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GOVERNMENT SIZE AND ECONOMIC GROWTH IN ASIA - EVIDENCE FROM CHINA AND JAPAN

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ABSTRACT

In this paper, we examined the relationship between government size, proxied as general government consumption expenditure in GDP and economic growth, measured as real per capita GDP growth under Smooth Transition Autoregressive (STAR) approach in China (a developing country) and Japan (a developed country) over 1971-2013 period. Results show that Exponential STAR (ESTAR) is better fitted for China. Meanwhile, there is no convergence for Japan, means that this relationship should be explained by an alternative non-linear model. The threshold value of government size for China is found at 14.23% (or 14.18%). However, BARS curve is not really supported. Economic growth still is marginally positive when government expenditure exceeds this value. In spite of that, this also implies inefficient use of resources and government should pay more attention on this issue to enhance economic growth.

Contribution/ Originality: This study contributes to the existing literature by documenting a non-linear nexus between GDP growth and government size that implies an inefficiency of government size beyond the threshold value. The study uses a new approach of Smooth Transition Autoregressive model when investigating the link between GDP growth and government size.

1. INTRODUCTION

Theories of growth have been developed for a long time. Among of those, there are two prominent schools: exogenous and endogenous economic-growth models. Exogenous models (also called neoclassical models) pioneered by Solow (1956) and Swan (1956) assert that long-run growth would be explained by capital accumulation, labor (or population) and technological process which enhance productivity. Thus, public spending does not have effects on long-run growth in exogenous models. On the other side, endogenous models developed by Romer (1986); Barro (1990); Rebelo (1991) attempt to seek new motivation for economic growth after almost thirty years of stagnation. They argue that long-run economic growth may be explained by various endogenous variables. Among of them, fiscal policy is a factor that is attractive to many researchers. Government spending has positive impact on growth through not only directly increasing outputs but also indirectly providing productive goods and services that are considered as inputs to private production (Grossman, 1988). In addition, government also establishes a legislative system that helps to protect property rights and provide an investment-friendly climate. However, over-expanding government size would also have an adverse impact on growth (Barro, 1990; Armey, 1995). Distortion of resource allocation, crowding-out effects, tax burdens... dampen private sector's incentives, therefore affect growth.

Some studies find out that government spending have positive impact to growth (Ram (1986); Grossman (1990); Ghali (1999)). On the other hand, Landau (1983); Guseh (1997); Dar and AmirKhalkhali (2002) among others give evidence that shows a negative relation between growth and government expenditure. Others demonstrate they have non-monotonic nexus. As a result, the relationship between government size and economic growth becomes ambiguous. However, evidence on non-linear relation seems more persuasive: under-expanding or over-expanding government size is not better. Therefore, we support the views that suggest an existence of optimal value that maximizes economic growth.

In terms of methodology, almost authors in former studies use methods that incorporate cross-sectional or panel data in their work. Few studies examine non-monotonic relationship with time-series data. One of disadvantages of cross-sectional or panel data is that they do not reflect specific features for each country; therefore results might become unreliable. In spite of difficulties in reaching time-series data, it has outstanding advantages that help us to have more reliable results. One of ideal tools examining the non-linear relationship between two variables is non-linear Smooth Transition Autoregressive – STAR models. Those models could allow us to detect a non-linear relationship with a smooth adjustment between regimes. Moreover, they could be used to be a multivariate, thus they are appropriate to investigate effects of government size to growth. In addition, they help us to find out the threshold value for government size that is meaningful for policy implications.

In this paper, we follow Chiou-Wei *et al.* (2010) to explore the nature of the relationship between government size and economic growth with a non-linear technique. However, there are some points different from their paper. First, instead of concentrating on developing countries, we study on two groups of countries depending on level of economic development for comparison purpose: China and Japan standing for a developing country and a developing country respectively. Second, the robustness test will be implemented with an alternative proxy for export.

China is a developing country with the largest population in the world. After carrying out huge reform in 1979, China experienced high economic growth for many years impressively. In 2010, it officially overtook Japan to become the second largest economy (measured by GDP). We cannot reject that government spending is an important contribution to its growth. Particularly, investment in infrastructure has been growing fastest in the world. Fiscal policy seems to have positive effects on growth. Government expenditure is an incremental factor to growth (Sinha, 1998) Wagner's law does not hold in China (Huang, 2006). Large fiscal multiplier (more than 2) helps China preventing from economic slowdowns. However, government spending also causes inflation and investment booms, then damages growth (Wang and Wen, 2013). At present, government spending tends to extend too much, meanwhile growth tends to reduce. Hence, dispute over government expenditures in China has been raised again.

Japan is a developed country with the third largest GDP in the world. Since the asset price bubble in earlier 1990s, Japan has been facing difficulties and economic growth has been at one of the lowest. In contrast, general government total expenditure has been increased, falling in the range from 30% to 40% since 1990. To stimulate the demand and remain the growth rate, Japan ran a huge budget on public work programs. National debt is a problem that Japan is facing. Terasawa and Gates (1998) show that government spending has decremental effect on growth. They argue that "government programs typically lack competition, profit incentives, quantitative output measures, and a link between production costs and consumer values" (p.217). On the other hand, Guerrero and Parker (2010) indicate that government spending really has a positive effect on real GDP and "expansionary fiscal policy may have played the role of avoiding a deeper economic depression than the one observed during Japan's lost decades" (p.2).

The rest of this paper is organized as follows. Section 2 summarizes related theories and previous empirical studies. Next, Section 3 outlines methodology and describes data and variable measurements. Section 4 provides empirical results and conclusion is given in Section 5.

2. LITERATURE REVIEW

Barro (1990) developed a theoretical framework in which the nexus between government size and economic growth is the inverted U-shaped. In short, he asserts that there exists a threshold at which different government sizes have two different effects to growth. When the government is small, below the threshold, an increase in government size will foster growth and the opposite effect will happen in cases which government size is above the threshold (Figure 1). There are several authors attempting to confirm the existence of this curve. Results will be reviewed later.

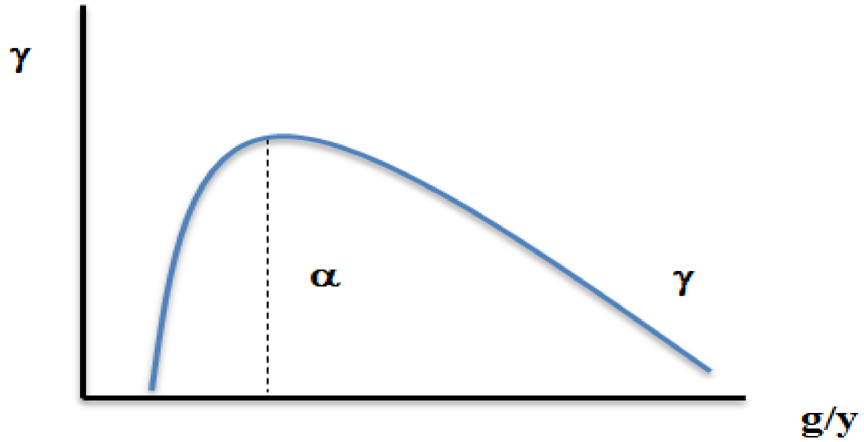

Figure-1. Relationship between government size and economic growth
Source: Barro (1990).

