
Does Government Debt Promote Economic Growth? An Empirical Analysis with Structural Breaks for the Economy of China

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This paper investigates the relationship between economic growth and government debt for one of the biggest economies in the world, the economy of China. The data were fitted into a regression equation using econometric techniques such as unit root tests and Granger causality. Regarding unit root tests we are using three kind of tests: i) The conventional unit tests, which do not take into account structural breaks, ii) the unit root tests that take into account one structural break and iii) tests that take into account multiple structural breaks. The analysis is based on data over the period 1984 to 2011 for China. The results reveal that there are structural breaks in the economy of China but no Granger causality between the variables.

Keywords Economic growth; Government Debt, Unit Root tests, Structural Breaks, Bai Perron Test, Granger causality.

JEL Classifications: A10; C32; N15; O40;

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Introduction

The impact of public debt on economic growth is one of the most long standing subjects in the history of macroeconomics. Nowadays the policy makers around the world are facing increasing fiscal imbalances, so the relation between these variables has become crucial for the economies.

In economic theory, it is accepted that with a typical Keynesian behaviour, fiscal policy may induce economic growth at moderate levels of public debt. As we are moving at high levels of public debt, the increases of the expected tax will reduce the positive effects of public spending, it will decrease the all the consumption expenses and the investments and finally we will have lower growth rates and less employment. Also in the economic literature there is a clear consensus view that, with lower levels of growth we have less public revenue and more public expenditure, which lead and contribute to the increasing of public debt.

Literature Review

The literature on the relevance of government debt and economic growth is scarce. Most of the studies are emphasizing in the impact of external debt and debt restructuring on economic growth in developing countries, while analyses for developed countries are virtually absent. Analyses like that become even more relevant as many governments around the world are facing mounting fiscal pressures, with the financial and economic crisis to be so close.

The theoretical literature on the relationship between public debt and economic growth tends to point to a negative relationship. Growth models augmented with public agents issuing debt to finance consumption or capital goods tend to exhibit a negative relationship between public debt and economic growth, particularly in a neoclassical setting.

The empirical evidence on the relationship between debt and growth is primarily focused on the role of external debt in developing

countries. Several recent studies find support for a non-linear impact of external debt on growth. Pattillo et al. (2002) used a large panel dataset of 93 developing countries for the period 1969-1998. They found that the impact of external debt on per-capita GDP growth is negative for net present value of debt levels above 35-40% of GDP. Also Clements et al. (2003) used a panel of 55 low-income countries for the period 1970-1999. They found that the turning point in the net present value of external debt is at around 20-25% of GDP. Other empirical studies that find a non-linear effect of external debt on growth are those of Smyth and Hsing (1995) and Cohen (1997). On the other hand, in his study Schclarek (2004) found that there was a linear negative impact of external debt on per-capita growth in a panel of 59 developing countries for the period 1970-2002.

According to (Feldstein, 1982); (Hoelscher, 1986); (Abell, 1990); (Miller and Russek, 1996); (Raynold, 1994); (Tanzi and Fanizza, 1995); (Cebula, 1993 and 1997); (Svensson, 1997); (Mitra, 1997); and (Vamvoukas, 1997) government debt increases interest rates, and as a consequence is an obstacle to the entrepreneurial activities (Georgiou, 2009b). Schclarek (2004) in his study investigated the relationship between gross government debt and per capita GDP growth in developed countries, but he didn't find any robust evidence of significant relationship. In a recent paper Reinhart and Rogoff (2010), analyze the developments of public debt and the long-term real GDP growth rate in 20 developed countries for a period that cover about two centuries (1790 - 2009). They found that the relationship between government debt and long-term growth is weak for debt/GDP ratios below 90% of GDP; above 90%, the median growth rate is falling by 1% and the average by considerably more.

