

The structure and sustainability of China's debt

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In this paper, using a new comprehensive debt set, we describe the evolution of China's debt structure in detail, and then we assess the sustainability of China's domestic and external debt by employing a fiscal space framework, the threshold estimation, and the debt service-capacity measure. The empirical results suggest that, China's public debt from the central government and external debt are sustainable, whereas the highly indebted local governments, non-financial corporations and the shadow banks could lead to potential risk for China's financial stability. Nevertheless, China's debt overall is sound and sustainable in the near and medium term.

Key words: Debt Structure; Debt Sustainability; Public and Private Debt; China's Economy

JEL classifications: H63, H74, E62

1. Introduction

The global financial crisis of 2008 and the European sovereign debt crisis have spurred growing research interest in the credit bubble and debt problem worldwide. Against this backdrop, China's debt problem has also attracted considerable concern, inasmuch as China's economic stimulus package that was implemented for weathering the global financial crisis has significantly expanded its leverage, especially in the local government sector and the private sector. However, empirical study on China's debt issues has been constrained by the lack of a detailed debt database covering long series and wide categories. In this paper, first, we collect debt data for China from all possible sources and compile an updated debt dataset. Our debt dataset covers nearly all debt categories and spans the longest time periods up to now; we then analyse the evolution of the debt structure in China since 1985. Third, we investigate the sustainability of China's debt in every sector in terms of international standards.

Our main contributions is that our debt dataset for China tracks the development of the entire categories of China's debt, including public debt, non-financial private debt and financial debt domestically and external debt to the rest of the world. Based on this debt dataset, we have developed a set of indicators to describe and explain China's debt structure and its evolution from multiple perspectives. We have estimated the long-run and maximum sustainable debt levels of China's public debt, and evaluated

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the sustainability of public debt in China with a fiscal space framework. In terms of the threshold estimation and the debt service-costs measure, we have assessed the sustainability of China's non-financial private debt. The sustainability of the external debt has also been analysed using universal approaches. Our empirical results suggest that China's public debt and external debt are sound and sustainable in the near and medium term, whereas the non-financial corporate debt and thereby the non-financial private debt are unsustainable since 2009.

The remainder of the paper is structured as follows. Section 2 discusses the literature. Section 3 describes the data of China's debt in detail. Section 4 analyses the debt structure in China. Section 5 examines the sustainability of all sorts of debt in China. Section 6 concludes.

2. Literature review

Historically, economic and financial crises are closely connected with excess indebtedness and defaults of public and private sectors. Excess indebtedness often triggers debt crisis, currency crisis and financial distress on the one hand; the bailouts of government of the financial sector during the crisis and the expanding expenditure of government for enhancing the aggregate demand after the crisis increase the public debt level on the other hand. Therefore, a sustainable debt level is a key factor for preventing financial distress and promoting stable economic growth. As the authorized regulator of the financial markets worldwide, IMF has compiled and published many guidelines and papers on the assessments of public debt sustainability for advanced countries, emerging countries and low-income countries (IMF, 2002; IMF, 2003A, B; IMF, 2010; IMF, 2011; IMF, 2013). Notably, a handbook by Burnside (2005) provides many useful approaches and instruments for fiscal sustainability analysis. Ostry *et al.* (2010) and Ghosh *et al.* (2011) developed a "fiscal space" framework for conducting public debt sustainability analysis by using estimated fiscal response functions and the concepts of long-run debt level and maximum sustainable debt level. Moreover, following the framework of fiscal space, IMF (2011) has given a range of 49–58 percent for the long-run debt level and 63–78 percent for the maximum sustainable debt level by re-estimating public debt thresholds for a sample of Emerging Markets (EM) for the period 1993–2009. Although there exists no standard approach for assessing private debt sustainability, the destabilising effects of excessive indebtedness build-ups in the private sector have been recognized in theory and practice (for example, the debt-deflation hypothesis by Fisher [1932]; and the recent study by Clemons and Vague [2012]). Literature about China's debt sustainability analysis is scarce, except that it has recently attracted much attention to the sustainability of local government debt in China (Lu and Sun, 2013; Zhang and Barnett, 2014).

Debt structure and its evolution play an important role in debt sustainability analysis. However, there has been very little research done on the evolution of domestic government debt and domestic private debt in emerging markets. Missale (1999) conducted a comprehensive study of the structure of domestic government debt in OECD countries. Cowan *et al.* (2006) examined the evolution of sovereign debt in the Americas. Claessens *et al.* (2003) studied the role of institutional and macroeconomic factors in explaining the currency composition of government bonds. Guscina (2008) employed the new Guscina–Jeanne EM Debt Database 2006 to analyse the evolution of sovereign debt structure in emerging market countries. She identified some important determinants of sovereign debt structures in emerging markets.

The prior literature on the structure of external debt in emerging markets mostly focused on two aspects: the maturity structure (Blanchard and Missale, 1994; Rodrik and Velasco, 1999) and the currency composition (Eichengreen and Hausmann, 1999; and Eichengreen *et al.*, 2003). Most prior studies did not cover China, except for the cross-country panel analysis by Guscina (2008), which did not reach far back in time and provided little information exclusively involving China's debt structure. Motivated by this, we conduct a detailed analysis of China's debt structure and its sustainability in this paper.

3. China's debt dataset

Due to the limitation and incompleteness of data released by China's authority, we make considerable efforts to collect China's debt data from every possible source, including official publications and individual literature. We bring together a number of other datasets and information from original sources. These included the databases from IMF, BIS, World Bank, China's Statistical Authorities, academic papers and consultant reports. Needless to say, we have to extend some data by statistical technique to complete the database (Supplementary Information available online).