Up to now, there are many studies regarding this topic, however, results are not consistent. Some studies find the positive relationship between government size and economic growth. Ram (1986) outlines the two-sector production function framework to model the overall effect and externality effect of government size and relative factor productivity between government and non-government sectors. He finds the positive relation between government size and economic growth. A result also shows that the positive impact of government size seems to be stronger in nations with lower income levels. Ghali (1999) considers the short-run and long-run impact of government size on economic growth. Results show that government size (proxied as the share of total government spending in GDP) Granger-causes growth in all 10 OECD countries. Especially, for some countries government size has impact on economic growth via indirectly impact on either investment or trade variables (imports and exports). Grossman (1990) attempts to differentiate positive and negative effects of government on growth and finds that government has a net significant positive impact on overall economic growth.

While there is a little evidence showing positive effects of government size on growth, adverse effects seem to be found in more studies. Landau (1983) uses data of 104 countries to examine the relationship between the average growth rate and the average share of government consumption expenditure in national income. Results show "a significant negative partial correlation between the government share and the rate of increase in per capita output" (Landau, 1985). Landau (1985) extends the analysis of Landau (1983) over 16 developed countries and the same results are found. Government spending has negative impact on growth. Especially, both government consumption and government investment also have negative effects on growth, however, no significant evidence found for government transfer. Grier and Tullock (1989) aim to discover the effects of the range of variables on economic growth. Regarding government size, results show that government growth has negative impact on economic growth in three of four subsamples (OECD, Africa and America excluded Asia). Barro (1991) investigates the relationship between share of government consumption in GDP and growth among other variables on a sample of 98 countries over 1960-1985. A negative association between government consumption and real per capita GDP growth is found. In his study in 1996, he extends from cross-country analysis to panel analysis on data of roughly 100 nations from 1960 to 1990 and finds the same results of this relation. Guseh (1997) investigates this nexus among different political and economic systems. Results show that the growth of government size has negative effects on economic growth and the magnitude of negative effects also depends on political and economic systems. Kneller *et al.* (1999) evaluate the relationship between structure of taxation and government expenditure and steady-state rate of growth. Results strongly support (Barro, 1990) endogenous growth model. Consequently, they find that distortionary taxation lowers growth and productive government expenditure boosts growth, meanwhile both non-distortionary taxation and nonproductive government expenditure do not affect growth. Tanninen (1999) studies the link between economic growth and inequality, and finds that share of government consumption expenditure in GDP has negative effects on growth. Also, government transfer payments and growth have a positive relation. Dar and AmirKhalkhali (2002) examine the relationship between the government size along with other variables and economic growth. Results indicate that in average, government size (measured by government spending to GDP) has negative impact on the economic growth via the adverse impact on factor productivity. However, when it is measured by the rate of growth in government consumption instead, it shows a positive impact on economic growth. They suggest that the negative impact found may reflect the effects of taxation and transfer payments, especially a significant increase in transfers over past 30 years in studied period. Romero-Ávila and Strauch (2008) focus on the relation between fiscal variables and long-term growth in Europe and find that both sides of the budget, revenues and expenditures have long-term relationship and co-move in the same direction. They have opposite effects on growth therefore they cancel out each other. Also, results show that government size (measured as total expenditure or total revenue shares), government consumption as well as direct taxation have a negative effect on per capital GDP growth, however public investment has opposite impact, being a growth-enhancing factor.

Unlike those authors focusing on the monotonic nexus, many studies concentrate on testing the existence of BARS curve. Grossman (1988) develops a model which enables the non-linear relationship measured. He argues that a change in relative size of government (measured as the share of government expenditure in total economic growth) would have negative effects on growth while a change in absolute size would have positive effects on growth. Results strongly support his reasoning. The non-linear model is preferable to the linear one. Sheehey (1993) examines this nexus with levels of government size and development (measured as per capita GDP). He proposes that a change in relative share of government consumption has significantly negative impact on high income countries and significantly positive impact on low income – low government share countries. Karras (1996) develops a new methodology which indirectly examines the non-linear relation between two variables through focusing on the productivity of government services. The author concludes that services which government provides are significantly productive, however, underprovided in Asia and overprovided in Africa, optimal provided in somewhere else. Particularly, the optimal government size (measured as government consumption in GDP) is found at 23% for the average country but has a broad spectrum geographically (from 14% for average OCED country to 33% for one in South America). Vedder and Gallaway (1998) test an existence of Armey curve on very long-time U.S government spending and GDP. Results show that the Armey curve really exists and is robust. Particularly, a tendency of larger transfer payments causes an economic slowdown. Hence, they suggest government spending growth should be below the economic growth, especially focus on constraining the growth of transfer payment. Analogously, Tanninen (1999) asserts that a non-linear relationship may exist between public sector magnitude and growth. He concludes that there is a non-linear relationship only between growth and government spending on public goods, confirming the existence of BARS curve. The optimal government spending on public is 6.1% of GDP (in OLS estimation) or 6.6% of GDP (in 2SLS estimation). Chen and Lee (2005) tests an existence of Armey curve for Taiwan by modifying two-sector production function developed by Ram (1986) and employing Hansen (2000) threshold regression model to test threshold effects of government size on economic growth. Results show that when all three kinds of government size in sequence: "total government expenditure divided by GDP", "government investment expenditure divided by GDP" and "government consumption expenditure divided by GDP" are set as the threshold variables, the threshold effects really exist in government size and growth relationship in Taiwan. The threshold regimes found are 22.839%, 7.302% and 14.967% respectively. Thus, an existence of Armey curve in Taiwan is confirmed. Chiou-Wei *et al.* (2010) employ the non-linear Smooth Transition Autoregressive (STAR) models developed by Teräsvirta and Anderson (1992) and Teräsvirta (1994) to investigate the relationship between government size (proxied by the share of government consumption expenditure in GDP) and economic growth in five countries. Results show the non-linear relationship is found for each country except Malaysia. The threshold value of government size is around 11% in South Korea, Singapore, Thailand and 16% in Taiwan. Following Vedder and Gallaway (1998); Altunc and Aydin (2013) test an existence of Armey curve for Turkey, Romania and Bulgaria. Adopting ARDL bound testing approach, results reveal that Armey curve does exists in all three countries and the optimal total public expenditure which maximizes economic growth are roughly 25%, 20% and 22% respectively. More recently, Christie (2014) examines a non-linear relationship between government size and long-term economic growth by applying the threshold regression. Results support the existence of Barro (1990) hypothesis. However, above a threshold value government spending has detrimental effect on growth while below that one, no statistically significant evidence is found. Interestingly, he also shows the effectiveness of government[1] also has impact on non-linear relation. Growth in countries with low government effectiveness is explained better by non-linear effect of government spending. Two authors Asimakopoulos and Karavias (2015) employ a new method, non-linear panel GMM and confirm the non-linear relationship between two variables. They find that the optimal level of government size for developed and developing countries is 17.96% and 19.12%, respectively. Thanh (2015) examines the relationship between government size (proxied as the ratio of government consumption expenditure to GDP) and economic growth (per capita GDP growth) in China and Japan under STAR approach for a model of 5 variables. He finds evidence of the existence of non-linear relation in both countries. The threshold value for government consumption spending is 15.23% for Japan and 19.43% for China.