Debt can influence economic growth with another channel, the channel of total factor productivity (TFP). This idea has been expressed by Patillo (2004) and many other researchers. According to the theory of productivity we can link debt and growth. It has been

stated that as a country funds its deficits by foreign external debt, it dedicates a larger fraction of the future output to foreign entities. This in turn can reduce the incentives for higher productivity as people will not be motivated to innovate and become more efficient because foreign investors would benefit most. With dangerously high levels of debt, investments decrease and uncertainty increases. This change in expectations has a structural change in investments, which become predominantly short-term rather long-term. All these changes have a negative effect on the sustained capital accumulation since the investments bear a higher risk and uncertainty. Intuitively no investor would like to tie a big portion of capital in an investment that may be risky. This may have a negative effect on productivity in the economy. An attempt has been made to incorporate debt in the Solow model for an open economy by Villanueva et al (2006). They found that in the long-run the debt-to-GDP ratio can vary substantially based on differing levels of savings, investments, depreciation and exogenous factors such as perceived risk and required risk premiums from lenders. They assumed that in the long-term projection the equilibrium debt-to-GDP ratio is fixed but it can be altered through the above mentioned factors.

On a recent paper Abbas and Christensen (2007) tried to explore the role of domestic debt markets in economic growth. Their study covered 93 countries over the 1975 to 2004 period and revealed that government debt markets play an increasingly important role in supporting economic development in developing countries.

According the macroeconomic theory the government expenditures should have positive relationship with the level of economic growth. The above theory is supported by the paper of Freeman and Webber (2009). In their paper they found that expenditures such as education, health and nutrition (productive type of expenditure) can leads to the economic growth and returns. We must mention that the returns can only be seen in few years time. Also according to the authors, the

productive expenditures can give direct impact to the improvement of the well-being the welfare of the citizens. As a result, from all the above we can achieve the higher level of economic growth. However, if most of the parts of the government expenditures are driven to unproductive type of expenditures, then this will result to the economic growth and we will give us a decline (Hayati, 2012).

The majority of the policymakers seem to think that government debt reduces long-run economic growth. This view agreed with the results of the empirical literature which shows that there economic growth and debt are in negative correlation in advanced and emerging economies. The correlation is becoming strong when government debt approaches 100 percent of GDP (Reinhart and Rogoff, 2010a,b; Kumar and Woo, 2010; Checherita and Rother, 2010; Cecchetti, Mohanty and Zampolli, 2011).

In this paper we investigate the causal relationship between the government debt to GDP ratio and economic growth for a big economy like China, for a period from 1984 to 2011.

Data

This study uses annual time series data on GDP per capital and Gross Government Debt (as percentage on GDP) sourced from IMF (International Monetary Fund). The data covers the period between 1984 and 2011 in China. The logarithm of GDP and Gross Government Debt are used in the analysis. The transformation of the series to logarithms is intended to eliminate the problem of heteroskedasticity

Econometric Methodology

The basic equation we are using is $GDP_t = f(DEBT_t)$ and $GDP_t = \beta_0 + \beta_1(DEBT_t) + \mu_t$ according the model proposed by Georgiou (2009). In order to avoid spurious regression outcomes on

the time series data, we are using unit root tests that affirm the stationarity of the series. In this paper we use three kinds of unit roots tests. Firstly we use the traditional unit roots tests which do not take into account structural breaks such as Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) the Phillips-Perron test (1988) and the test of Kwiatkowski et al. (1992). The second kind of unit root tests we use are the tests that take into account one structural break such as Zivot and Andrews (1992). The third method we use in the paper is the Bai Perron (1998, 2001) test for estimating linear regression models subject to multiple breaks. Finally we have used Granger causality analysis in order to investigate the relationship between GDP and Gross Government Debt.

4.1 UNIT ROOT TESTS WITHOUT STRUCTURAL BREAKS

ADF test

$$\Delta y_t = c + \alpha y_{t-1} + \sum_{j=1}^k d_j \Delta y_{t-j} + \varepsilon_t \quad (1)$$

$$\Delta y_t = c + \alpha y_{t-1} + \beta_t + \sum_{j=1}^k d_j \Delta y_{t-j} + \varepsilon_t \quad (2)$$

The first equation (1) tests the null of a unit root against a mean stationarity in y_t (y is the time series we examine each time). The second equation (2) tests the null of a unit root against the alternative of trend stationarity (ΔY_{t-j} is lagged first differences)

PHILLIPS PERRON TEST

The PP test (1988) makes the semi-parametric correction for autocorrelation and its more powerful in the case we have weakly autocorrelation and heteroskedastic regression residuals. We can say that Phillips Perron test is an extension of the ADF test.

KPSS TEST

Unlike most of the unit root tests Kwiatkowski-Phillips-Schmidt-Shin (1992) provide a test where the null hypothesis is that a series is stationary. The test has been developed to complement unit root tests

as the last have low power with respect to near unit root and long run trend process.

