the determinants.

4.3 Urbanization Ratio

Urbanization ratio is defined as the ratio of urban residents to the whole population in a certain region. Urbanization is believed to affect the demand of insurance by some researchers (e.g. Browne *et al.*, 2000; Esho *et al.*, 2004), who consider density of population as a source of risk. Urbanization is truly a highlighted social and economic phenomenon in China for the last four decades, millions of rural residents moved into the cities during this process, resulting in rapid expansion of the size of the cities. Fast expansion of population in big cities challenges the management of the cities and brings a lot of problems, such as increasing traffic accidents, polluted air, and frequent infectious deceases, etc. Many people may feel the exposure to various risks and worry more about their safety, thus PHI would be desired at a higher level.

4.4 Dependency Ratio

Dependency ratio is defined as the number of dependent (including retired people and children) divided by the number of labors, this index generally indicates the financial burden of working people. For the case of China, along with the growing aging population, many old people in the rural areas have only very limited provisions from government, if any, and the pension for retired people in the city is also slender, so the financial burden for the young generation is heavy. With the policy of easing the birth control, the birth rate is expected to grow in short term, further enhancing the burden of labor population. To fulfill the financial obligation of family, buying health insurance for family members is usually a practical option.

4.5 Social Security Expenditure

Social security mainly includes various government insurance programs, e.g. pension and social medical insurance. Social security can provide some coverage which otherwise could be provided with the PHI, thus has "substitution effect" and decreases the demand for PHI; meanwhile, coverage of social insurance and subsequent claim settlement may result in stronger awareness of risk and insurance for the mass, and may encourage them to utilize PHI as a complement of protection, so social security may have "complement effect" as well (Willcox, 1991). The general contribution of social security to PHI demand is the sum of these two effects which have opposite direction.

4.6 Education Level

In literature studying the determinants of insurance, education level is widely used to proxy for the awareness of risk and insurance, it is generally assumed that people with higher education level will be more inclined to buy insurance on purpose to transfer risks they faced (Hofter, 2006; Kansra, 2015; Mulenga *et al.*, 2017). As risks are not easy to be identified and measured, and insurance policies are usually hard to be fully understood, we believe education level is one of the key factors for health insurance transaction.

4.7 Medical Expenses

Covering the medical expenses, especially the catastrophic medical bills, is the major reason for people to buy insurance (Willcox, 1991). We suspect that when medical expenses rises, people have stronger motive to utilize insurance to strengthen their financial capability.

The expected sign of coefficient of the determinants is listed in Table 1.

Specification of Equation (1) assumes that the elasticities (β coefficients) are constant across units and over time. However, this might be unwarranted as the income level of each region may play a role in the private health demand and nonlinear effects may be important. To generalize model (1), we employ the panel smooth transition regression (PSTR) model developed by González *et al.* (2005) and recently improved by González *et al.* (2017). The PSTR model extends the basic model to Equation (2):

$$\mathrm{HID}_{it} = \mu_i + \beta_0 X_{it} + \beta_1 X_{it} g(q_{it};\ \gamma\ , c) + \varepsilon_{it}, \tag{2}$$

for i = 1, . . . , N and t = 1, . . . , T, where N and T denote the cross section and time dimensions of the panel, respectively. Transition function $g(q_{it}; \gamma , c)$ is a continuous function of the observable variable q_{it} and is normalized to be bounded between 0 and 1. Generally, the effective regression coefficients is $\beta_0+\beta_1 g(q_{it}; \gamma , c)$ for individual i at time t. When value of transition function is 0 or 1, the corresponding regression coefficients will be β_0 or $\beta_0+\beta_1$, and we call these two extreme status as low regime and high regime, respectively. The transition function is usually set as a logistic specification as in Equation (3)

$$g(q_{it};\ \gamma\ ,c) = \left(1 + \exp\left(-\gamma \prod_{j=1}^{m}(q_{it} - c_j)\right)\right)^{-1} \quad \text{with } \gamma > 0 \text{ and } c_1 \leq c_2 \leq :::\leq c_m, \quad (3)$$

where $c = (c_1, \ldots, c_m)$ is a m-dimensional vector of location parameters and the slope parameter γ determines the smoothness of the transitions. m is the number of transition function. In practice it is usually sufficient to consider m = 1 or m = 2, as these values allow for commonly encountered types of variation in the parameters (González *et al.*, 2017). In the current research, the interested transition variable is disposable income per capita (DIS) and assumed to have a nonlinear relation with the growth of PHI demand.

