

## Research Article

### Research on Relationship between China's Social Security Expenditure and Consumption Level: Based on a Nonlinear-STR-Model

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**Abstract:** The study verifies the existence of nonlinear relationship between social security expenditure and private consumption in China from 1952 to 2009 by applying nonlinear STR model. The main conclusions found that the relationship is obviously negative, while presents remarkable stage characteristic which is frequently converted between linear and nonlinear and which can be divided into three stages. The first stage is from the year 1958 to 1963; the negative nonlinear relationship is obvious. The year from 1964 to 1978 is the second stage, but the relationship is insignificant. The relationship reconverts to negative nonlinear in third stage from the year 1979 to 2009. According to these conclusions, the policy recommendations are proposed to promote private consumption in China.

**Keywords:** Private consumption, social security expenditure, STR model

## INTRODUCTION

As an important means of regulation of income distribution, especially the financial social security expenditure, social security is mainly used for pension and social relief and plays a significant role in income distribution. Constructing the social security system of Coordinating Urban-Rural Development can not only be able to achieve social fairness and justice but also effectively alleviate the man provide for the aged, medical treatment and other worries, it must be practically significant to stimulate citizens consumptive demand. Therefore, increasing financial investment in social security is now a consensus reached by experts, scholars and even government department in China.

While the quantitative relationship between social security and private consumption is argued by domestic and foreign. The main conclusions in foreign are as followings:

- Social security does indeed reduce private savings and increase household consumption (Feldstein, 1996).
- Social security dose not affect private savings (Kurz, 1981; Barro, 1978).
- Social Security does decrease the private consumption (Leirmer and Lesnory, 1982).
- It is impossible to decide one way or another on the basis of the currently available data (Esposito, 1978).
- Because of the complexity of any realistic macro-model, it has been impossible so far to test the true

effect of social security on saving and even more so, on capital accumulation Over-idealization of the existing models can not measure the social security on saving and capital accumulation (Eisner, 1983). But both time-series studies and cross-sectional studies had have respectively obtained the conclusions, which pointed the impact of social security on consumption is positive, negative or close to zero (Burman, 1998). The difference conclusions of these studies precisely illustrate that the complex relationship between social security and consumption needs to be tested by more empirical analysis.

Compared with foreign researches, China's related quantitative researches are much more backward and most studies are carried out under the linear model framework. The financial social security expenditure had crowded out private consumption (Yang and Xiaoting, 2007). Because the system of social security was not perfect and unreasonable (Wang and Huachen, 2008). A study found that the relationship between financial social security expenditure and the total consumption was positive, but the expenditure and average propensity to consumption was negative (Li and Yongle, 2010). In comparison, only few individual scholars tried to research the both relationship under the nonlinear model framework. Such as Zhang and Dingzheng (2010) used the regression approach to find point elasticity so as to analyze non-linear relationship between both and found that in the year from 1978 to 1998, financial social security expenditure has played

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the crowd-in role in China, but in 1999-2007, which has played the crowd-out role. In light of large divergence of views of the existing research findings, we still could not confirm the relationship between financial social security expenditure and private consumption, it is urgent to need keeping the empirical test. Generally under the linear model framework, the average trend relations between the two will be drawn, often smooth dynamic change trend. The nonlinear model framework is convenient for describing the dynamic change process between both, if significant non-linear relationship between the two can be tested, then the linear model framework will not accurately describe the actual relationship between both, so the research under the non-linear model framework must need continuing to expand.

The current Chinese social security system is in the transition period, this structure change must inevitably affect the behavior of private consumption from full protection to an emphasis on personal responsibility. The economic environment, particularly the economic volatility, carries out much aggregate fluctuations. In view of this dynamic changing situation, this study plans to use nonlinear time-series STR model to analyze the dynamic relationship between the both. STR model is a nonlinear time-series model that can reflect continuous transformation of the mechanism, which can accurately describe smooth transition relationship in the two extremes mechanisms. It is widely used in finance, economy and other areas because of its advantage of having simulating real economy and sudden economic policy. While it is not yet applied in the social security field, this study attempts to use its advantage to deep the research the relationship between social security expenditure and private consumption. In order to examine the long-term dynamic relationship between the both much more systematically, the study selects for up to 58 years data between the year from 1952 to 2009, researches policy changes, economic environment and analyzes the impact of these shocks on the relationship between the both and will give suggestions for a better financial reference so that social security expenditure can boost private consumption.

