On the dynamics of sovereign debt in China: sustainability and structural change

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Abstract

The dynamics of public debt are an important determinant of the macroeconomic environment of an economy and of the investment climate in the private sector. There have been concerns recently about the sustainability of debt in China, given the surge in the fiscal deficit in the last few years that has aided economic activity. This paper aims to shine some light on the dynamics of public debt in the Chinese economy given the risk of a debt crisis, taking nonlinearities and structural breaks into account. Our results show that caution needs to be exercised as there was a clear trend in 2014 towards an unsustainable path in the debt-to-GDP ratio.

Key words: public debt; sustainability; structural breaks; nonlinearities.

JEL code: C22, E39, H63

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1. Introduction

After the collapse of Lehman Brothers in 2008 and the end of the Great Moderation, the sovereign debt of a number of countries started to pile up at high speed (see Paret, 2007, among many others). In the European Union this was a consequence of the introduction of expansionary fiscal policies to reverse the effects of the downturn (EC, 2009).

China meanwhile makes an interesting case study for its ability to sustain high levels of economic growth and controlled levels of unemployment and public debt even after 2008. However, concerns about the Chinese miracle have recently appeared as China's economic growth slowed down sharply from 2014 and the level of sovereign debt escalated, after it had dropped and then recovered between 2008 and 2010. Excessive borrowing by the public sector in China may be traced back to the huge stimulus package introduced during the 2008-2009 global financial crisis. On top of this, the government subsidised the development of several important industries (Chen and Liu, 2017), and an RMB 4 trillion investment plan focusing on infrastructure was rolled out, creating the biggest fiscal stimulus in the world (Zheng and Chen, 2009). The initial plan was for the stimulus package to be funded from three sources: central government, local governments and borrowing from banks. However, local governments had limited fiscal capacity so they turned to banks, many of which felt unable to decline loan requests because of their government ownership. For some time, growth remained fast and China was able to handle the increase in debt. However, when growth started to slow down in 2012, the authorities responded with further expenditure on infrastructure projects to revive the economy. Stimulus packages have blotted China's consolidated deficits every year since 2008. China's

public debt in 2015 was above 40% of GDP,[1] which may look small by the standards of advanced economies, but the rate of debt growth is unmatched elsewhere.

One of the biggest problems with an uncontrolled escalation of sovereign debt is how credible it is that the government will be able to repay the debt. This may increase the cost of borrowing, and this may then increase the fear of default, which is what happened to the Asian Tigers during their 1997-1998 crisis. As a result, efforts to analyse the sustainability of China's debt have gathered momentum. Debt sustainability has been a very popular topic recently in Europe, with for instance Cuestas and Staehr (2013) and Cuestas et al. (2014) analysing the stability of the sovereign debt in EU countries given that there may be endogenously determined breaks. Their results show how the year 2008 changed the dynamics of debt.[2]

This paper aims to shed some light on the sustainability of China's sovereign debt, paying particular attention to changes in its dynamics, and to provide clear policy recommendations. Such recommendations are of increasing importance, as it would be helpful to link changes in debt dynamics with particular events so that conclusions with policy relevance could be provided. To the best of our knowledge this is the first attempt to analyse changes in the dynamics of the public debt in China in more recent times. Li and Zhang (2017) express some concerns about debt sustainability since their calculations suggest an overall debt-to-GDP ratio of 249% in 2015 from all sectors, but most of this debt is in the private sector while the public sector debt is 41% of GDP. [4]

[1] https://fred.stlouisfed.org/series/GGGDTACNA188N.

[2] See also Cunado et al. (2004) among others for the US case.

[4] Several news reports have quoted this research. See: http://www.china.org.cn/china/2016-06/16/content_38681734.htm

The remainder of the paper is organised as follows. The next section provides a brief summary of the economic underpinning of this paper and the econometric methodology applied in it. Section 3 presents the results and then Section 4 provides some concluding remarks and policy recommendations.

2. Economic and econometric background

In this paper we focus on the dynamics of debt and potential sustainability problems amid increasing concerns about China's expansionary fiscal policy.

In a seminal contribution, Bohn (2007) established that the concept of debt sustainability, which implies that the transversality condition of the intertemporal budget constraint is met, as can be analysed by cointegration and unit root tests over the deficit, had lost its economic meaning. The transversality condition is defined as

$$\lim_{n\to\infty} \delta^n E_t(D_{t+n}) = 0 \tag{1}$$

where δ is the rate of discount and $E_t(.)$ is the expectations operator; therefore the intertemporal budget constraint is the expected present value condition D_t

$$D_t = \sum_{i=0}^{\infty} \delta^i E_t(G_{t+i} - T_{t+i}) \tag{2}$$

where $G_t - T_t$ is the fiscal deficit at moment *t*. The intertemporal budget constraint would be satisfied if the transversality condition (1) is also satisfied.