4.2 UNIT ROOT TESTS WITH STRUCTURAL BREAKS

4.2.1 Zivot and Andrews Model:

Zivot and Andrews (1992) proceed with three models to test for a unit root: model A, which permits a one-time change in the level of the series; model B, which allows for a one-time change in the slope of the trend function, and model C, which combines one-time changes in the level and the slope of the trend function of the series. The 3 models are:

$$\Delta Y_t = \kappa + \alpha * Y_{t-1} + \beta * t + \theta_1 DU_t + \sum_{j=1}^k d_j \Delta Y_{t-j} + \varepsilon_t \quad (\text{Model A})$$

$$\Delta Y_t = \kappa + \alpha * Y_{t-1} + \beta * t + \gamma_1 DT_t + \sum_{j=1}^k d_j \Delta Y_{t-j} + \varepsilon_t \quad (\text{Model B})$$

$$\Delta Y_t = \kappa + \alpha * Y_{t-1} + \beta * t + \vartheta_1 DU_t + \gamma_1 DT_t + \sum_{j=1}^k d_j \Delta Y_{t-j} + \varepsilon_t \quad (\text{Model C})$$

DU_t is an indicator dummy variable for a mean shift occurring at each possible break-date (TB) while DT_t is corresponding trend shift variable

$$DU_t = \begin{cases} 1 & \text{if } t \succ TB \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad DT_t = \begin{cases} t - TB & \text{if } t \succ TB \\ 0 & \text{otherwise} \end{cases}$$

The null hypothesis in all the models is that $\alpha=0$, which means that the series $\{y_t\}$ contains a unit root with a drift that excludes any structural break. The alternative hypothesis is that $\alpha < 0$. It implies that the series is a trend-stationary process with a one-time break occurring at an unknown point in time.

The Bai-Perron Method

Bai and Perron (1998, 2001) proposed a method for estimating linear regression models subject to multiple breaks. The model assumes that the dependent variable, y_t , is related to a set of state variables, x_{t-1} but that the relationship has been subject to q breaks up to time T :

$$\begin{aligned} y_t &= \beta'_1 x_{t-1} + \hat{u}_t & t = 1, 2, \dots, T_1 \\ y_t &= \beta'_2 x_{t-1} + \hat{u}_t & t = T_1 + 1, \dots, T_2 \\ y_t &= \beta'_{q+1} x_{t-1} + \hat{u}_t & t = T_q + 1, \dots, T \end{aligned}$$

$T_1 < T_2 < \dots < T_q < T$ and U_t is a disturbance term. The Bai and Perron method permits consistent estimation of the number and location of the breakpoints and the parameters.

The model it's possible to be restricted to allow partial breaks that only affect some of the regression coefficients. Because the breaks are viewed as deterministic and the approach thus does not require specifying the underlying process that generated the breaks in the first place. The approach relies on a number of design parameters such as the maximum number of breaks and the minimum distance between breaks.

We can determine the number of the breaks with many ways. One approach is to determine the number of breaks sequentially by testing for $q + 1$ against q breaks. Alternatively a global approach of testing for q breaks against no breaks can be used. Finally, the number of breaks can be selected by using penalized likelihood methods such as the Schwarz information criterion (SIC) or Akaike's information criterion (AIC) which differ in terms of the penalty they apply to the inclusion of additional breakpoint parameters. All of the above and other practical issues are further discussed in Bai and Perron (2001).

4.3 GRANGER CAUSALITY TEST

The test procedure as described by (Granger 1969) is illustrated below:

$$GDP = \sum_{j=1}^K A_j ED_{t-i} + \sum_{j=1}^K B_j GDP_{t-j} + U_{it} \quad (3)$$

$$DEBT = \sum_{j=1}^K C_j DEBT_{t-j} + \sum_{j=1}^K D_j GDP_{t-j} + U_{2t} \quad (4)$$

Equation (3) represents that current GDP is related to past values of itself as well as that of DEBT and vice-versa for Eq. (4). Unidirectional causality from DEBT to GDP is indicated if the estimated coefficient on the lagged DEBT in equation (3) are statistically different from zero as a group and the set of estimated coefficients on the lagged GDP in Eq. (4) is not statistically different from 0. The converse is the case for unidirectional causality from GDP to DEBT. Bilateral causality exists when the sets of DEBT and GDP coefficient are statistically different from 0 in both regressions (Gujarati, 2004). (Note: we are using the variables in first differences).