### CONSTRUCTION OF THEORETICAL MODEL

Chinese social security system has experienced the process of change from a planned economy to market economy, during which this change is likely to influence and change people's consumption behavior, making the relationship between the two represent the characteristics with dynamic structural change. That is, the relationship between the two represents remarkable stage characteristic and significant nonlinear characteristic. STR model is specialized in analyzing the nonlinear conversion relationship between the

variables, timely responding to dynamic changes in the relationship between the variables and accurately describing the transition relationship in the two extremes mechanisms between the variables. It can be a good response to real changes in the relationship. Because the STR model has such advantages, it is just probable for the purpose of this research study. This study intends to use the STR method to analyze the dynamic relations between the two and then accurately portray how financial social security expenditure impacts the consumption level. The basic idea of STR is briefly described as follows:

Smooth Transition Regression (STR) model's general form is as below:

$$y_t = x_t' \phi + (x_t' \theta) G(\gamma, c, s_t) + u_t \quad t = 1, \dots, T \quad (1)$$

$$G(\gamma, c, s_t) = 1 + \exp[-\gamma(s_t - c)^{-1}], \quad \gamma > 0 \quad (2)$$

$$G(\gamma, c, s_t) = 1 + \exp[-\gamma(s_t - c_1)(s_t - c_2)]^{-1}, \quad \gamma > 0, c_1 \leq c_2 \quad (3)$$

where,  $y_t$  is the dependent variable,  $x_t$  is the vector of independent variables, including the k-order lagged variables of target variables and other explanatory variables, that is,  $x_t = (1, x_{1t}, \dots, x_{pt})' = (1, y_{t-1}, \dots, y_{t-k}; z_{1t}, \dots, z_{mt})'$ .  $\phi = (\phi_0, \phi_1, \dots, \phi_p)'$  and  $\theta = (\theta_0, \theta_1, \dots, \theta_m)'$  are parameter vectors of linear and nonlinear, respectively. Transition function  $G(\gamma, c, s_t)$  is a continuous function between [0, 1].  $s_t$  is transition variable, it can either be a single random variable, or be a linear combination of precedent variables including random variables or linear time trend and so on.  $\{u_t\}$  is an error sequence with iid.

If the transition function  $G(\gamma, c, s_t)$  is formula (2), then formula (1) is called LSTR1 model. In this case transition function  $G(\gamma, c, s_t)$  is the monotonically increasing function of transition variable  $s_t$ , constraint  $\gamma > 0$  is a restrictive recognition. Slope  $\gamma$  reflected the transition speed from "0" state to "1" state, the parameter  $c$  is to determine the moment of state transition. If the transition function  $G(\gamma, c, s_t)$  is formula (3), then formula (1) is called LSTR2 model. The transition function  $G$  is on the symmetry of  $c_1 + c_2 / 2$ , when  $s_t \rightarrow \infty$ ;  $G(\gamma, c, s_t) \rightarrow 1$ ; for all  $c_1 \leq s_t \leq c_2$ , when  $\gamma \rightarrow \infty$  there are  $G(\gamma, c, s_t) \rightarrow 0$ , otherwise,  $G(\gamma, c, s_t) \rightarrow 1$ .

### EMPIRICAL ANALYSIS

**Variable selection, data declaration and test:** Selecting the data of financial social security expenditure and private consumption level in the year from 1952 to 2009, which are recorded respectively as sbzc and cons. Finance social security expenditure and the consumption level are respectively adjusted to 1978 year's price level deflating by the consumer price index

and the consumption level index. Noted that: In 1995 and before, financial social security expenditures are the government budget used for the expenditures of pension and social welfare; 1996 to 2005, the expenditure included social security pension, social welfare and administrative costs for the retired; In 2006 National Bureau of Statistics adjusted the structure of social security expenditure, including pension and social relief, social security subsidization expenditure, expenditure of retired in administrative institutions; 2007 to 2009, including social security and employment, health care expenditures. In addition, in order to eliminate the impact of possible heteroskedasticity, to take logarithmic on annual financial social security expenditure and consumption level. All data are compiled from national statistical offices and public offering of the “China Statistical Yearbook”, “China Financial Yearbook” and “Sixty Years of New China Statistical Information” and so on.