Table 1: Expected Signs of Coefficient of Explanatory Variables

Explanatory Variable	**Description of Variable**	**Expected Sign**
Disposable income (DIS)	Disposable income of a certain province divided by population of that province.	Uncertain
Urbanization rate (URB)	Population who have a formal urban citizenship divided by the total population in a certain province.	+
Social security expenditure per capita (SSE)	Provincial social security expenditure divided by the provincial population.	Uncertain
Dependency ratio (DER)	Population in which people are above 65 and lower than 18 divided by the number of total labors in a certain province.	+
Out-of-pocket medical expense per capita (MCE)	Provincial general out-of-pocket medical expense divided by provincial population.	+
Education level (EDU)	The average years of education in a certain province.	+

The PSTR model employed in this study is an extension of the Panel Transition Regression (PTR) model proposed by Hansen (1999). PSTR model follows the work of Granger and Teräsvirta (1993) on Smooth Transition Autoregressive (STAR) models. This approach allows, when the nonlinear relation does exist between the dependent variable and the transition variable(s), the coefficients of interested variables to change smoothly between the values associated with two (or more) extreme regimes. Contrasted to Threshold Regression (TR) model, transition of the coefficients in the PSTR model can be smooth rather than dichotomous switch(es). Both the location and the smoothness of the transition can be estimated from the data. Since the transition variable is time-varying and unit specific, the regression coefficients for each of the cross-sectional units in the panel change gradually over time, thus makes the nonlinear relation between the dependent variable and explanatory variables more alike the real world. With PSTR model, we can further test the nonlinearity of the relation between income and PHI demand, and identify the evolving effects of the determinants when the income changes.

5. Data and Empirical Results

5.1 Data

This study employs the province-level annual data from 30 provinces of China (except Tibet due to data availability) over the period 2007-2016. Among these data, disposable income per capita is adopted from CEInet Statistical Database; PHI premium, total dependency ratio, and total social security expenses are derived from Wind database; population which has at least the third tier of education, numbers of urban residents, total population, and total medical and healthcare expenditures for each province are from National Bureau of Statistics and yearbooks of statistics of various years. To decrease heteroscedasticity, log transformations are conducted for dependent variable PHI premium per capita, and explanatory variables disposable income per capita, social security expenditure per capita, and out-of-pocket medical expense per capita. Summary statistics of the variables (after log transformations) used in this research is shown in Table 2, and all the data of each variable is in reasonable range. To verify the correlation between each pair of variables, we also explore the Pearson Correlation Coefficient matrix (in Table 3) and notice that significant and strong correlation exists between dependent variable HID and other explanatory variables, and between transition variable DIS and other explanatory variables as well, thus the selection of explanatory variables and transition variable are statistically supported.

Table 2: Descriptive Statistics of Variables

variable	unit	mean	max	min	median
HID	LN（yuan）	4.1	7.305	1.873	3.975
SSE	LN（yuan）	7.242	9.406	5.002	7.218
DER	%	35.55	55.09	19.27	36.02
DIS	LN（yuan）	9.558	10.902	8.477	9.568
EDU	%	11.115	45.462	3.064	9.384
URB	%	52.986	89.600	8.151	50.871
MCE	LN（yuan）	6.606	7.909	5.074	6.604

Table 3: Pearson Correlation Coefficients Matrix

	HID	SSE	DIS	DER	URB	EDU	MCE
HID	1						
SSE	0.88779***	1					
DIS	0.88077***	0.57674***	1				
DER	-0.42198***	-0.56570***	-0.49788***	1			
URB	0.69824***	0.36830***	0.52625***	-0.39222***	1		
EDU	0.77601***	0.59482***	0.65631***	-0.40257***	0.39657***	1	
MCE	0.86561***	0.40365***	0.5687***	-0.55085***	0.42724***	0.41278***	1

Note: * indicates significance at 10%, ** 5%, *** 1%.