3. DATA AND METHODOLOGY

3.1. Methodology

3.1.1. Theoretical Framework

In this paper, we borrow the production function developed by neoclassical economists:

$$Y = AF(K, L) \qquad (3.1)$$

[1]According to World Bank, Government effectiveness indicator: captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Higher values correspond to more effective government (see Christie (2014)))

Where Y is output, A represents Total Factor Productivity, $F(K, L)$ is a function with K is capital, L is labour.

Now we define $y = \frac{Y}{L}$ is output per worker, $k = \frac{K}{L}$ is capital per worker, equation (3.1) becomes:

$$y = Af(k) \qquad (3.2)$$

Differencing equation (3.2) and dividing it by y, we obtain growth accounting equation:

$$\frac{dy}{y} = \frac{dA}{A} + Af\frac{dk}{y} \qquad (3.3)$$

Where $\frac{dy}{y}$ is the growth rate of per labor output, by implication, economic growth. $\frac{dA}{A}$ is the TFP growth rate and $\frac{dk}{y}$ is the rate of per labor capital change.

Assuming that export and government spending are two factors which affect Total Factor Productivity (following Dar and AmirKhalkhali (2002)). Export helps fostering productivity through concentrating investment in more efficient sectors, holding low costs to remain competitive and expanding the economy of scale, thus enhances growth of output (Emery, 1967). The role of public expenditure is mentioned above in Section 2. Therefore, economic growth not only depends on the rate of factor accumulation but also depends on both government spending and the growth rate of export. Adding those two factors into equation (3.3), we obtain:

$$\frac{dy}{y} = f(\frac{dk}{y}, \frac{dx}{y}, \frac{g}{y}) \qquad (3.4)$$

Where $\frac{dx}{y}$ is the rate of export expansion; $\frac{g}{y}$ is the relative government size.

3.1.2. Econometric Model

From equation 3.4, an econometric model is as follow:

$$\left(\frac{dy}{y}\right)_t = \alpha_0 + \alpha_i'\omega_t + \varepsilon_t \qquad (3.5)$$

Equation (3.5) is four-variable VAR model, where α_0 is constant term, α_i' is a vector of parameters, ω_t is a collection of variables with p lags for each one:

$$\omega_t = \left(\frac{dy}{y}\right)_{t-1}, \dots, \left(\frac{dy}{y}\right)_{t-p}, \left(\frac{dk}{y}\right)_{t-1}, \dots, \left(\frac{dk}{y}\right)_{t-p}, \dots, \left(\frac{dx}{y}\right)_{t-1}, \dots, \left(\frac{dx}{y}\right)_{t-p}, \dots, \left(\frac{g}{y}\right)_{t-1}, \dots, \left(\frac{g}{y}\right)_{t-p}$$

p denotes optimal length of lag, ε_t is residual with $\varepsilon_t \sim n.i.d\ (0, \sigma^2)$

To detect the relationship between government size and economic growth, we follow Chiou-Wei *et al.* (2010) using a STAR model to describe the smooth transition between regimes in the rate of growth depending on the government size. In this paper, we assume that a STAR model with two regimes is chosen.

Equation (3.5) is rewritten as follows:

$$\left(\frac{dy}{y}\right)_t = \alpha_{10} + \alpha'_{1i}\omega_t + (\alpha_{10} + \alpha'_{1i}\omega_t) \times F\left(\left(\frac{g}{y}\right)_{t-d}; \gamma; c\right) + u_t \qquad (3.6)$$

$F\left(\left(\frac{g}{y}\right)_{t-d}; \gamma; c\right)$ represents a continuous transition function that is bounded between 0 and 1. In this function, $\left(\frac{g}{y}\right)_{t-d}$ is threshold variable; d > 0 is delay parameter that a threshold variable leads the switch in regimes of a dependent variable; γ is the speed of transition process and c is estimated value of threshold variable.

Proposed by Teräsvirta and Anderson (1992) there are two popular transition functions. The first one is the logistic transition function, defined as:

$$F\left(\left(\frac{g}{y}\right)_{t-d}; \gamma; c\right) = \left\{1 + exp\left[-\gamma\left(\left(\frac{g}{y}\right)_{t-d} - c\right)\right]\right\}^{-1} \text{ with } \gamma > 0 \qquad (3.7)$$

Equation 3.6 with a continuous transition function described by equation 3.7 is so-called Logistic STAR or LSTAR. When $\gamma \to \infty$, $\left(\frac{g}{y}\right)_{t-d} < c$ then $F\left(\left(\frac{g}{y}\right)_{t-d}; \gamma; c\right) = 0$ and $\left(\frac{g}{y}\right)_{t-d} > c$ then $F\left(\left(\frac{g}{y}\right)_{t-d}; \gamma; c\right) = 1$. That implies a non-linear adjustment process and LSTAR becomes a threshold model with two regimes. When $\gamma \to 0$, the model becomes a linear VAR model.

The second transition function is so-called exponential function, follow as:

$$F\left(\left(\frac{g}{y}\right)_{t-d}; \gamma; c\right) = 1 - exp\left[-\gamma\left(\left(\frac{g}{y}\right)_{t-d} - c\right)^2\right] \text{ with } \gamma > 0 \qquad (3.8)$$

Equation 3.6 with continuous transition function described by equation 3.8 is Exponential STAR or ESTAR. In this model, when $\gamma \to 0$ and $F\left(\left(\frac{g}{y}\right)_{t-d}; \gamma; c\right) = 0$, equation 3.6 becomes a linear VAR model. When $\gamma \to \infty$ and $F\left(\left(\frac{g}{y}\right)_{t-d}; \gamma; c\right) = 1$, the model changes to another regime, implying a non-linear adjustment process of $\left(\frac{dy}{y}\right)_t$.