Data stability is the starting point for time series analysis. This study selects ADF unit root test, the results indicate that on significance level of 5%,  $\lnsbzc$  and  $\lncons$  are non-stationary series, but  $\Delta \lnsbzc$  and  $\Delta \lncons$  are stationary series. Therefore,  $\lnsbzc$  and  $\lncons$  are both I (1) series. Then followed by the Granger causality test of series  $\lnsbzc$  and  $\lncons$ . Granger causality test requires all variables must be stationary series, so test the first-order difference of both variables. Granger causality test is sensitive to the lag order, the paper select the lag order 2, 3 and 4 for testing. The test results show that on significance level of 1% both exists one-way Granger causality from  $\Delta \lnsbzc$  to  $\Delta \lncons$ , not exist Granger causality from  $\Delta \lnsbzc$  to  $\Delta \lncons$ . This means that under the linear

assumption, increasing with the consumption level, financial investment on social security is increasing too, but increasing financial social security expenditure does not promote the improvement of consumption level. Note that under the linear assumption, the test is likely to ignore the structure changes and nonlinear relationship between financial social security expenditure and consumption level, so it is necessary to re-test under the nonlinear assumption.

### MODEL ESTIMATION

**Set the linear model:** Using AIC, SC criteria in VAR model to select lag order and ultimately determine the lag order in AR part is 5. Gradually eliminate insignificant lag variables and finally obtain the linear model:

$$\begin{aligned} \Delta \lncons = & 0.95\Delta \lncons (-1) - 0.67\Delta \lncons (-2) \\ & + 0.40\Delta \lncons (-3) - 0.48\Delta \lncons (-4) \\ & + 0.48\Delta \lncons (-5) - 0.05\Delta \lnsbzc (-2) \\ & + 0.04\Delta \lnsbzc (-3) + 0.017 \end{aligned} \quad (4)$$

Corresponding to the model’s major diagnostic statistics is as follows:

$$R^2 = 0.622, \bar{R}^2 = 0.5620, AIC = -6.307, SC = -6.007。$$

Adjusted goodness of fit  $\bar{R}^2$  is not high, indicating that the effect is not good. The following is to test whether existing non-linear relationship between social security expenditure and consumption level.

Table 1: Linear hypothesis testing and the options of transition function type

Transition variable	F	F <sub>4</sub>	F <sub>3</sub>	F <sub>2</sub>	Model
$\Delta \lncons (-1)$	1.58E-5	3.40E-2	2.27E-1	3.04E-6	*LSTR1
$\Delta \lncons (-2)$	2.68E-4	2.32E-2	2.79E-1	2.34E-4	LSTR1
$\Delta \lncons (-3)$	5.46E-4	6.91E-2	3.84E-2	1.99E-3	LSTR1
$\Delta \lncons (-4)$	9.03E-3	1.30E-1	2.95E-2	6.42E-2	LSTR2
$\Delta \lncons (-5)$	6.10E-4	1.00E-1	2.34E-2	2.47E-3	LSTR1
Trend	1.20E-4	2.31E-1	6.59E-2	8.94E-6	LSTR1

Table 2: Estimation results of LSTR model

Variable		Start	Estimate	p-value
Linear part	$\Delta \lncons(t-1)$	0.811	0.906	0.000
	$\Delta \lncons(t-2)$	-0.320	-0.321	0.029
Non-linear part	Const	0.057	0.039	0.001
	$\Delta \lncons(t-2)$	-0.781	-0.791	0.003
	$\Delta \lncons(t-3)$	0.748	0.810	0.010
	$\Delta \lncons(t-4)$	-0.998	-1.070	0.000
	$\Delta \lncons(t-5)$	-0.941	1.039	0.000
	$\Delta \lnsbzc(t-2)$	-0.109	-0.089	0.005
	$\Delta \lnsbzc(t-3)$	-0.105	-0.102	0.012
	Gamma	10.000	2088	NaN
C <sub>1</sub>	0.0215	0.019	NaN	
AIC	-6.7537			
R <sup>2</sup>	0.7845			
$\bar{R}^2$	0.7887			

**Determine the type of transition function:** The test results of Table 1 show that the transition variables have wide selections, which indicate that exist the nonlinear relationship between the two variables. When  $\Delta \ln \text{cons}(-1)$  as a transition variable, the corresponding probability value is less than the choice of other transition variables corresponding to, so  $\Delta \ln \text{cons}(-1)$  as the transition variable is reasonable, then LSTR1 model is the best transition function model.