The first part of our dataset focuses on public debt¹ at the general government level, which consists of the central government and local governments. The central government debt data (domestic and external) after 2005 were compiled from official publications by the National Bureau of Statistics of the People's Republic of China (NBSC hereafter), and IMF's historical public debt database. The data prior to 2005 for the central government debt were collected from Lin (2010). The local government debt data were brought together from several sources: the recent data for period 2010–13 are linked to the Audit Findings on China's Local Governmental Debts (2011) and the Audit Findings on China's Local Governmental Debts (2013) by the National Audit Office of the People's Republic of China (hereafter NAOC); the data for 2014–15 were sourced from the Wind database; the data between 2000 and 2009 were available from Goodstadt (2014); and the data for 1999 were from our estimation. Prior to 1996, since China's central government and local government shared the mutual tax revenue, the data of central government debt were taken as the data of general government debt.

The second part of our dataset involves the debt of the non-financial private sector, comprising household debt and non-financial corporate debt. The total private non-financial sector debt data were collected from the database by the Bank for International Settlement (2016, hereafter BIS), namely the "Long series on total credit and domestic bank credit to the private nonfinancial sector" database. Besides BIS (2016), other databases were employed for collecting household debt and non-financial corporate debt; for example, Clemons and Vague (2012) for the period after 2004, and He *et al.* (2012) for period 1999–2004. The household debt data for 1986–98 were estimated by the difference between the total non-financial private debt and the non-financial corporate debt. The non-financial corporate debt data for 1985–98 were proxied by the total loans to business from the People's Bank of China (hereafter the PBC, China's Central Bank).

¹ Our definitions of public sector debt for Chinese governments and of private sector debt follow the category and method provided by the National Bureau of Statistics of the People's Republic of China and National Audit Office of the People's Republic of China, which are also adopted in other literature (BIS, 2016; Goodstadt, 2014; etc.). Particularly, the debt piled up by the SOEs is calculated in the category of non-financial corporate debt (belong to private debt) rather than public debt in terms of the international convention and Chinese current statistical standard.

The third part of our dataset concentrates on financial sector debt. Following the definition by MGI ([McKinsey Global Institute, 2015](#)), financial sector debt covers the commercial papers, loans and bonds issued by banks and other parts of financial sector, excluding interbank borrowings. The data source is CEInet Statistics Database (hereafter CEIN).

The fourth part of our dataset provides data about China's international debt, comprising central government external debt, private non-financial sector external debt and financial sector external debt. We collected the data from the database of China's State Administration of Foreign Exchange (hereafter SAFE), the Global Financial Development Database (hereafter GFDD) of the World Bank and the database of NSBC.

4. Styled facts about the structure of China's debt

Prior to the global financial crisis of 2008, researchers mainly focused on international debt problems, because most currency crises during the last century resulted from the defaults of lower-income and developing countries in the international debt markets. The international financial crisis and the European sovereign debt crisis have turned attention towards domestic public debt and private debt. In addition, some economists stressed that some major financial crises are preceded by a run-up in private debt, rather than in public debt.² Since the debt level and the debt structure (shares) have significant implications for both economic stability and financial stability, in this section, using our new China's debt database (hereafter CDD), we describe and summarize the size and structure of China's debt in terms of borrowers, maturity and currency.

The shares of China's aggregate debt level in 2007 and 2015 are summarised in [Figure 1](#), which indicates that the debt shares changed minimally from 2007 to 2015 except for those of the public sector and of the shadow banks; the latter increased dramatically and aroused concerns recently. Most importantly, China's total debt is dominated by domestic debt from 1985 to 2015; external debt represents less than 5% for the same period with a downward trend.

China's aggregate debt level wasn't significant until mid-2008. At 159.53% of GDP and 266.89% of GDP, respectively, in 2007, the domestic non-financial debt and the total debt (including the financial sector and the external sector) are lower than that of most emerging markets and advanced economies.³ Since then, both have increased dramatically. The two ratios had reached 244.14% and 401.12%, respectively, by the end of 2015 ([Figure 3](#)), with respective annual average growth rates of approximately 11% and 16.8%, which are higher than most other important economies. [Figure 2](#) depicts the aggregate debt in real terms by category from 1985 to 2015. [Figure 3](#) exhibits the change in the ratios of debt to nominal GDP (hereafter NGDP) by sector from 1985 to 2015.

In [Figure 3](#), the public debt-to-NGDP ratio⁴ and the external debt-to-NGDP ratio were relatively lower and flatter over the sample period, whereas the non-financial

² See, for example, [Clemons and Vague \(2012\)](#).

³ See, for example, the MGI Report (2015) on the ratios of overall debt to nominal GDP across countries.

⁴ We use the nominal GDP as the denominator because the debt stocks are also nominal; the inflation effects hence are cancelled out when calculating the regarding debt ratios.