LSTAR model can characterize an asymmetric S-shaped transition while ESTAR model can characterize a symmetrical U-shaped transition.

3.1.3. Process

The process of detecting the relationship between economic growth and government size using STAR model approach is followed:

First, we will identify the optimal lag length (p) for linear VAR model. The optimal lag length can be determined by conventional methods, for example Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBC).

Next, we will test the linearity against non-linearity in equation 3.6. The null hypothesis is that the linearity exists, implying that $H_0: \gamma = 0$. However, γ in STAR models are not identified, therefore, we follow Luukkonen *et al.* (1988) to estimate the auxiliary regression:

$$\varepsilon_t = \beta_0 + \beta_1' \omega_t + \beta_2' \omega_t \left(\frac{g}{y}\right)_{t-d} + \beta_3' \omega_t \left(\frac{g}{y}\right)_{t-d}^2 + \beta_4' \omega_t \left(\frac{g}{y}\right)_{t-d}^3 + \varphi_t \qquad (3.9)$$

Where ε_t is the residual from equation 3.5, β_0 is the constant term, β_z' with z = 1,2,3,4 is a $(4 \times p \times 1)$ vector. Equation 3.9 is estimated across a range of value for d. Testing the null hypothesis of the linearity means testing the following hypothesis:

$$H_0: \beta_2' = \beta_3' = \beta_4' = 0$$

If the null hypothesis is rejected, that means the non-linear model hypothesis is accepted.

A next step is to choose an appropriate model between LSTAR and ESTAR in case which the the non-linear model is accepted. Thus, we will test these following null hypotheses:

$$H_{01}: \beta_4' = 0$$

$$H_{02}: \beta_3' = 0 | \beta_4' = 0$$

$$H_{03}: \beta_2' = 0 | \beta_3' = \beta_4' = 0$$

The rules for selection are as follows:

If H_{01} is rejected, the LSTAR model is selected. If H_{01} is not rejected but H_{02} is rejected, the ESTAR is selected.

If both H_{01} and H_{02} are not rejected but H_{03} is rejected, the LSTAR model is selected.

After choosing an appropriate model, we will estimate values for parameters. Especially, the LSTAR or ESTAR model is selected, we will estimate threshold value for government size, c.

This process is employed by Chiou-Wei *et al.* (2010).

In addition, we also replace trade openness (measured as the rate of per capita total import and export in GDP) for the rate of export in equation 3.6 for robustness test.

3.2. Data Descriptions and Variable Measurements

In this paper, data of China and Japan is reached from World Bank. We use annual observations for 43 years from 1971 to 2013. Main variables using in this paper are explained as follows:

DY_Y stands for per capital Gross Domestic Product (GDP) Growth. In equation (3.4), it represents for $\frac{dy}{y}$, measured by first difference of per capita GDP and divided by per capita GDP. DY_Y is a proxy for economic growth and a dependent variable in our model.

DK_Y stands for $\frac{dk}{y}$ in equation (3.4), representing for capital accumulation in economy. It is measured by first difference of gross capital formation per worker and divided by per capita GDP. Ram (1986) shows that even though population is not a good proxy for labor force in some situations, there are several advantages such as reliability and availability of population data which make population become desirable. Therefore in this paper, we used population instead of labor force to measure gross capital formation per worker.

DX_Y stands for $\frac{dx}{y}$ in equation (3.4), representing for the export expansion. It is measured by first difference of per capita exports of goods and services and divided by per capita GDP. This variable is expected to have positive impact on economic growth.

G_Y stands for $\frac{g}{y}$, representing for government size. It is measured by per capita general government final consumption expenditure divided by per capita GDP.

Besides, ***OPNS*** represents for trade openness, is measured by first difference of per capita total imports and exports of goods and services divided by per capita GDP.

Data are deflated in real terms and measured as unit of local currency. G_Y will be a threshold variable in equation (3.5) to find out the relationship between government size and economic growth.

4. RESULTS

4.1. Variables' Descriptive Statistics

Table 1 presents some basic statistics for each variable in both countries. The GDP growth in China fluctuates from -3.11% (1976) to 13.71% (2007). However, this variable in Japan varies from -5.52% (2009) to 7.14% (1973). On the other hand, government size (G_Y) in China fluctuates from 11.72% to 15.87% and reaches the average of 14.04%, meanwhile this variable in Japan swings from 11.42% to 20.57% with the average of 15.58% over 1971-2013.

Figure 2 and 3 plot GDP growth and government size in China and Japan, respectively. Both variables in China fluctuate much more compared with Japan. However, the trend of GDP growth and government consumption expenditure seems to move in the opposite.

Table 1 also presents statistics for gross capital formation growth in GDP (DK_Y) and export growth in GDP (DX_Y) for both countries.

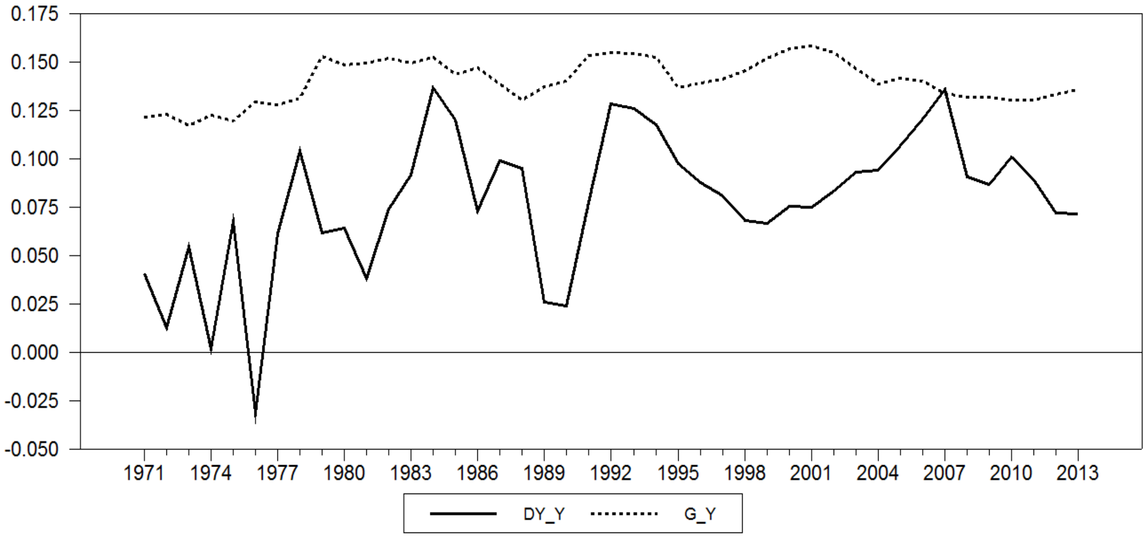

Figure-2. Government size and GDP growth in China (1971-2013)
Source: World Development Indicators, World Bank.