**Estimate LSTR model:** Estimate using of software, where the parameters  $C_1$  range is  $[-0.1056, 0.2295]$ ,  $\gamma$  is  $[0.5, 10]$ . Then, using Newton-Raphson iterative method obtained estimates of the model's parameters and gradually remove the insignificant variables, finally obtained the final estimation results. Show in Table 2. According to Table 2 can derive the concrete form of LSTR1 model:

$$\begin{aligned} \Delta \ln \text{cons} = & 0.90 \Delta \ln \text{cons}(-1) - 0.32 \Delta \ln \text{cons}(-2) \\ & + G[\gamma, c, \Delta \ln \text{cons}(1)] * [0.04 - 0.79 \Delta \ln \text{cons}(-2) \\ & + 0.81 \Delta \ln \text{cons}(-3) - 1.07 \Delta \ln \text{cons}(-4) \\ & + 1.03 \Delta \ln \text{cons}(-5) - 0.09 \Delta \ln \text{sbzc}(-2) \\ & - 0.10 \Delta \ln \text{sbzc}(-3)] \end{aligned} \quad (5)$$

$$G[\gamma, c, \Delta \ln \text{cons}(1)] = [1 + \exp(20889(\Delta \ln \text{sbzc} - 0.019))]^{-1} \quad (6)$$

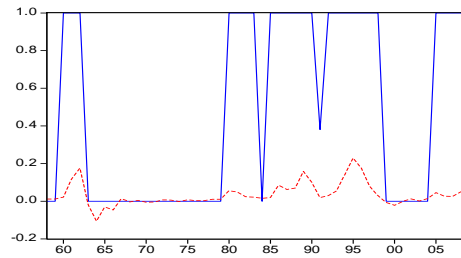
Corresponding to the model's major diagnostic statistics is as follows:

$$\begin{aligned} \text{ARCH-M} &= 6.357 (p = 0.6072); F_{LM} = 0.929 (p = 0.5052) \\ \text{J-B} &= 0.377 (p = 0.8282) \end{aligned}$$

In the brackets is the corresponding probability value. Test results show that the model at the 1% significance level, passed through the ARCH-LM heteroskedasticity test and normality tests, the model setting is reasonable and the conclusions are credible.

### INTERPRET THE MODEL RESULTS

Analyzing the estimated results of Table 2: In the linear part of the LSTR model,  $\Delta \ln \text{cons}$  is only affected by its own lagged items,  $\Delta \ln \text{sbzc}$  does not affect  $\Delta \ln \text{cons}$ . The consumption level is only affected by the consumption level in the past and reflects that the consumption level has a strong "rigid" in China; the current consumption level has a stronger relationship with that in the past two years. Concretely, the elasticity of the first order lag and second order lag of consumption level on current consumption level are 0.9060 and -0.3211, the sum of both, that the elasticity of the past two years consumption level on the current consumption level can be seen as 0.5849, means that, when the consumption level in the past two years



— transition function    - - - - - transition variable

Fig. 1: The figure of transfer functions and transfer variable curve

change for 1%, the current consumption level will change for 0.5849%. In terms, the current consumption level has a smaller change, which precisely illustrates the consume habits of residents live within their means, unless there is a larger increase of consumption level, or consumption level reflects the strong continuity. While in the linear part, the consumption level is not related with financial social security expenditure, which is the same conclusion under the assumption of linear Granger causality test that the financial social security expenditure on consumption had no significant effect.