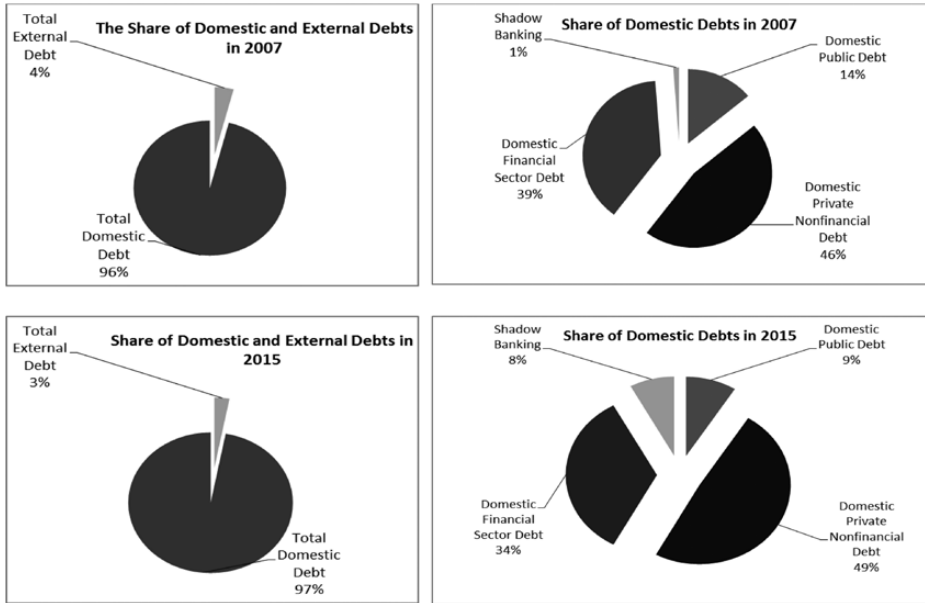


Fig. 1. Shares of China's debt at the end of 2007 and 2015.

Source: Author's dataset.

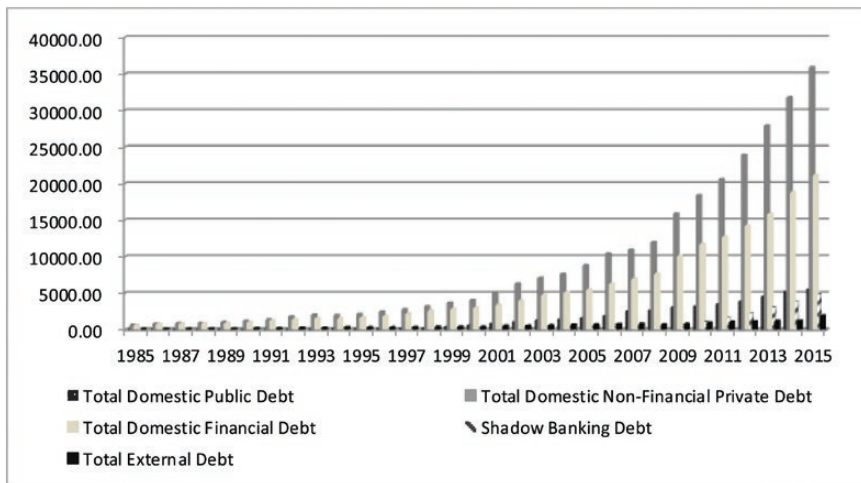


Fig. 2. China's debt by category (unit: billion yuan RMB deflated by CPI).

Source: Author's dataset.

private debt-to-NGDP ratio and the financial sector debt-to-NGDP ratio were relatively higher and steeper over the same period. Moreover, the two latter ratios have been rising at accelerated rates since 1985.

China's aggregate debt contains public debt, non-financial private debt, financial sector debt (including shadow banking debt) and international debt by sector. In what follows, we provide a detailed description of their structures.

China’s public debt includes central government debt and local government debt. They are combined together as the general government debt according to the definition by IMF. Figure 4 depicts the evolution of central government debt and local government debt from 1985 to 2015. At the end of 2015, China’s public debt reached 2,292.97 (nominally 10,659.96) billion yuan RMB at the central government level and 3,409.62 (nominally 16,000) billion yuan at the local government level. The central government debt in 2015 is 1.66 (2.07 nominally) times the level in 2007 and 76.40 (358.55 nominally) times the level in 1985, growing annually at an average growth rate of 15% (nominally 32.5%). The local government debt has soared since 2007 and grown annually at an average growth rate of approximately 16.08% (nominally 28.22%) since 1997. Since 2009, the local government debt level has exceeded the central government debt level. The rapid increase in local government debt has recently led to more attention from the inside and outside.

The evolutions in the ratios of government debt to nominal GDP and to fiscal revenues, respectively, are shown in Figure 5, where we find that both the ratio of public

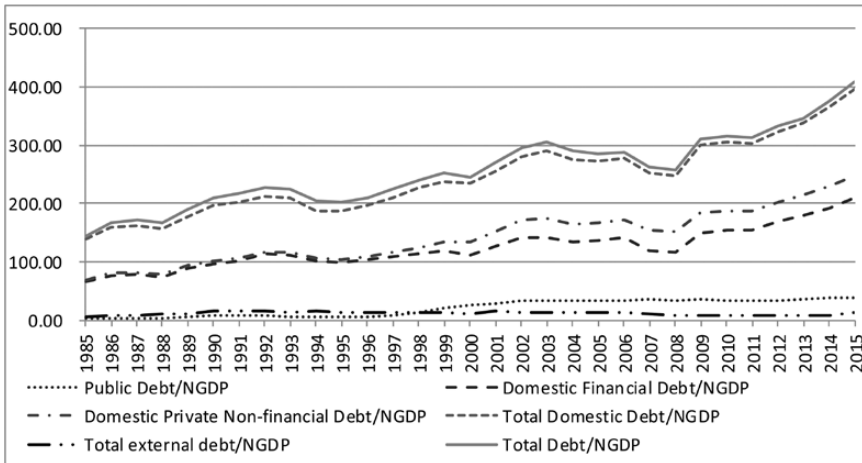


Fig. 3. Evolutions in ratios of debt to nominal GDP (%) by sector. Source: Author’s dataset.