Empirical Results

Unit Root Tests without Structural Breaks

In order to guard against spurious regression we have to find whether our variables are stationary or non stationary. So we applied unit root tests to check the stationarity. The results of the tests we have used are presented in Table 1. We have expressed our variables in natural logarithms so that elasticities can be determined.

Insert Table 1

All the unit root tests (without structural break) have shown that our variables are integrated of order I (1).

Zivot Andrew's Results

In Table 2 we represent the results for Zivot and Andrew's unit root test (with one structural break). The results suggest that we can reject the null of unit root for the variables of DEBT and GDP (with statistical significance at level 10%). At the same time, the test identifies endogenously the point of the most significant structural break in every time series examined in the paper. The Break point for the variable of DEBT is 1998 (Figure 1), since 1998 was the year of the Asian financial crisis. The Break point for the variable of GDP is

2005 (Figure 2). If we move back to 2005 in the economic history of China we can find that in 2005, regulations that prevented privately-owned companies entering a number of sectors of the economy, such as infrastructure, public utilities and financial services were abolished. With this decision further improvement in multifactor productivity was possible. All these changes have permitted the emergence of a powerful private sector in the economy.

Results of Bai-Perron's breakpoint test

The next test we had obtained was the Bai-Perron's breakpoint test. In Table 3 we report the optimal number of breakpoints (i.e the one associated with the minimum BIC score or the maximum Log – Lik score). The optimum number of breakpoints we have in our model is 4 and the breaks were in the years 1989, 1993, 2002 and 2007.

Granger Causality Test

After the stationarity we proceed to find the causality using the Granger causality test. Table 4 presents our findings. From the results there is no evidence that there is any causality between Government Debt (DEBT) and economic growth (GDP) in China. We can state that government debt is not a specific factor determining the rate of economic growth or economic slowdown in China.

Conclusions

In this paper we empirically examined the relationship between economic growth and government debt for the economy of China. In order to test the stationarity of our variables we have used two kinds of unit root tests. The traditional unit roots tests which do not take into account structural breaks such as Augmented Dickey-Fuller (ADF) tests (Dickey and Fuller, 1979 and 1981) the Phillips-Perron test (1988) and the test of Kwiatkowski et al. (1992). The results have shown that our variables are stationary of order one. The second kind

of unit root tests we have used are the tests that take into account one structural break such as Zivot and Andrews test (1992). The Zivot and Andrews's test indicated that the Break point for the variable of DEBT was 1998 and for the variable of GDP was 2005.

After the unit root tests we have tested our model with Bai Perron's test. The Bai Perron's method (1998, 2001) is using for estimating linear regression models subject to multiple breaks. The test has shown that the optimum number of breakpoints we have is 4 and the breaks were in years 1989, 1993, 2002 and 2007. Finally we have used Granger causality analysis in order to investigate the relationship between our variables. The results suggested that we cannot establish causality between government debt and growth in China.

The first aim of the paper was to contribute to the empirical literature on the effects of government debt to economic growth. Our findings are in line with the results of Schclarek's (2004) survey where he didn't find any robust evidence of significant relationship between gross government debt and per capita GDP growth in developed countries. Also our results agree with the results of Reinhart and Rogoff (2010), where they found that the relationship between government debt and long-term growth is weak for debt/GDP ratio. The second aim of this paper was to examine the economy of China for structural changes during the last decades. Our results indicated that China (regarding the variable of growth and the variable of government debt) is clearly characterized by dynamic transformations. The economy of China has been affected by critical economic incidents that lead the variables of GDP and government debt to yield structural breaks.