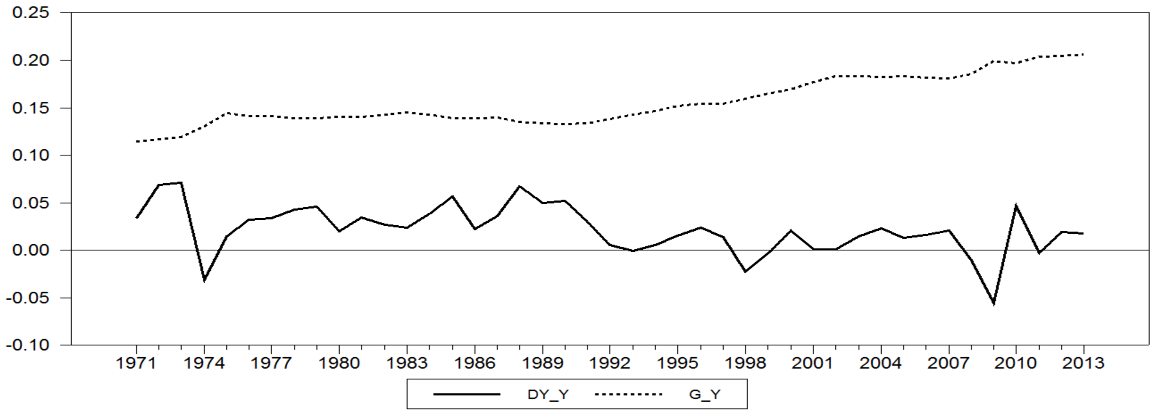

Figure-3. Government size and GDP growth in Japan (1971-2013)
Source: World Development Indicators, World Bank.

Table-1. Descriptive statistics of variables

Country	Variables	Obs	Mean	St. Dev	Min	Max
China						
	DY_Y	43	0.078367	0.03569	-0.031109	0.137053
	G_Y	43	0.140395	0.01130	0.117167	0.158683
	DK_Y	43	0.034351	0.02888	-0.028537	0.125730
	DX_Y	43	0.019085	0.02683	-0.058989	0.091689
	OPNS	43	0.036394	0.04733	-0.094271	0.152980
Japan						
	DY_Y	43	0.021647	0.02566	-0.055152	0.071420
	G_Y	43	0.155828	0.02544	0.114206	0.205724
	DK_Y	43	0.003192	0.01557	-0.038044	0.040058
	DX_Y	43	0.004380	0.00982	-0.040794	0.032942
	OPNS	43	0.007904	0.01504	-0.061941	0.046213

Source: estimated by the authors

4.2. Unit Root Tests

Based on visual observations of variables used in this paper, Phillips-Perron and Augmented Dickey-Fuller (ADF) unit root tests with constant and no trend are utilized to test stationarity. Table 2 shows results for unit root tests for both techniques. Almost variables are stationary at 1%, except government size (G_Y). However, differencing of this variable (D(G_Y)) shows stationary at 1% for both countries.

Table-2. Summary of unit root tests.

Country	Variables	Phillips-Perron	ADF
China			
	DY_Y	-3.80683***	-3.22382**
	G_Y	-2.38839	-2.26714
	DK_Y	-4.90085***	-4.84245***
	DX_Y	-5.28358***	-5.09584***
	OPNS	-4.99673***	-4.84566***
	D(G_Y)	-6.30349***	-6.14403***
Japan			
	DY_Y	-4.84667***	-4.69446***
	G_Y	-0.18226	0.04569
	DK_Y	-4.51936***	-4.48985***
	DX_Y	-9.68613***	-8.69085***
	OPNS	-9.2508***	-7.9774***
	D(G_Y)	-4.73936***	-4.65224***

Note: *** denotes significance at 1%

4.3. VAR Estimation and Tests for Linearity

Based on conventional approaches (AIC/SBC), the 1-lag length is the optimal lag in VAR model for both countries.

Table 3 presents the results for VAR estimate for China and Japan.

Table-3. Results for VAR estimates.

	Dependent variable DY_Y	
Independent variables	**China**	**Japan**
Constant	0.0368(0.0128)***	0.0142(0.0084)
DY_Y_{t-1}	0.4185(0.2279)*	0.7995(0.3655)**
$D(G\_Y)_{t-1}$	1.5799(0.8196)*	-1.3372(1.4765)
DK_Y_{t-1}	0.1430(0.2717)	-0.8683(0.6293)
DX_Y_{t-1}	0.2731(0.1984)	-1.2242(0.4489)***
σVAR	0.0285	0.0217
ARCH(1)	0.023[0.87992]	0.551[0.4624]
ARCH(4)	1.236[0.31535]	0.255[0.9042]
JB	19.0404[0.000]	14.381235[0.000754]

Notes: *, ** and *** respectively denote significance at 10%, 5% and 1%. ARCH is the test of Autoregressive Conditional Heteroskedasticity, JB is the Jarque-Bera normality test. Standard Errors are given in the parentheses and p-values are given in the square brackets.

Results of VAR model in China is presented in Column 2. There are only two variables which are able to explain the economic growth at 10%. Especially, the difference of government consumption expenditure in GDP has statistically significant positive impact on economic growth. An expansion of gross capital formation as well as exports of goods and services do not contribute growth of economic following statistically insignificant coefficients.

In context of Japan, an expansion of exports of goods and services (DX_Y) which appears in the model as a measure of TFP shows significantly negative at 1%. A coefficient of government consumption expenditure is negative even though it is insignificant. Both negative coefficients of these variables might imply a slowdown of TFP in Japan which are also found in studies of Amador and Coimbra (2007) and Cette *et al.* (2009) (Column 3 in Table 3).

Table 3 also presents some tests to residuals in both countries. ARCH test is the test for Autoregressive Conditional Heteroskedasticity effects. Following Chiou-Wei *et al.* (2010) we decided to test ARCH effects with 1 lag and 4 lags respectively. Results show that there is no serially correlation in residuals. Residuals have normal distribution, mean is 0 and variance is constant.

However, the relationship among variables and especially the relation between government size and economic growth in China and Japan might be explained better by non-linear models. Therefore, next step, we implement the test of linearity against non-linearity (in this paper specified by STAR model) following the process described in Section 3.1.3. The range of plausible values for delay parameter (d) is set from 1 to 5. The optimal delay length is the one which has the minimum p-value of the LM test statistic in Equation (3.9). As a result, d = 2 and ESTAR model is selected for China while d = 1 and LSTAR model is the proper one for Japan (Table 4).