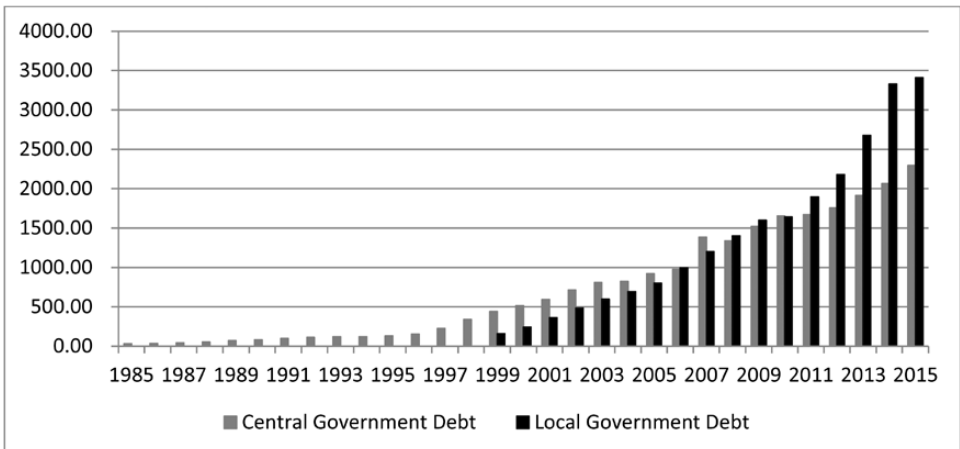


Fig. 4. Central government debt and local government debt (unit: billion yuan RMB deflated by CPI). Source: Author’s dataset.

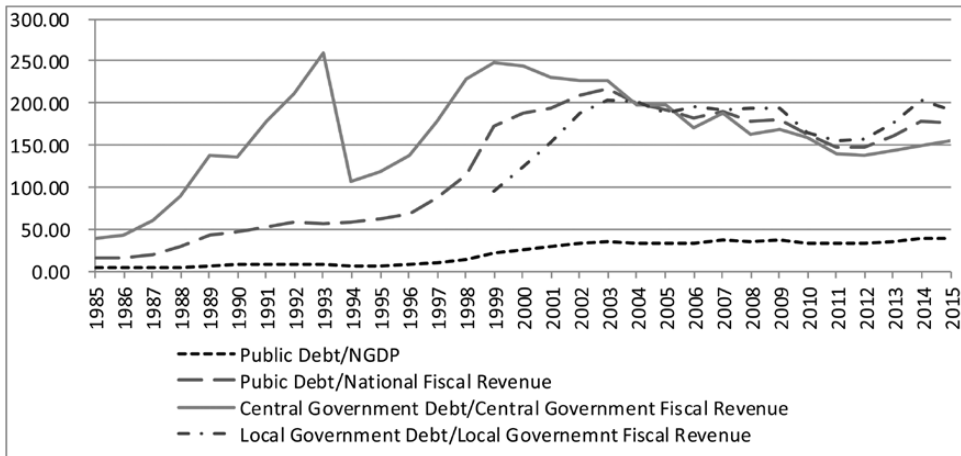


Fig. 5. Changes in ratios of public debts to GDP and fiscal revenues (%).
Source: Author's dataset.

debt to national fiscal revenue and the ratio of central government debt to central fiscal revenue almost remain above 150% since 1999. This implies potential risk for financial stability in China. In addition, the ratio of local government debt to local fiscal revenue has exceeded 150% since the global financial crisis of 2008. This could result in some loan defaults at the local government level. Nevertheless, given 38.69% of nominal GDP, China's public debt is still low by international standards.⁵ Notably, in Figure 5, the dramatic fall in the ratio of public debt level to central government revenue from 1993 to 1994 is due to the distinguished increase in central government revenue, which is the consequence of the reform of the tax system in 1993. Prior to 1993, the general government tax revenue was shared by the central government and local government. Since 1993, tax distribution reform was conducted and the central government and local government have collected the tax revenue separately. The new tax assignment system quadrupled the central government fiscal revenue in 1994 compared with that in 1993 and reduced the local fiscal revenue by about 25% in 1994.

The ratios of local debt to local GDP and to local fiscal revenue by region at the end of 2015 are plotted in Figure 6, which indicates that nearly all of the ratios of local debt to local GDP are lower than 50%, except that of Guizhou province (86.98%). Note that the ratios of local debt to local fiscal revenue are significantly high in many provinces, particularly for Anhui (243.49%), Neimenggu (228.91%), Liaoning (409.82%), Qinghai (280.38%), Hainan (237.58%), Guizhou (607.68%), Sichuan (232.70%), Yunnan (366.57%), Shaanxi (245.87%), Gansu (229.81%), Hunan (269.55%), Jilin (245.55%), Heilongjiang (271.47%), Guangxi (294.69%), Ningxia (304.73%), Xinjiang (215.18%) and Hebei (222.26%).

Those provinces with the ratio of debt to fiscal revenue greater than 200% would be given more concern by the regulators. Given that China's local government revenues heavily rely on land sale and extensively use off-balance-sheet local government financial platforms (LGFPs: local government financing platforms),⁶ which are unstable

⁵ The average ratio of public debt in OECD countries is above 100% in the same year.

⁶ See, for example, the research conclusions from MGI Report (2015) and Wu (2014), among others.