5.2 Empirical Results

According to González *et al.* (2005) the application of PSTR models requires a three-step procedure, i.e. specification, estimation, and evaluation. The specification includes linearity (homogeneity) tests which verify whether or not the transition variable q_{it} is appropriate. If the null hypothesis of linearity is rejected, we should then choose the appropriate value of m (the number of location parameter) in Equation (2) to fit the nonlinearity. To conduct the linearity test, the linearity of Equation (2) against a PSTR model with two regimes and a given candidate transition variable q_{it} (the disposable income is selected in the current study) is examined. According to Lukkonen *et al.* (1988), we test the m-order Taylor expansion of the nonlinear part under the null $\gamma = 0$. The auxiliary function we test is:

$$HID_{it} = \mu_i + \beta_0 X_{it} + \beta_1 X_{it} q_{it} + \beta_2 X_{it} q_{it}^2 + \cdots + \beta_m X_{it} q_{it}^m + \varepsilon_{it}, \quad (4)$$

where ε_{it} is the sum of the residuals of (2) and the remainder of the series expansion. Thus the linearity test of Equation (2) is now equal to test the null $\beta_1 = \beta_2 = \beta_3 = \ldots = \beta_m = 0$ in the auxiliary function (4). The null hypothesis can be tested by using a (heteroskedasticity-robust) LM-test statistic. Under the null, the test statistic follows asymptotically a χ^2 distribution with m degrees of freedom. The F-version of the LM test (LM_F) is also conducted for small samples.

Hurn and Becker (2009) and Becker and Osborn (2010) dealt with the problem of heteroskedasticity to avoid rejecting the null of linearity when it is not the case by conducting HAC_LM test with asymptotically χ^2/ F distribution. But the weakness of the HAC test is that robustification can remove most of the test power. To improve the effects of heteroskedasticity test, Gonçalves and Kilian (2004) developed heteroskedasticity-robust test statistics by using wild bootstrap (WB) to calculate the critical values. We follow Gonçalves and Kilian (2004) to conduct wild bootstrap (WB) and wild cluster bootstrap (WCB) test, where the WB evaluation tests are heteroskedasticity robust, while the WCB ones are both cluster-dependency and heteroskedasticity robust. If the linearity is rejected, then the number of switch (m) that leads to the strongest rejection of the null is selected.

As is shown in Table 4, the statistics of Lagrange multiplier (LM) test are generally large and the corresponding P values are small, the null of linear relation between the dependent variable HID and the transition variable DIS is significantly rejected when assuming the number of switches m satisfies $1 \leq m \leq 3$, indicating the appropriateness of setting the disposable income as the transition variable.

To determine the best m, Granger and Terasvirta (1993) and Terasvirta (1994, 1998) proposed a sequence of tests for choosing between m = 1 and m = 2[1]: Using the auxiliary regression (4) with m = 3, test the null hypothesis $H_0^*: \beta_3 = \beta_2 = \beta_1 = 0$. If it is rejected, test $H_{03}^*: \beta_3 = 0$, $H_{02}^*: \beta_2 = 0 | \beta_3 = 0$ and $H_{01}^*: \beta_1 = 0 | \beta_3 = \beta_2 = 0$. Select m = 2 if the rejection of H_{02}^* is the strongest one, otherwise select m = 1. Table 5 apparently shows that the rejection of H_{02}^* is not the strongest one, so m = 1 is decided.

Table 4: Results of the Linearity (Homogeneity) Tests

LM tests based on transition variable 'dis'										
m	**LM_X²**	**PV**	**LM_F**	**PV**	**HAC_X²**	**PV**	**HAC_F**	**PV**	**WB_PV**	**WCB_PV**
1	39.42	5.926e-07	5.650	1.565e-05	18.05	0.006103	2.587	0.01882	0	0
2	54.82	1.952e-07	3.837	2.159e-05	21.40	0.044850	1.498	0.12500	0	0
3	92.46	5.210e-12	4.212	9.178e-08	24.52	0.138700	1.117	0.33570	0	0

Table 5: Sequence of Homogeneity Tests for Selecting Number of Switches 'm'