Bohn's (2007) conclusion arises because equations (1) and (2) will be satisfied for a sufficiently large value of the discount rate, regardless of the order of integration *I(d)* of D_t. This is because the discount rate is $0 < \delta < 1$.

Bohn (2007) then proposes comparing the autoregressive parameter δ in

$$D_t = \delta D_{t-1} + \varepsilon_{1t} \tag{3}$$

with the interest rate of debt. Equation (3) relates directly to the econometric analysis of unit roots and autoregressive parameters, so $\delta = 1$. This reaction function, and in particular the parameter δ, can give us information about the way debt is accumulating.

In this paper we not only test for unit roots in D_t, but also look for structural breaks in δ endogenously determined, and in the way the order of integration moves from I(1) to I(0) and back again.

As preliminary analysis we apply the Ng and Perron (2001) unit root tests to assess the order of integration of the variable for the full sample. These tests are linear, but the authors have proposed a series of modifications that can improve their size and power in short samples (see Ng and Perron, 2001, for more details).

Even with the modifications of Ng and Perron (2001), it is well known in the literature that assuming a linear model when the data generation process is nonlinear may reduce the power of the tests, meaning that the null might not be rejected in cases where it is false.[5] This has made it now customary when considering analysis of the order of integration of macrovariables to

[5] We are grateful to an anonymous referee for pointing this out.

consider nonlinear models so as to account for asymmetric adjustments (see Sollis, 2009 and the references therein).

It could be argued for debt mean reversion that the speed of adjustment towards the equilibrium may actually depend on the size of the shock, implying that the speed of mean reversion is not constant. This means the authorities may choose not to act upon small deviations from the equilibrium, implying that up to a certain threshold the variable behaves as a random walk. When deviations from the equilibrium are larger though, the authorities may apply policies to restrain them, and the variable may return to its equilibrium faster. We can then see a process with a central regime where the variable's speed of mean reversion is very slow at yielding to an I(1) process, and an outer regime where the variable behaves as a stationary process, with a faster speed of mean reversion.[6]

To test the hypothesis of a unit root in a nonlinear model we apply the Kapetanios et al. (2003) (KSS) test. These authors find that the auxiliary regression to test for unit root in the nonlinear framework is based on an exponential smooth transition autoregressive (ESTAR) model such as:

$$\Delta D_t = \alpha D_{t-1} + \phi D_{t-1}(1 - \exp(-\theta D_{t-1}^2)) + \varepsilon_{2t} \quad (4)$$

where the first term of the right-hand side of the equations represents the order of integration in the central regime and the second corresponds to the outer regime. KSS assume that $\alpha = 0$ in a globally stationary process. To test for unit roots in the outer regime the null hypothesis is $H_0 : \theta = 0$ against the alternative $H_1 : \theta > 0$. Since some of the parameters in equation (4) cannot be identified, KSS propose the following first order Taylor approximation:

$$\Delta D_t = \beta D_{t-1}^3 + \varepsilon_{3t} \quad (5)$$

[6] See Cuestas and Mourelle (2011) and Cuestas and Regis (2013) amongst others.

meaning that the test becomes $H_0 : \beta = 0$ against $H_1 : \beta < 0$. Equation (5) may contain lags of the dependent variable to control for autocorrelated residuals.

By applying the Ng and Perron (2001) and KSS tests we can have an idea of the overall order of integration of the debt-to-GDP ratio. However, we are interested in analysing how China's debt accumulation may have changed over time, and for this purpose we propose the use of the Leybourne et al. (2007) (LKT) test. LKT developed a unit root test that allows us to find changes endogenously in the order of integration from I(1) to I(0) and from I(0) to I(1). The test is based on the following statistic

$$M = \inf_{\lambda\in(0,1)} \inf_{\tau\in(\lambda,1)} \mathrm{DF}_G(\lambda, \tau) \tag{6}$$

with $\lambda \in (0,1)$, $\tau \in (\lambda,1)$ and *DF* the Dickey-Fuller test for a generalised least square detrended series, so $\Delta D_{t-1}^d = \hat{\rho} D_{t-1}^d + \hat{\varepsilon}_t$. The results from this analysis can be very insightful since they can endogenously give the periods when the debt-to-GDP ratio behaves as a mean reverting variable and periods when it behaves as a random walk, with shocks having permanent effects.