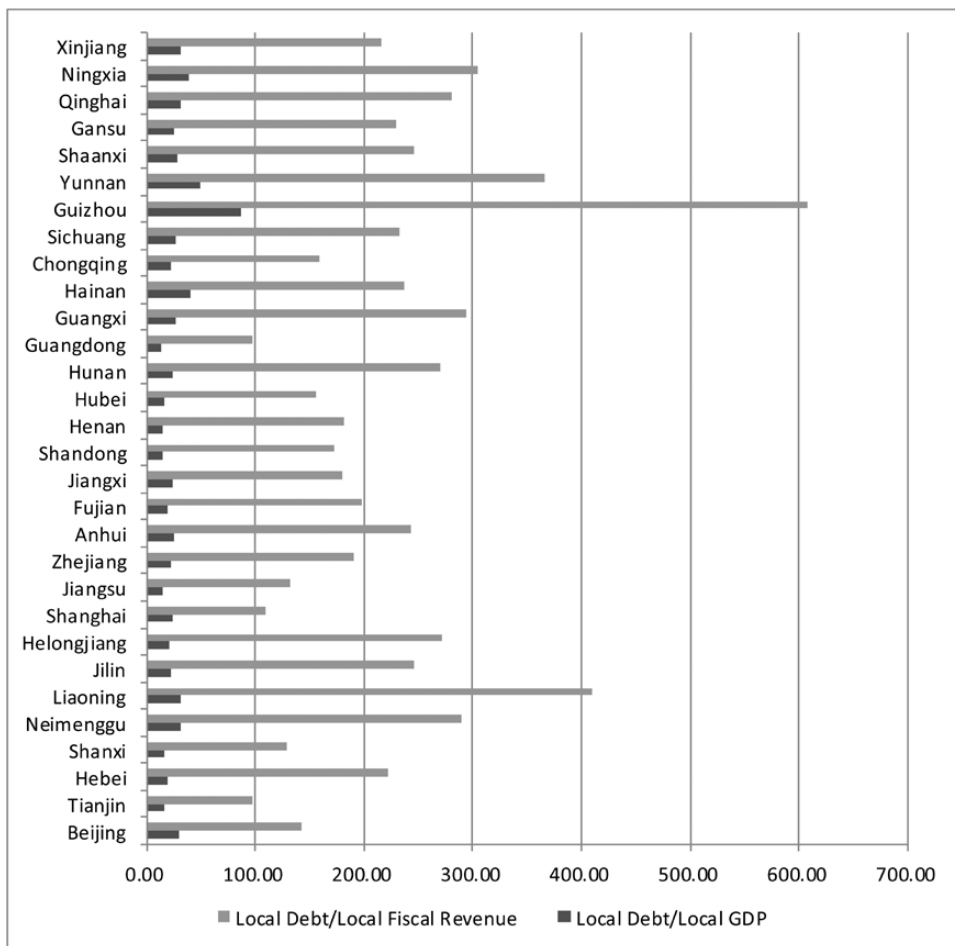


Fig. 6. Debt/GDP and debt/fiscal revenues ratios by region, end of 2015 (%).
 Source: Author's dataset.

and unsustainable, local governments should transfer their fiscal models and seek more reliable revenue sources to reduce debt accumulations and repayment burdens.

China's non-financial private debt, consisting of household debt and non-financial corporate debt, remains the uptrend since 1990s. Household debt has increased approximately 41 times (200 in nominal terms) since 1985 and more than quintupled from 2007 to 2015, rising from 133.42 billion yuan in 1985 to 5,696.75 (nominally 26,732.59) billion yuan in 2015. Non-financial corporate debt has increased nearly 51.9 times (444 nominally) since 1985 and quadrupled from 2007 to 2015, rising from 474.68 billion yuan in 1985 to 24,618.42 (nominally 115,524.4) billion yuan in 2015 (Figure 7).

Figure 8 presents changes in the ratios of household debt to disposable income, and of non-financial corporate debt to non-financial corporate annual revenue and of total non-financial private debt to nominal GDP. The non-financial private debt-to-NGDP ratio had tripled by the end of 2015, reaching 212.72% of NGDP. Driven by the increase in mortgage volumes, the ratio of household debt to household disposable income rose from 26.34% in 1985 to 88.53% in 2015. The leverage in the corporate

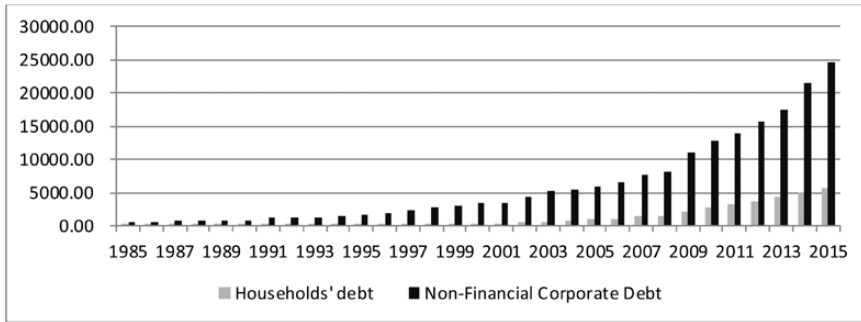


Fig. 7. Household debt, non-financial corporate debt (unit: billion yuan RMB deflated by CPI). Source: Author's dataset.

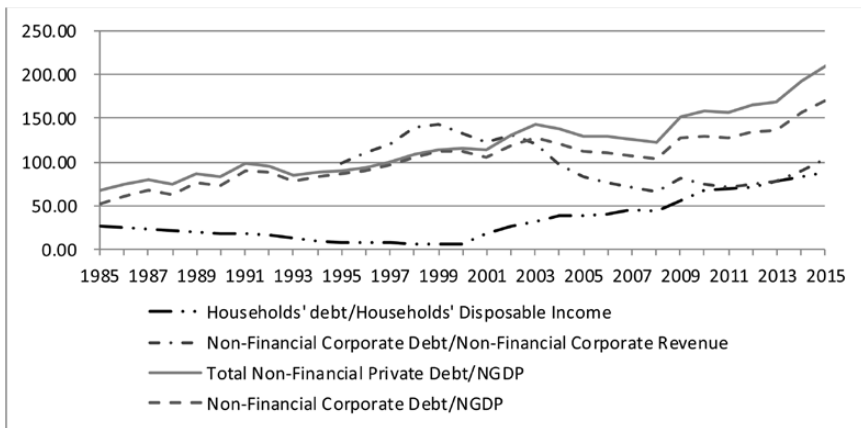


Fig. 8. Evolutions in ratios of non-financial private debt to income (%). Source: Author's dataset.

sector has increased steadily since 1997, rising from 52.65% (to GDP) in 1985 to 173.92% in 2015, which is one of the highest levels of corporate debt in the world.