Based on linearity tests and appropriate model selection, next, we proceed to estimate the proper STAR model for each country.

Table-4. Linearity tests and model selection.

Country	Delay (d)	H_0	H_{01}	H_{02}	H_{03}	Model
China	1	0.1734	0.6100	0.1844	0.0721	
	2	**0.0552**	**0.1507**	**0.0895***	**0.2241**	**ESTAR**
	3	0.0753	0.2168	0.0825	0.2392	
	4	0.7466	0.7183	0.9069	0.1920	
	5	0.4435	0.4849	0.3475	0.3911	
Japan	**1**	**0.0708**	**0.0135***	**0.7184**	**0.4716**	**LSTAR**
	2	0.1023	0.0403	0.4341	0.4924	
	3	0.1359	0.2774	0.4235	0.0602	
	4	0.8126	0.6738	0.9219	0.3125	
	5	0.9627	0.8461	0.8229	0.7502	

Note: Asterisk signs indicate minimum p-value.

4.4. Smooth Transition Autoregressive Model Estimation

After identifying the type of model and the delay length of a transition variable, the next step is to estimate the proper STAR model for each country. The ordinary least square cannot be used to estimate for STAR models, Therefore the nonlinear least square approach is adopted to reach the estimates of the parameter values instead. Suggested by Teräsvirta (1994) the exponent of transition function is standardized by using standard deviation of transition variable (σ_{G_Y}) in LSTAR model and variance of transition variable in ESTAR model ($\sigma^2_{G\_Y}$). This makes it easier to choose starting value for γ.

The process of STAR model estimates is applied using sample mean of government consumption expenditure in GDP (G_Y) variable as starting value for threshold variable. However, there is only convergence found for China. Results of LSTAR model estimates for Japan do not reach convergence. This may imply that LSTAR is not an appropriate model for data of Japan. It is careful to keep in mind that in spite of rejection of linearity and STAR model is selected, it is not necessary to imply STAR model fitted. It might be explained by another non-linear model. Hence, from now on, we concentrate on STAR model estimation for China only.

In fact that results for ESTAR straightforwardly estimated from VAR(1) do not show a good estimated model when all variables in both regimes are insignificant. Therefore, we decided to remove variables which have the smallest t-statistic until all t-statistic of parameters are greater than 1 in absolute value (following Van Dijk *et al.* (2000)). The final model is presented in Table 5.

Table-5. ESTAR model estimated for China (2).

	Dependent variable DY_Y	
Independent variables	**Coefficients**	**p-Value**
Constant	0.0379 (0.0116)***	0.0026
$D(G\_Y)_{t-1}$	3.9710 (2.4018)	0.1077
DX_Y_{t-1}	1.6762 (0.4348)***	0.0005
$DY\_Y'_{t-1}$	0.5086 (0.1485)***	0.0017
$D(G\_Y)'_{t-1}$	-3.1943 (2.5632)	0.2215
$DX\_Y'_{t-1}$	-1.6695 (0.4866)***	0.0016
γ	59376.8687 (54039.249)	0.2798
c	0.1423 (0.0018)***	0.0000
σ_{STAR}	0.0265	
ARCH(1)	0.087	0.7701
ARCH(4)	1.729	0.1679
JB	53. 2733	0.0000

Notes: *** denotes significance at 1%. ARCH is the Autoregressive Conditional Heteroskedasticity test; JB is the Jarque-Bera normality test. σ_{STAR} is the standard deviation of residuals. Standard errors are given in parentheses.

First of all, this model shows significance for almost variables at 1% except DG_Y. The diagnostic tests on residuals, serial correlation and normality tests all support the STAR model for China. Furthermore, $\sigma^2_{STAR}/\sigma^2_{VAR} = (0.0265)^2/(0.0285)^2 = 0.8646$ less than 1 demonstrates the outperformance of STAR model compared to linear model.

Figure 4 plots STAR versus linear model residuals. In general, we can see that the STAR model captures a recovery of per capita GDP growth better than the linear model, especially in some periods such as (1979-1981), (1988-1990) and (1997-1998). Those periods witness the strong recovery in China's GDP growth.

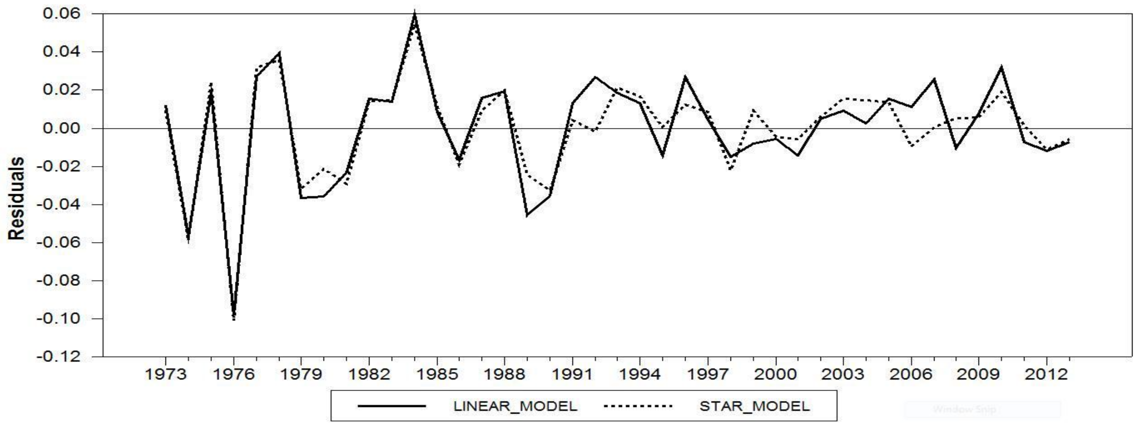

Figure-4. STAR versus Linear model residuals

Source: estimated by the authors

In this model, γ takes a quite large value and not significant. However, following Van Dijk *et al.* (2000) insignificance of γ might not be interpreted for the weakness of nonlinearity. Large changes in γ have very small effect on transition function and the reasons for a large standard error are solely numerical. Therefore it is not necessary to get the precise value for γ.

Figure 5 illustrates the estimated exponential smooth transition function against the threshold variable (G_Y_{t-2}) for China. The threshold value is found at 14.23%. The number of observations falling in Regime 1 dominates. When government size is asymptotic to the threshold value, the transition function is close to 0 and the relation between economic growth and government consumption expenditure is strongly positive (the coefficient is 3.9710 even though it is insignificant). When government consumption expenditure is larger than the threshold value, the relation is still positive but remains marginally.