To complement this analysis, and to gain more insights into the changes of the δ parameter showing how the Chinese government is piling up debt, we also apply the Bai and Perron (2003) method, which allows us to estimate

$$D_t = \gamma_1 I(t < T_b) + \gamma_2 I(t \geq T_b) + \alpha_1 t I(t < T_b) + \alpha_2 t I(t \geq T_b) + \delta_1 I(t < T_b) D_{t-1} + \delta_2 I(t \geq T_b) D_{t-1} + \varepsilon_{4t} \tag{7}$$

where I(.) is an indicator function which equals 1 when the condition in the bracket is fulfilled and 0 in other cases. This is a truncated equation that can be used to estimate the different parameters conditional on different subsamples. This allows us to assess changes in the dynamics

of debt and, as Bai and Perron (2003) showed, to find the dates for the breaks endogenously. Bai and Perron (2003) propose a method for determining the number of breaks from a maximum set by the user. It is a sequential test based on an *F*-test for the null of no breaks against the alternative of more than zero, and so on.

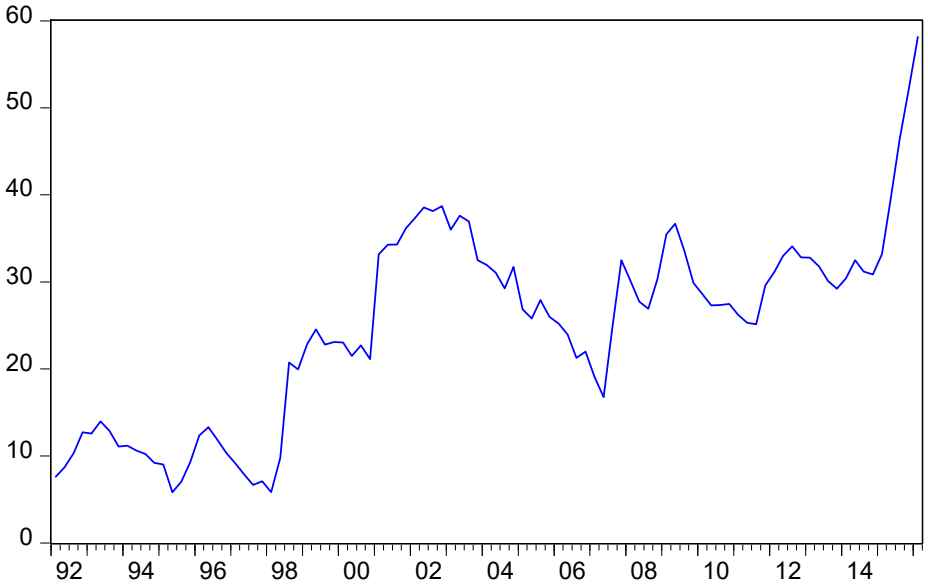
Like in LKT the dates for the subsamples can be obtained endogenously, with some confidence intervals.

With these methods we can analyse firstly whether the debt-to-GDP ratio is a mean reverting process or whether shocks have permanent effects for the full sample; secondly whether there is evidence that the variable's speed of mean reversion is related to the size of the shocks; and thirdly whether there are breaks in the sample affecting the order of integration and the way that past debt affects the public deficit.

3. Data and results

The data consist of quarterly observations for the period 1992Q1-2016Q1 for net claims on central or general government as a percentage of GDP, code 32AN-ZF--- from the International Financial Statistics of May 2016, which have been taken from the National Bureau of Statistics of China. The resulting series has been seasonally adjusted using the X13 procedure and is plotted in the figure.

Figure: Claims on central or general government as % of GDP



Notes: Authors' own calculations based on IMF and NBSC. The data have been seasonally adjusted.

As the figure shows, the debt-to-GDP ratio crossed the 20% threshold in 1999. It ranged around 30% from the early 2000s until recently, when it climbed above 50%. As a preliminary analysis we also display the results of the Ng and Perron (2001) unit root test and the KSS test in Tables 1 and 2.

As both Tables 1 and 2 show, the null hypothesis of a unit root for the full period cannot be rejected by either of the tests, the Ng and Perron (2001) based on linear models, or the nonlinear KSS test. So we can find no evidence of reversion to equilibrium even when we consider that the speed of mean reversion may be asymmetric. This implies that the Chinese authorities have been accumulating debt in a way that could pose a danger to the stability of the public finances. However, there may be sub-periods when the authorities have managed to keep the debt-to-GDP ratio under control, and this feature cannot be identified with these tests.