LM tests based on transition variable 'dis'										
m	**LM_X²**	**PV**	**LM_F**	**PV**	**HAC_X²**	**PV**	**HAC_F**	**PV**	**WB_PV**	**WCB_PV**
H_{01}^*	39.42	5.926e-07	5.650	1.565e-05	18.05	0.006103	2.587	0.01882	0	0
H_{02}^*	17.73	6.947e-03	2.482	2.376e-02	7.566	0.271600	1.059	0.38760	0	0
H_{03}^*	24.96	3.473e-04	3.411	2.983e-03	16.120	0.013100	2.204	0.04330	0	0

[1] Granger and Terasvirta (1993) and Terasvirta (1994, 1998) also argue that m=1 and m=3 have similar effect of specification, thus only m=1 and m=2 compete with each other.

At the stage of estimation, the estimation is carried based on the minimizing of a concentrated Sum of Squared Residuals (SSR) via Nonlinear Least Squares (NLS). A given combination of the nonlinear parameters (c_1 and γ_1) is used to estimate a standard fixed effects estimator for panel data, this computation will be iterated for the nonlinear optimization.

To facilitate interpretation, we report estimates of β_0 and $\beta_0 + \beta_1$ in Table 6, corresponding to regression coefficients in the regimes associated with $g(q_{it}; \gamma , c) = 0$ and 1, respectively.

The estimation in Table 6, together with cluster-robust and heteroskedasticity consistent standard errors (see Cameron *et al.,* 2011) show that PHI demand experiences a switch when the value of log transformation of disposable income (DIS) equals 9.943. In the low extreme regime (where DIS $\ll$ 9.943), all the coefficients, except for URB's, are positive, only DIS and URB are found significantly correlated with the PHI consumption at 5% and 1% significance level, respectively. In the high extreme regime (where DIS $\gg$ 9.943), the coefficients of URB, SSE, and MCE are statistically significant at 1%, 1% and 5% significance level, respectively. γ = 6.178, indicating a fast transition occur around the location parameter c (= 9.943). The transition can be observed from Figure 3, in which the transition function is plotted against log transformation of disposable income with each circle representing an observation.

Table 6: Parameter Estimations

	Parameter estimates in the low extreme regime		**Parameter estimates in the high extreme regime**	
	Est	s.e.	Est	s.e.
DIS	0.9279**	0.4187	0.5527	0.3733
URB	-0.0181***	0.004246	-0.05677***	0.01985
SSE	0.02495	0.1275	1.092***	0.2467
DER	0.004821	0.009396	0.05333	0.0263
MCE	0.6256	0.2528	0.2363**	0.4222
EDU	0.000632	0.01727	-0.01916	0.01631
gamma	6.178	3.917		
C	9.943***	0.1501		

Note: * indicates significance at 10%, ** 5%, *** 1%.

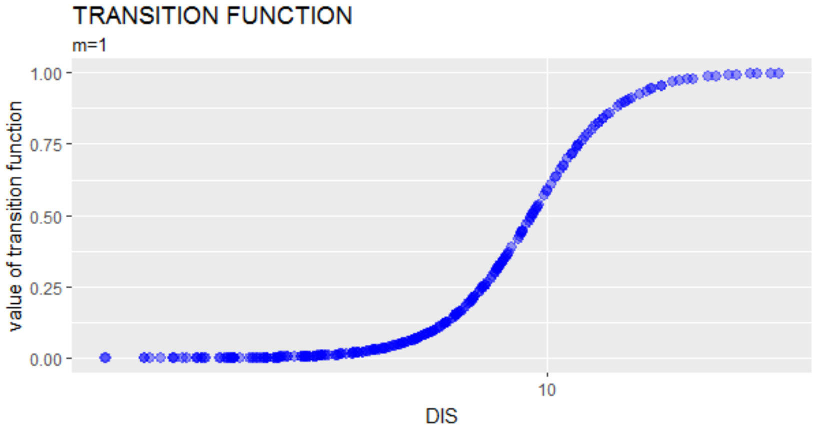

Figure 3: The Plot of Transition Function

At the evaluation stage the estimated model is subjected to misspecification tests to check whether it provides an adequate description of the data. The null hypotheses to be tested at this stage include parameter constancy, and no remaining heterogeneity in the errors. We consider two misspecification tests for this purpose. Specifically, we adopt the tests of no remaining nonlinearity and of parameter constancy over time developed by Eitrheim and Terasvirta (1996) for univariate STAR models to fit the present panel framework, where we interpret the former as a test of no remaining heterogeneity.