Following the definition of MGI (2015), China's financial sector debt was calculated by bringing together loans, commercial paper, and banking bonds. Although the banking industry dominates the financial sector, some non-bank lending institutions, the so-called shadow banks, have grown rapidly since the onset of the twenty-first century. The financial sector (excluding shadow banks) debt in real terms has tripled since 2007, while the shadow banks' debt in real terms has increased 22.21 times for the same period. The recently rapid growth of shadow banking is due to two factors: one is the constraint of liquidity in the credit market in terms of the highest required reserve ratio (about 20% from 2010 to 2015); the other is the high demand for the higher-yield investment financial products (Figure 9).

Figure 10 exhibits the debt-to-asset ratio of the financial sector and the debt-to-NGDP ratios of the financial sector and of shadow banking. The financial sector debt-to-assets ratio decreased 10% during the past decade, which reflects the modification of assets' quality and the steady reduction in the NPL of China's banking industry. The shadow banks' debt-to-NGDP ratio has increased more than 10 times since the global

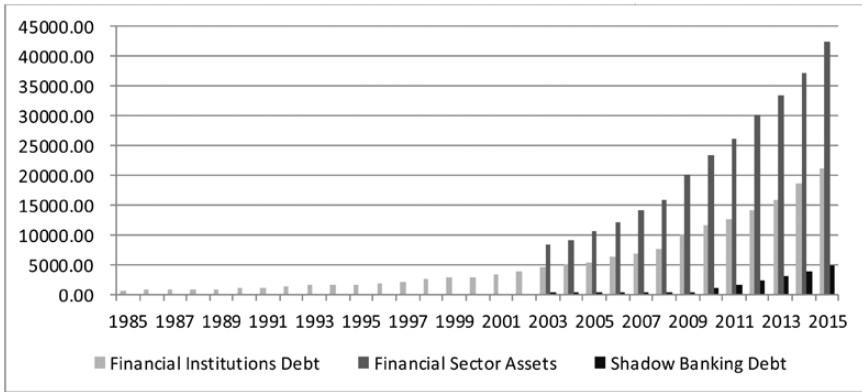


Fig. 9. Financial (banks mainly) sector debt and shadow banking debt (unit: billion yuan RMB deflected by CPI). Source: Author’s dataset.

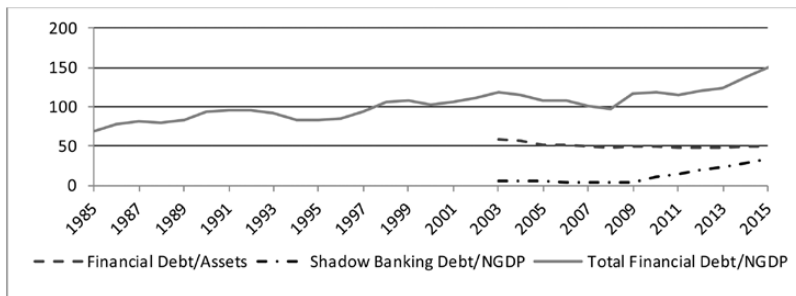


Fig. 10. Debt-to-assets ratio and debt-to-NGDP ratios for the financial sector (%). Source: Author’s dataset.

financial crisis of 2008. The rapid rise in the debt-to-NGDP ratio for the financial sector, especially for shadow banks, has important implications for financial stability in China.

In particular, China’s shadow banking is less complicated than that in advanced economies. China’s shadow banking does not involve long intermediation chains, multiple layers of securitization or highly leveraged players, and most loans involve a single intermediary and minimal or no leverage or currency risk according to the MGI report (2015). However, the debt-to-NGDP ratio of China’s shadow banks increased approximately 10 times after the global financial crisis of 2008, reaching 33.41% in 2015. Due to non-transparency, potential contagious effects to the official banking sector, and speculation motives, China’s regulators should be cautious of the shadow banking development.

It is well known that international debt has played an important role in promoting China’s rapid economic development starting in 1978. Nevertheless, external borrowing has been strictly controlled and remains a small proportion in China’s debt. The ratio of external debt to nominal GDP has never exceeded 17%, reaching the peak in 1994 at 16.12%, the lowest point in 1985 at 5.57%, and 12.80% in 2015. Importantly, the share of short-term external debt in overall external debt had grown to 65% by 2015, and the ratio of short-term external debt to national annual fiscal revenue has tripled, increasing from 12.03% to 37.67% since 1990 (Figure 11).