The nonlinear part of LSTR model contains two parts: the transition function items and return items and the critical value of the transfer function  $C_1 = 0.0192$ ,  $\gamma = 2088$  indicates that the model conversion speed is fast. Transition function value  $G$  is an increasing function of transfer variable  $\Delta \ln \text{cons}$ , when the value of the transition variable increases, the transition function value also increases, so the non-linear part of model has a great influence on consumption level. When  $G=0$ , LSTR1 model changes into a linear model, the linear part has no effect on consumption, so in this case financial social security expenditure has no direct relationship with consumption; when  $G = 1$ , the elasticity of the second order lag and third order lag of financial social security expenditure on consumption levels were -0.0898 and -0.1024; when  $0 < G < 1$ , the elasticity of financial social security expenditure on consumption is between the both. Shows that when  $G = 1$ , the financial expenditure on social security crowded out consumption mostly. When  $0 < G < 1$ , it clearly also plays the role of crowding out consumption, at this moment the extrusion elasticity of the second order lag and third order lag of financial social security expenditure on consumption level fluctuated respectively between  $[-0.0898, 0]$  and  $[-0.1024, 0]$ . No matter what, as long as the nonlinear part exists, the finance social security expenditure and consumption is always negatively correlated, so finance social security expenditure does not promote consumption level. Figure 1 is transfer function and transfer variable curve.

From the transition function of Fig. 1, we can clearly see the relationship between financial social security expenditure and consumption level which

presents remarkable stage characteristics and can be concretely divided into three main stages, the year from 1958 to 1963, the year from 1964 to 1978 and since 1979 years. In the year from 1958 to 1963, the elasticity of financial social security expenditure on consumption level is negative, especially in the year from 1962 to 1963, it has reached the maximum value (in this case  $G = 1$ ). At this stage China is in “during natural disasters”, the economic situation is very serious and financial social security expenditure albeit small, but large fluctuations, while large changes in financial social security expenditure is no large increase consumption levels, mainly due to more confusion in the economic situation, the residents are greatly depressed consumer demand, not dare to consume and not able to consume co-exist. Finance social security expenditure is mainly used for social relief and social welfare, but the amount is too small and not fundamentally improves people's consumption level. In the period from 1964 to 1978, there was not direct relationship between the financial social security expenditure and consumption level (in this case  $G = 0$ ). And this period went throughout the beginning and end of the Cultural Revolution. Because of the serious economic setback, the cause of stagnation changed into a company to protect national security and financial social security expenditure was seriously decreased and even less than previous years in some years, which made the relationship between financial social security expenditure and consumption level was not reflected. Consumption level during this period is mainly affected by previous consumption level and reflects a certain “rigid”, in line with prevailing circumstances. In the period from 1979 to 2009, the fiscal expenditure on social security has become a negative elasticity of consumption levels and frequently changed between linear and nonlinear. The effects had also reached the maximum for many years (in this case  $G = 1$ , such as 1980-1984 years, 1986-1990 years, 1993-1999 years, 2005-2009 years). This period began with China's reform and opening up and continues to today. After the reforms, on the one hand, the state introduced measures to restructure the economy; on the other hand, the social security system had a fundamental change from national security into a system emphasizing society and personal responsibility. But these two aspects have influenced the residents' consumption level from different paths, the former accelerated the economic development and provided the fundamental impetus to increase the level of consumption and improve the national's consumption level. However, changes in the social security system have increased residents' uncertainty and the marketing of health care, housing and education make the enormous pressure for residents. Although the growth rate of total social security expenditure was greater than consumption level growth, social security expenditure had not played an active role.