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Annexes:

Table 1

Unit Root Tests

	Dickey – Fuller			Phillips - Perron		KPSS	
	τ_{μ}	τ_{τ}		τ_{μ}	τ_{τ}	η_{μ}	η_{τ}
LGDP	0.637 [0.988]	-3.251 [0.066]	1	0.763 [0.991]	-1.760 [0.696]	0.675**	0.115***
LDEBT	-2.870 * [0.041]	-3.517 * [0.046]	1	-2.710 * [0.041]	-3.514 * [0.038]	0.669**	0.192**
Δ LGDP	-3.546** [0.015]	-3.567 * [0.053]	0	-2.984 ** [0.049]	-3.734 ** [0.042]	0.122	0.052
Δ LDEBT	- 8.083*** [0.000]	-7.878 ** [0.000]	0	-8.083 *** [0.000]	-7.878 *** [0.000]	0.262	0.103

Notes:

τ_{μ} is the t-statistic when a time trend is not included in the equation and τ_{τ} is the t-statistic when a time trend is included in the equation. The calculated statistics are those reported in Dickey-Fuller (1981). The critical values for the tests of Dickey – Fuller and Phillips - Perron are at 1% -3.711, at 5% -2.981 and at 10% -2.630 for τ_{μ} and -4.47, -3.65 and -3.26 for τ_{τ} respectively.

η_{μ} and η_{τ} are the KPSS statistics for testing the null hypothesis that the series are I(0) when the residuals are computed from a regression equation with only an intercept and intercept and time trend, respectively. The critical values at 1%, 5% and 10% are 0.739, 0.463 and 0.347 for η_{μ} and 0.216, 0.146 and 0.119 for η_{τ} respectively (Kwiatkowski et al, 1992, table 1).

***, **, * indicate significance at the 1, 5 and 10 percentage levels.

Table 2

Zivot Andrew's test

	t-Statistic	Break Point
Zivot-Andrews test statistic (DLGDP)	-4.712704	2005
Zivot-Andrews test statistic (DLDEBT)	-8.394546	1998
1% critical value:	-5.34	
5% critical value:	-4.93	
10% critical value:	-4.58	

Table 3

Bai-Perron Breakpoints Test

Breakpoints	0	1	2	3	4	5
BIC	14.62549	8.736564	-7.646532	-14.42801	-21.72394	-18.21867
Log-Lik	-0.721071	8.815066	23.59829	33.58070	43.82034	48.65938
RSS	1.667578	0.822828	0.275254	0.131401	0.061545	0.043005
N. Coefs	4.000000	8.000000	12.00000	16.00000	20.00000	24.00000

Chosen number of breaks: 4

Breaks : 1989
 1993
 2002
 2007

Table 4

Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
DLGDP does not Granger Cause DLDEBT	25	0.89009	0.4263
DLDEBT does not Granger Cause DLGDP		1.91237	0.1738

Figure 1

Zivot – Andrew's Breakpoint DLDEBT (1998)

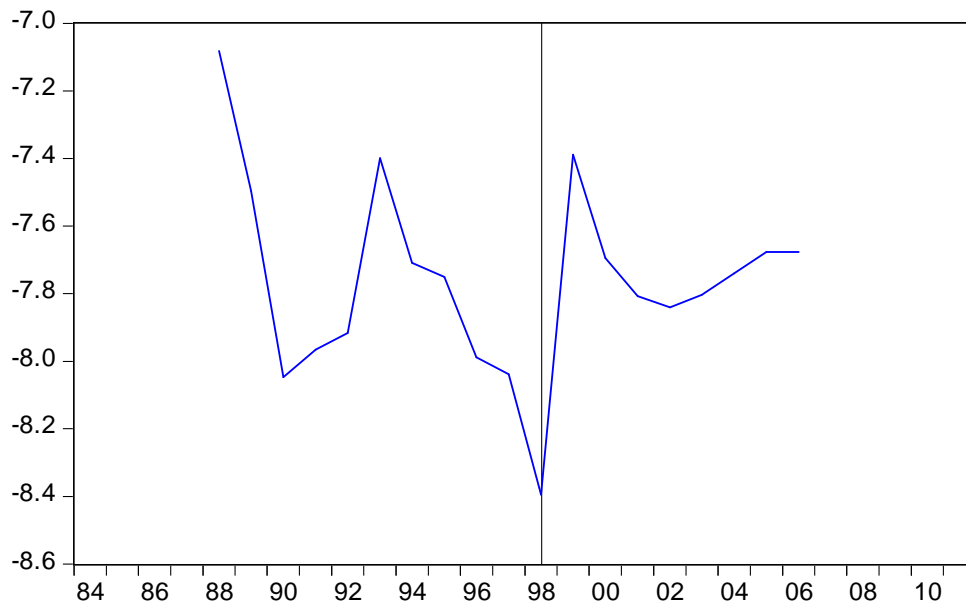


Figure 2

Zivot – Andrew's Breakpoint DLGDP (2005)