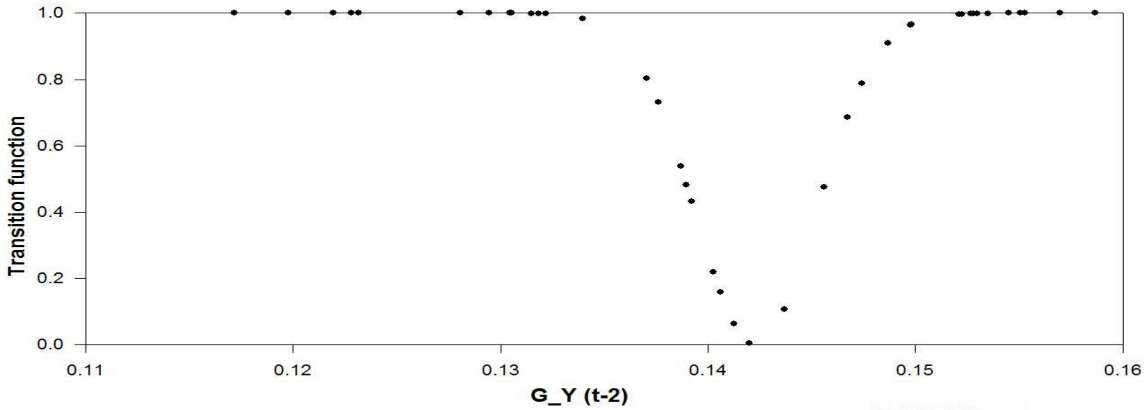

Figure-5. The estimated transition function for China

Source: estimated by the authors

Next, we consider parameter estimates in the model. The growth of exports of goods and services in GDP (DX_Y) affecting economic growth as a measure of TFP is statistically significant in both regimes. In regime 1, it has strongly positive impact on economic growth. In regime 2, even though it still remains positive, there is only marginal effect. The coefficient of DX_Y in regime 2 is close to 0 (1.6762 – 1.6695 = 0.0067).

Coefficients of government size (D(G_Y)) do not show significance in the model. However, we should pay a little attention on the magnitude of coefficients. First, in regime 1, the coefficient is quite large and positive, meanwhile it is marginally positive in regime 2 (3.9710 – 3.1943 = 0.7767). This might imply that an impact of government size on economic growth declines when government consumption expenditure exceeds a threshold value. Second, because the positive impact of government size still remains positive as government size is larger than the threshold value, this means BARS curve is not found in China case and the optimal value of government size which causes negative effect on economic growth might be larger than 14.23% (found in this paper). Moreover, even though the relationship between per capita GDP growth and government consumption expenditure is not negative when government size exceeds the threshold value, remaining marginally positive (coefficient of D(G_Y) in Regime 2 is 0.7767) partly indicates the inefficiency of government expenditure. Therefore, it is possible to cause the adverse impact of government spending on economic growth if the government spending continues to grow.

As a result of marginally positive coefficients in both DX_Y and D(G_Y) when government expenditure is beyond the threshold value, it possibly indicates that TFP growth is slipping away in China. This is similar to results found in Wu's research (2014). In his paper, he discovers "China's best TFP growth post-reform is found for 2001-07 by 4.1 percent per annum and poorest TFP performance is found for 2008-12 by -0.8 percent" (p.1).

The model is estimated again with replacement of the growth of trade openness (OPNS) for the growth of exports of goods and services. In this model, the growth of trade openness in GDP takes a role of the factor which affects economic growth via a measure of TFP. Results are similar with the model described above and are given more detailed in Appendix.

In fact that, this paper only uses general government consumption expenditure as a proxy for government size to detect the relationship between government size and economic growth due to the limit of data availability. It would be more interesting and useful for policy makers if we can use other proxies for it such as government investment spending, government transfer payments, the number of employees working for public sector…As discovered in former studies, each of them has different impact on growth.

5. CONCLUSION

Research on the relationship between economic growth and government size is not a fresh topic in not only academic field but also policy making. However, reduction of GDP growth and an increase in government spending in almost countries in recent years over the world make it become a non-stop theme. Many authors have tried to model this relation under various approaches and employ different dataset. Results among of them seem quite conflictive. In this paper, we support the non-linear nexus between GDP growth and government size and investigate this relation under a new approach of Smooth Transition Autoregressive model. Employing data of China and Japan over 1971-2013 period, results show that STAR model (ESTAR) is fitted better for China, however, it is not an appropriate model for Japan in spite of rejection of linear relationship. Consequently, the objective for comparison between China and Japan could not be obtained. The optimal threshold value for government size in China is found at 14.23% and 14.18% for the case in which the growth of trade openness (proxied by the growth of total imports and exports of goods and services in GDP) is a measure for TFP. Nonetheless, when the government expenditure is larger than this threshold, it does not cause an adverse impact on growth immediately. Instead of that, it remains marginally positive effect for both measures of TFP, an expansion of exports of goods and services (or an expansion of trade openness) and growth of government consumption expenditure (even insignificant coefficients found) on per capita GDP growth. Therefore, BARS curve is not truly supported for China. In spite of that, it partly implies that government spending is inefficiently used when government size beyond the threshold value. In last couple of years, China has pursued the high economic growth using extensive government expenditure as the major policy tool. Investment in public infrastructure has been growing faster. This helps to stimulate China's economy through the positive support for the private sector (Wang and Wen, 2013). However, an expansion of public spending also has its cost. With large multiplier effect (more than 2), the government expenditure might be a main cause of macroeconomic instability, unintended inflation and boom-bust cycles (Wang and Wen, 2013) which means a decrease in economic growth.

Finally, it does not suggest a reduction of government spending. The problem is use of resources. An inefficient allocation of resources causes crowding out effects and costs. Consequently, we need to pay attention on government's efficient resource use to enhance productivity, which also means an increase in economic growth.

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APPENDIX

Results of ESTAR estimation for China in which the growth of trade openness (OPNS) is used

Table-A.1. VAR lag selection based on AIC

Country	Lags				
	1	2	3	4	5
China	**-21.579510***	-20.951162	-19.299414	-17.142877	-13.075599
Japan	**-28.141103***	-27.743288	-26.356964	-24.197346	-20.005947

Note: * denotes the optimal lag.

Table-A.2. VAR estimate

	Dependent variable DY_Y
Independent variables	
Constant	0.0368 (0.0129)***
DY_Y_{t-1}	0.4614 (0.2219)**
$D(G\_Y)_{t-1}$	1.5097 (0.8208)*
DK_Y_{t-1}	0.0628 (0.2581)
$OPNS_{t-1}$	0.1277 (0.2536)
σVAR	0.0287
ARCH(1)	0.037 [0.8483]
ARCH(4)	1.280 [0.29834]
JB	16.2898 [0.00029]

Notes: *, ** and *** respectively denote significance at 10%, 5% and 1%. ARCH is the test of Autoregressive Conditional Heteroscedasticity, JB is the Jarque-Bera normality test. Standard Errors are given in the parentheses and p-values are given in the square brackets.