The assumption that a two-regime PSTR model (2) with (3) adequately captures the heterogeneity in a panel data set can be tested in various ways. In the PSTR framework we consider an additive PSTR model (5) with two transitions as an alternative.

$$HID_{it} = \mu_i + \beta_0 X_{it} + \beta_1 X_{it} g_1(q_{it}^{(1)};\ \gamma_1\ , c_1) + \beta_2 X_{it} g_2(q_{it}^{(2)};\ \gamma_2\ , c_2) + u_{it}, \quad (5)$$

where the transition variables $q_{it}^{(1)}$ and $q_{it}^{(2)}$ can be but need not be the same. The null hypothesis of no remaining heterogeneity in an estimated two-regime PSTR model can be formulated as H0 : $\gamma_2 = 0$ in (5). As before, we replace $g_2(q_{it}^{(2)}; \gamma_2, c_2)$ with a Taylor expansion around $\gamma_2 = 0$ (see Equation (6)).

$$HID_{it} = \mu_i + \beta_0^* X_{it} + \beta_1^* X_{it} g_1\left(q_{it}^{(1)};\ \gamma_1'\ , c_1'\right) + \beta_{21}^* X_{it} q_{it}^{(2)} + \cdots + \beta_{2m}^* X_{it} q_{it}^{(2)m} + u_{it}, \quad (6)$$

where γ_1' and c_2' are estimates under the null hypothesis. Instead of testing $\gamma_2 = 0$, now the hypothesis of no remaining heterogeneity can be restated as $H_0^* : \beta_{21}^* = \ldots = \beta_{2m}^* = 0$. Aside from LM_$\chi^2$/LM_F test and HAC_$\chi^2$/HAC_F test, we also implement the wild bootstrap (WB) and the wild cluster bootstrap (WCB) evaluation test of no remaining heterogeneity by following Gonzalez *et al.* (2017). According to Gonzalez *et al.* (2017), WB/WCB method are more robust than others, so even though all the results are displayed, we only focus on WB and WCB. Table 7 shows that the more robust WB and WCB statistic can’t reject the null hypothesis, supporting that there is no remaining nonlinearity/heterogeneity under the specification of Equation (2), and one transition function is adequate to capture the nonlinearity.

Using the same null model the parameter constancy is tested too. The results are shown in Table 8. According to the HAC, WB and WCB statistic, the null cannot be rejected, indicating that the factor of time do not need to be considered in the model specification. Interested reader can refer to Gonzalez *et al.* (2017) for details.

Table 7: No Remaining Nonlinearity (Heterogeneity) Test

m	LM_X^2	PV	LM_F	PV	HAC_X^2	PV	HAC_F	PV	WB_PV	WCB_PV
1	54.43	2.292e-07	3.719	3.555e-05	18.10	0.1127	1.2370	0.2582	1	1
2	86.29	5.873-09	2.804	3.479e-05	28.23	0.2503	0.9176	0.5780	1	1
3	106.30	7.254e-09	2.185	3.136e-04	30.13	0.7374	0.6193	0.9567	1	1

Table 8: Parameter Constancy Test

m	LM_X^2	PV	LM_F	PV	HAC_X^2	PV	HAC_F	PV	B_PV	WCB_PV
1	148.0	0	10.110	4.441e-16	19.52	0.07678	1.3340	0.1997	0.25	1
2	168.3	0	5.471	8.787e-13	28.24	0.25000	0.9178	0.5778	1.00	1
3	194.9	0	4.007	7.755e-11	30.14	0.74290	0.6195	0.9566	1.00	1