Financial social security expenditure as a transferring payment, have not played a role in promoting consumption. We should consider this problem from the following aspects: firstly, the total social security expenditure is less. Because China's social security expenditure has a small base, so the growth speed becomes high. However, in recent years, China's fiscal expenditure on social security has been maintained at 11% of total fiscal expenditure and even been declined in some years. This proportion is far lower than the level of developed countries or even some developing countries. For example in 2001, the German social security financial expenditure accounting for 46.5% of the total fiscal expenditure, UK is 39.5%, France is 38.7%, Japan is 35%, Sweden is 41.4%, with developing countries such as Brazil and Malaysia, which have exceed China at 90 years in the 20<sup>th</sup> century, Brazil is 36.7%, Malaysia is 13.4%. Considering our large population, the lower total expenditure is an utterly inadequate amount. Secondly, China's financial expenditure on social security is a typical type of disability compensation social security expenditure. Under the limited total expenditures, pension and social relief funds, retirement funds for administrative institutions, social security benefits expenditure maintain their share of roughly 2, 3 and 5%, respectively. With the effective protection and the strongest redistribution nature for the grass-roots groups, pension and social assistance expenditures is significantly lower. Thirdly, there is a huge gap between urban and rural finance investment in social security. The rural social security funding expenditure share of GDP remains at a level of 0.1% and the per capita of urban residents enjoy the rural social security costs about more than 100 times, the gap is bigger than any one country (Tuo and Guojun, 2002). Finance social security expenditure is mainly used for social relief in rural and the converging is mostly poverty residents. The social relief funding in the proportion of financial expenditure is already low, so the role to the rural residents is also very small even with high marginal propensity to consume.

#### **THE MAIN CONCLUSIONS and POLICY IMPLICATION**

In this study, According to the nonlinear STR model we re-examine the relationship between social security expenditure and private consumption in china the year from 1952 to 2009 and verify the existence of its non-linear relationship. The relationship presents remarkable stage characteristics and is frequently converted between linear and nonlinear. Empirical conclusions demonstrate that the nonlinear dynamic relationship between financial social security expenditure and consumption level can be concretely divided into three main stages: the year from 1958 to

1963 (linear relationship), 1964 to 1978 (insignificant relationship), since 1979 year (non-linear relationship). Since the linear part without financial social security expenditure variable, so long as in the nonlinear stage the elasticity of financial social security expenditure on consumption level is always negative, that is, the financial social security expenditure has crowd out private consumption, which is similar with the majority of domestic research conclusions. Especially when  $G = 1$ , to achieve maximum impact, at this moment increases 1% in the second and third order lags of financial social security expenditure, the consumption level decreases by 0.0898% and 0.1024%, the crowding out effect is large. But when non-linear part does not exist, consumption level is mainly affected by previous consumption level; this "rigid" relationship reflects china's consume habit which is living within their means.

The conclusion of finance social security expenditure has crowded out china's private consumption level, according to Feldstein theory (1974), which can be interpreted as the substitution effect of China's social security wealth is less than its retirement effect. The reason is likely to be China's social security system begin to emphasize personal responsibility, pension, health care, education, housing and other issues have been gradually marketed, resulting in the enhancement uncertainty to expected future. At the same time, the total social security expenditure is too small and the imbalance of expenditure structure and further lead to inhibition on social security enhance consumption level.

In order to play the active role in finance social security expenditure on consumption, the following aspects should be considered.

Firstly, China's financial must support the development of social security and effectively improve the proportion of financial expenditure. Effective implementation of the government's commitment that "during the next National Twelfth Five-Year Plan period" assures the proportion of financial expenditure reaches to 25%. "Twelfth Five-Year" plan aims to transforming the economic growth mode, the core is to expand people's consumption needs. Finance social security expenditure as an important means of regulating the distribution of income, which should be tilted to the groups with the higher marginal propensity to consume, such as urban and rural disadvantaged groups, particularly the expansion of coverage of rural subsistence allowances, which should be institutionalized and gradually increase the level of protection, certainly play a positive role in the improvement on consumption level of urban and rural residents in China.

Secondly, the intensity of the central government subsidies should be increased. Over the years, most of the financial social security expenditure funding comes

from the local government and less comes from central government subsidies. The local government's finance is relatively tight, which is the important reason why the financial social security expenditure has been lower. For example, in 2006, the proportion of the central government subsidies in total expenditure was only 7.96%, so the local's proportion finance up to 92.04% (Calculated by CEInet database statistics). Increasing the intensity of the central government subsidies not only is the responsibility of the central government but also surely provides adequate guarantee for the steady growth of social security expenditure.

Thirdly, the social security system of Coordinating Urban-Rural Development should be constructed to accelerate to establish rural social security and eventually establish China's social security system with urban and rural co-development, which must contribute to reduce people's current general concern about the pension, medical care, housing, education and other issues, only really achieve to feel secure when they get old and sick, they could be treated promptly, can people dare to consumption and even excessive consumption. Social security is not empty words to promote consumption.

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