Table-A.3. Linearity test and model selection for China

Delay (d)	H_0	H_{01}	H_{02}	H_{03}	Model
1	0.2004	0.7515	0.1699	0.0657	
2	**0.0693**	**0.2506**	**0.0759***	**0.1853**	**ESTAR**
3	0.1025	0.2863	0.0969	0.2221	
4	0.7450	0.7917	0.9094	0.1466	
5	0.3426	0.3248	0.3821	0.3667	

Note: Asterisk signs indicate minimum p-value.

Table-A.4. ESTAR estimate for China

	Dependent variable DY_Y	
Independent variables	**Coefficients**	**p-Value**
Constant	0.0391 (0.0113)***	0.0015
$D(G\_Y)_{t-1}$	3.2054 (2.1791)	0.1508
$OPNS_{t-1}$	1.0099 (0.2625)***	0.0005
$DY\_Y'_{t-1}$	0.4980 (0.1500)***	0.0022
$D(G\_Y)'_{t-1}$	-2.4558 (2.3641)	0.3065
$OPNS'_{t-1}$	-1.0061 (0.2889)***	0.0014
γ	61528.1224 (49056.0073)	0.2186
C	0.1418 (0.0015)***	0.0000
σ_{STAR}	0.02655	
ARCH(1)	0.045	0.8334
ARCH(4)	1.655	0.1848
JB	55.2236	0.0000

Notes: *, ** and *** respectively denote significance at 10%, 5% and 1%. ARCH is the test of Autoregressive Conditional Heteroscedasticity, JB is the Jarque-Bera normality test. Standard Errors are given in the parentheses and p-values are given in the square brackets.

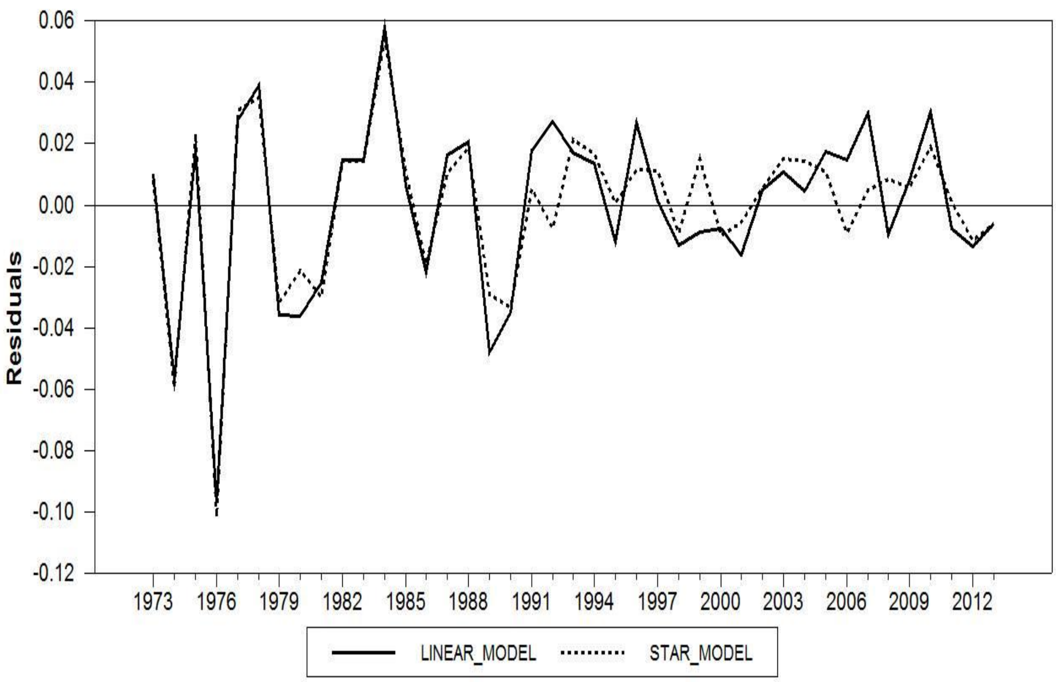

Figure-A.1. STAR versus Linear model residuals

Source: estimated by the authors

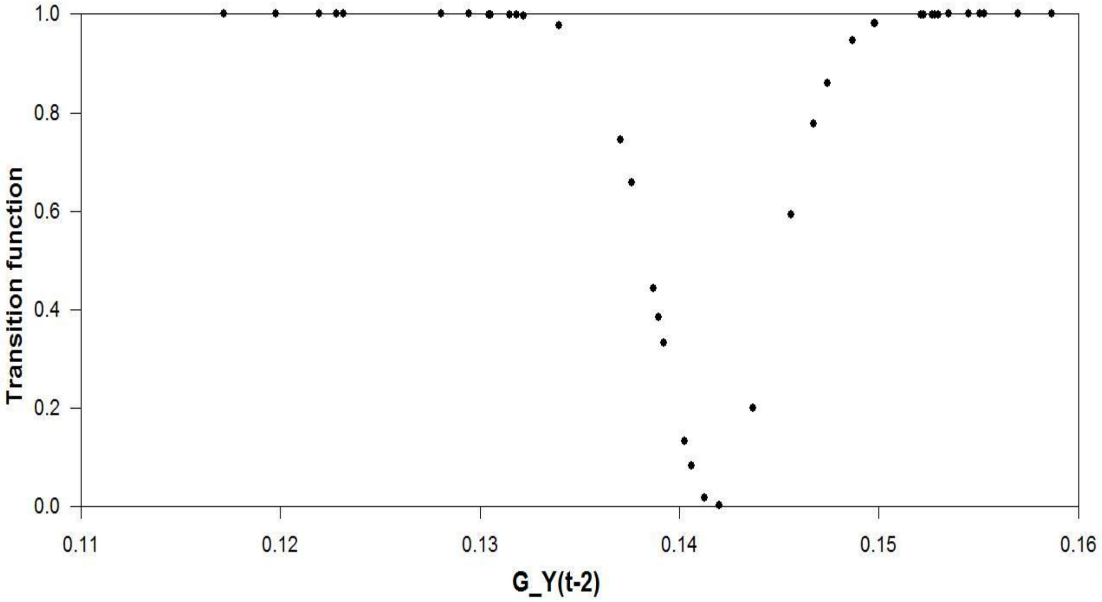

Figure-A.2. The estimated transition function for China

Source: estimated by the authors