Table 1: Ng and Perron (2001) and KSS results with intercept

		MZa	MZt	MSB	MPT	KSS
Ng-Perron test statistics		0.64549	0.22340	0.34610	13.8686	0.493
Asymptotic critical values:	1%	-13.8000	-2.58000	0.17400	1.78000	-3.48
	5%	-8.10000	-1.98000	0.23300	3.17000	-2.93
	10%	-5.70000	-1.62000	0.27500	4.45000	-2.66

Note: Critical values are obtained from Ng and Perron (2001) and KSS. Lag length comes from the Modified Akaike Information Criterion.

Table 2: Ng and Perron (2001) and KSS results with intercept and trend

		MZa	MZt	MSB	MPT	KSS
Ng-Perron test statistics		-13.2895	-2.40197	0.18074	7.84400	-0.864
Asymptotic critical values:	1%	-23.8000	-3.42000	0.14300	4.03000	-3.93
	5%	-17.3000	-2.91000	0.16800	5.48000	-3.40
	10%	-14.2000	-2.62000	0.18500	6.67000	-3.13

Note: Critical values are obtained from Ng and Perron (2001) and KSS. Lag length comes from the Modified Akaike Information Criterion.

As discussed, we also apply the Leybourne et al. (2007) unit root rest so we can consider potential changes in the order of integration. The results, displayed in Table 3, show that although the debt ratio behaved as a stationary process for the period 2005Q3-2014Q3, there is a clear pattern towards non-sustainable levels after that date. The beginning of this sub-period coincides with the Chinese government's announcement in 2005 of a more prudent fiscal policy focusing

on rural areas, after seven years of an expansionary fiscal policy.[7] In this period, the central government deficit is low while local government only starts to increase its debt after 2009. Nevertheless, the end of the stationary period coincides with a surge in government issuing as China shifted from a monetary stimulus to a fiscal one, while local governments found difficulties in raising new debt.

Table 3: Leybourne et al. (2007) test and Bai and Perron (2003) estimation

Leybourne et al.	*M-statistic = -5.364***		I(0) interval *2005Q3-2014Q3*		
Bai and Perron	γ_1 α_1 δ_1	T_1 (lower 95%, upper 95%)	γ_2 α_2 δ_2	T_2 (lower 95%, upper 95%)	γ_3 α_3 δ_3
	4.079 -0.099 0.719	1998:01 (1997:04, 1998:03)	6.547 -0.007 0.797	2014:04 (2014:04, 2015:01)	-625.2 7.133 -0.160

*Note: The symbol ** means rejection of the null in the given interval at the 5% significance level. The Leybourne et al. (2007) test has been applied in a model with constant and trend, and lag length obtained by the Bayesian Information Criterion from a maximum of 8 lags.*

These results are corroborated by the Bai and Perron (2003) estimation in Table 3, which suggests that there are two breaks. Although the autoregressive parameter is not significantly different from zero after the second break, which coincides pretty closely with the finding of the Leybourne et al. (2007) test, there is a clear change in the deterministic trend. The first break in

[7] http://www.oecd.org/china/economicsurveyofchina2005.htm

1998 coincided with a significant increase in central government expenditure to counteract the effects of the Asian tigers crisis of 1997-1998. The increase in the government debt ratio from 1998 to 2003 is caused by the introduction of fiscal policies to counteract deflation. After this period, the effect of these policies declined as public sector revenues increased rapidly. This is also consistent with the emergence of the I(0) interval suggested by the LKT test since the middle of 2005.

The end of the stationary period in 2014 coincides with the beginning of the third sub-period found by the Bai and Perron (2003) method, when the coefficient of the trend surged, highlighting how important it is to watch the evolution of the debt-to-GDP ratio in China closely. In 2015, the central government authorised provinces to issue new debt; however, demand for provincial bonds was weak due to their low interest rate.[8]

4. Conclusions

In the aftermath of the global financial crisis, many countries engaged in fiscal and monetary stimuli, and their fiscal deficits have increased in consequence. Economic growth has slowed in China since the beginning of the Great Recession, while the Chinese government has applied expansionary fiscal policies, and this makes the sustainability of the public debt of increasing concern. As the importance of China in the world economy continues to rise, any concern about the sustainability of its macroeconomic fundamentals becomes alarming to the rest of the globe.

In this paper we have analysed the time series properties of the public debt-to-GDP ratio by applying a battery of unit root tests accounting for nonlinearities and structural breaks. Our

[8] See: Hong, S., "China's Plan for Local Debt Amounts to a Bailout". Wall Street Journal (June 23, 2015).

findings indicate that debt accumulation has become non-stationary and the behaviour in the last part of our sample is consistent with dangerous paths towards unsustainability. Given the dynamics of the debt, this suggests the debt problem may escalate rapidly under current economic conditions. Unless economic growth bounces back to previous levels, which seems unlikely in the medium run, China faces a risky situation in its public sector debt position.

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