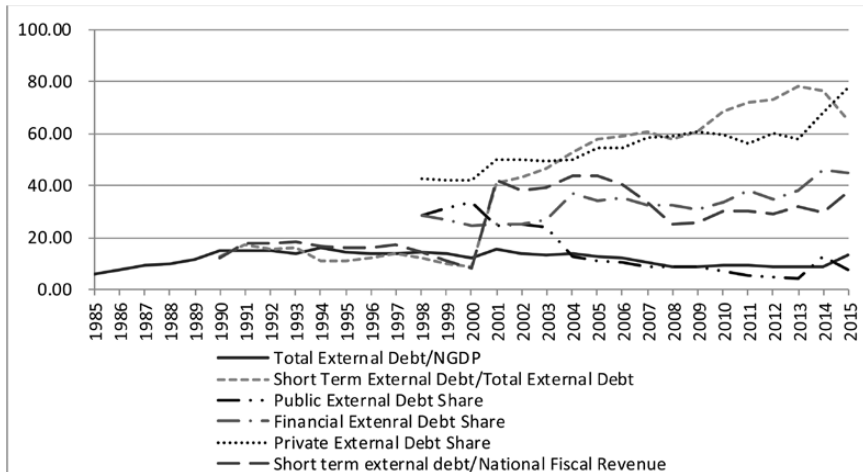


Fig. 11. Shares of external debt and ratios of external debt to fiscal revenue and NGDP (%).
Source: Author's dataset.

The increase in the share of short-term external debt in total external debt has pros and cons. It can reduce the financial costs on one hand, but raise the rollover risk especially under an unstable macroeconomic environment on the other hand. Fortunately, both the ratios of short-term external debt to NGDP and to national fiscal revenue are lower in China compared with international criteria.

5. The sustainability of China's debt

Sustainable debt often refers to that which can be serviced by the current issuer and in the future without adjustment. The sustainability of public debt is also defined as fiscal sustainability, which is a traditional and official focus on debt sustainability analysis (DSA). In this section, we test and assess not only the fiscal sustainability but also the non-financial private debt sustainability and the external debt sustainability.

Prodigious literature on the DSA of public debt exists. In accordance with the [IMF \(2011\)](#) and [Ostry et al. \(2010\)](#), we conduct our evaluation on China's public debt sustainability within the fiscal space framework. On the sustainability of non-financial private debt and of external debt, we employ the threshold estimation and the debt service-costs measure.

5.1 Assessment on the sustainability of China's public debt

Our methodology to assess the sustainability of China's public debt is in accordance with the [IMF \(2011\)](#), [Ghosh et al. \(2011\)](#), [Ostry et al. \(2010\)](#) and [Abiad and Ostry \(2005\)](#), in which a fiscal space framework has been developed. Two concepts of the sustainable level of public debt are defined in the fiscal space framework: the long-run debt level and the maximum sustainable debt level. The former is the level to which the debt-to-GDP ratio converges in the long run, and the latter is the level beyond which a debt distress event is likely or inevitable.

In this subsection, first, we estimate the fiscal response function for China, by which we calculate the long-run sustainable debt-to-GDP ratio and the maximum sustainable

debt-to-GDP ratio. Second, we compare China's public debt structure indicators with these sustainable thresholds and judge the sustainability of China's public debt.

The long-run sustainable public debt (percentage to GDP) is defined by

$$d^* = \frac{pb}{r^* - g}, \quad (1)$$

where d^* is the long-run debt level (percentage to GDP), pb is the historical average primary balance (percentage to GDP), r^* is the historical average risk-free interest rate and g is the historical average growth rate of GDP.

Given that the historical average risk-free interest rate is 5.12 for the 1985–2015 period, and the historical average growth rate of GDP for the same period is 9.75, equation (1) produces: $pb = -4.63d^*$, in terms of which the long-run sustainable debt is obtained.

A fiscal reaction function in the fiscal gap framework is given by

$$pb_t = f(d_{t-1}) + x_t + \varepsilon_t \quad (2)$$

where $x(t)$ is a vector of control variables capturing all systematic determinants of the primary balance other than lagged debt, $f(d_{t-1})$ is the response of the primary balance to lagged debt, which is a continuous function, and $\varepsilon(t)$ is an i.i.d. shock to the primary balance.

For the determinant case, the maximum sustainable debt level can be obtained by the higher intersection between the $x_t + f(d_{t-1})$ and $(r^* - g)d_t$ schedule:

$$x_t + f(d_{t-1}) = (r^* - g)d_t \quad (3)$$

The lower solution to (3) is also defined as the long-run sustainable debt level, in contrast to the definition by equation (1).

Using equations (1) and (3), we can obtain the long-run sustainable public debt level and maximum sustainable debt level, in terms of which we assess the sustainability of public debt for China.

Employing equation (1), we obtained that China's long-run sustainable public debt ratios (percentage to GDP) are 27.89% at the general government level for the 1985–2015 period. Furthermore, we estimated the fiscal reaction functions for China by using the approach suggested by Ghosh *et al.* (2011). The results are presented in Table 1 in the Appendix.

In estimating China's fiscal response function, we first employ an H-P filter to calculate the output gap and the government expenditure gap. In doing so, the λ is taken to be 100 due to the annual data frequency. The lagged debt is a one-period lag.

The estimated fiscal response functions for China are:

$$pb_t = -0.155d_{t-1} + 0.021d_{t-1}^2 + 0.00046d_{t-1}^3 + 0.0262\hat{y}_t - 0.021\hat{g}_t \quad (4)$$

and

$$pb_t = -0.065d_{t-1} + 0.15d_{t-1}^2 - 0.00036d_{t-1}^3 + 0.027\hat{y}_t - 0.097\hat{g}_t + 0.0415\pi_t + 0.565fc_t \quad (5)$$

where pb_t denotes the primary balance at the general government level (percentage to GDP) at time t , \hat{y}_t denotes the output gap, \hat{g}_t represents the government expenditure gap, π_t is the rate of inflation and fc_t denotes the financial crisis dummy.

Combining equation (3) and the estimated fiscal response equations (4) and (5) (detailed in Table 1 in the Appendix), we estimate the maximum sustainable debt level, which is 77.27% or 93.43% for the two specified fiscal response functions, respectively.