6. Economic Significance and Policy Implication

First, our empirical results indicate that the disposable income does have a threshold effect on PHI consumption, the unique location parameter c is estimated to be 9.943, by which two regimes, i.e. low regime and high regime, are divided for the PHI consumption function. When the value of DIS is far less than 9.943, a linear consumption regression model which works in low extreme regime is specified. The smooth nonlinear transition of consumption function occurs around the identified location parameter, then a new linear consumption function is obtained in the high extreme regime along with the increase of disposable income. Significant determinants may change accordingly. In the transition progress, the coefficients contain both the linear part and nonlinear part. According to the distribution of sample data, most data fall into low regime. However, at the end of 2016, none province is identified to belong to the low regime, all provinces are either in the transition process or already in high extreme regime, indicating that based on variable of income the PHI demand function has changed during the sample period for some provinces, while the change is just happening for others.

Second, in the low regime, the coefficients of explanatory variables are generally in accordance with our previous expectancy, except for urbanization rate (URB). The disposable income (DIS), social security expenditures (SSE), total dependency ratio (DER), medical and healthcare expenditures (MCE), and education level (EDU) are all identified to be positively correlated to PHI consumption. Among these variables, disposable income (DIS) is identified to be statistically significant and proved to have a stronger "income effect" than "self-insurance effect" and promote PHI consumption. The statistically significant negative correlation between PHI consumption (HID) and urbanization rate (URB) indicates that there are some other factors overweighting the effect of serious pollution and more accidental injury gonging along with urbanization on PHI consumption. We suspect that the high and continuously ascending dwelling expenses compared with income in Chinese cities and higher price level weaken the financial capability of residents to buy insurance, improving management of the cities may also help to offset the negative effects of urbanization.

Third, there are some major changes with the PHI demand in the high regime. Coefficient of disposable income (DIS) decreases in value and becomes statistically insignificant, indicating that the effect of disposable income on PHI consumption is weakened, maybe due to an increasing "self-insurance effect" compared with "income effect". Urbanization rate (URB), social security (SSE), and medical and health expenditures (MCE) are the statistically significant variables. Urbanization rate is still negatively correlated with PHI consumption, while social security and medical and healthcare expenditures positively correlated with PHI consumption. The coefficient of variable social security (SSE) not only increases in value, but becomes statistically significant at 1% significance level, indicating that social security has a stronger "complementary effect" than "substitution effect" when income level moves to a higher level. Even though social security provides more protection, people demand more PHI for complementary protection. Medical and health expenditures show a significant positive correlation with PHI consumption at 1% significance level, indicating that devastating medical bills are people's major concern and important motivation to buy PHI, which is in accordance with most observations from other researchers.

Policy implications can be drown from three aspects. Firstly, insurance firms which are in the PHI business should pay attention to the changes of determinants of PHI demand, and identify the target markets accordingly; secondly, PHI is usually considered as important complement for social security and helps promote the social stability, according to our empirical results, if government enhances social security, e.g. social insurance, then private insurance sector will also be favorably affected, thus government expenditures on social security will have an one-stone-for-two-birds effect on social safety net construction, our research supports more generous allocation of public financial resources into social insurance sector. Thirdly, our empirical results show that only low income people are significantly interested in purchasing PHI when income increase, but surely they are financially constrained, insurance premium subsidy may be necessary to promote the purchase. At the same time, regulatory institution can help the residents strengthen the consciousness of risk and insurance through various medias.

7. Conclusion

Disposable income is identified to have nonlinear impacts on people's PHI demand. Based on the constructed PSTR model, one smooth transition for the PHI consumption function is identified, two regimes (low vs. high) are divided with the location parameter (c = 9.943) and sharp differences are identified for the determinants of PHI demand under different regimes. In the low regime, disposable income significantly and positively correlated with PHI demand, indicating a stronger "income effect" rather than "self-insurance effect", while urbanization progress negatively contribute to the PHI demand; in the high regime, impact of disposable income on PHI demand is not statistically significant any more, instead, social security and medical and healthcare expenditure have significant positive correlation with PHI demand, indicating that a strong "complementary effect" of social security and people's concern about uncovered medical expenses are major impetus for PHI demand in China. It is also notable that up to date most provinces in China is in the high regime. According to our analysis, insurance firms, regulatory institutions and governments all have a role to play in order to promote the purchase of PHI coverage.

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