Given that China's public debt level (percentage to GDP) is 35.40% in 2013 and 39.45% in 2015, which are located in the sustainable scope [27.89% 93.43%], it is a reasonable conclusion that China's public debt at the general government levels is sustainable at the moment and in the near and medium future. Moreover, the fiscal space (54.03%) for China is significantly larger than other advanced economies and emerging countries. This provides a large space for China public debt adjustments in the future.

In a particular case, we consider the contingent liabilities of China's government, which include the potential costs associated with non-financial SOE debt; policy banks' liabilities; fiscal costs of recapitalizing banks; and liabilities of state-owned asset management companies.⁷ According to the estimation by Li *et al.* (2013), the contingent liabilities were approximately 100% of GDP in 2010 in China; hence the overall ratio of public debt to GDP at that moment could exceed the maximum sustainable debt level (93.43%). Obviously, this implies a potential vulnerability to China's debt sustainability.

5.2 Assessment on the sustainability of non-financial private debt

No standard threshold level has been developed for the DSA of non-financial private debt; we employ the debt threshold estimation under the context of an extended Solow growth model to examine the sustainability of non-financial private sector indebtedness. The idea is that the critical values (the threshold values) are identified following Hansen (2000) within an extended Solow growth model; if the actual level of the relevant non-financial private debt exceeds the threshold level, we conclude that the debt level is unsustainable.

The extended Solow growth model is given by

$$\bar{y}_{t+1, t+k} = \alpha + \rho'x_t + \tau'd_t^{pr} + \varepsilon_t \tag{6}$$

where $\bar{y}_{t+1, t+k} = \frac{1}{k} \sum_{i=1}^k y_{t+i}$ denotes the average value of the forward economic growth rates for k periods; x_t is a vector of control variables; d_t^{pr} is the set of the non-financial private debt variables including non-financial private debt level, household debt level and non-financial corporate debt level; and ρ, τ are coefficient vectors, respectively.

In accordance with the literature of extended Solow growth models, to avoid the endogenous problem, we use the forward average growth rate of real GDP per capita for five periods as the dependent variable. The control variables in equation (6) include:

⁷ Refer to, for example, Zhang and Barnett (2014).

- a. Real GPD per capita at t_0 , to capture the initial conditions of economic structure.
- b. Saving rate, share of national saving (public and private) in GDP.
- c. Population growth rate.
- d. Human capital, proxied by the education expenditure per capita.
- e. Openness, measured by the ratio of total foreign trade (exports plus imports) to GDP.
- f. Rate of inflation, calculated by CPI index.
- g. Financial markets development index, measured by the ratio of total loans and total deposits to GDP.

On the basis of regression equation (6), we use the following regression to identify threshold values for the non-financial private debt levels:

$$\bar{y}_{t+1, t+k} = \alpha + \rho'x_t + \tau_1\Phi[d_t^{pr} \leq \gamma] + \tau_2\Phi[d_t^{pr} > \gamma] + \varepsilon_t \quad (7)$$

where $\Phi[A]$ is an indicator variable that takes the value of unity if event A occurs and zero otherwise. γ denotes the threshold level for the concerning debt variable d_t^{pr} . We use a Monte Carlo simulation with bootstrap algorithm in accordance with Hansen (2000) to search for the threshold levels.

Data sources from the Wind database and BIS (2015) database. The sample period is from the first quarter of 1992 to the fourth quarter of 2014.

The results for growth regression are summarized in Table 2 in the Appendix.

Columns 1 to 4 in Table 2 show the effects of the non-financial private debt levels on China's p.c. GDP growth. The ratio of non-financial private debt to GDP has significantly negative effects on economic growth. Most importantly, it is the ratio of non-financial corporation debt to GDP rather than the ratio of household debt to GDP that has the remarkably negative impact on the p.c. GDP growth in China.

Table 3 in the Appendix reports the identified threshold levels. The significant threshold values for the non-financial private debt level and non-financial corporate debt level are 116% and 110.6% (percent to GDP), respectively. The threshold value for household debt level is insignificant. Given that the actual non-financial private level and the actual non-financial corporate debt have exceeded their threshold values since 2009 and remained above them until 2015 (the regarding levels at the end of 2015 are 210.22% and 170.72%, respectively), it can be concluded that China's non-financial private debt level and non-financial corporate debt level are unsustainable from 2009 onwards. However, the household debt level is sustainable because the threshold level identified for it is insignificant. Furthermore, we examine the effects of non-financial private debt and non-financial corporate debt on China's economic growth by splitting them according to the threshold levels and conducting the same regression as above. The results in row 4 of Table 3 suggest that when the non-financial private debt and the non-financial corporate debt exceed their threshold levels, the negative effects are remarkable; when they are lower than their threshold levels, the negative effects are weak. These also indicate that the non-financial private debt and non-financial corporate debt are unsustainable from 2009 onwards.

Considering that asset bubbles and currency appreciation could overestimate the debt sustainability of the private sector,⁸ we provide an alternative assessment on the debt sustainability of the private sector from the perspective of the debt service ratio (DSR). The DSR measures household (firm) debt-servicing costs as a percentage of its disposable income (revenue). Following [Drehmann and Juselius \(2012\)](#), we calculate the DSR by

$$DSR_t = DSC_t / Y_t = \frac{I_t D_t}{[1 - (1 + I_t)^{-M_t}] Y_t}, \quad (8)$$

where D_t is an aggregate borrowing stock, I_t is the average interest rate per year on the stock, M_t denotes the average remaining maturity in years in the stock and Y_t denotes annual aggregate income. I_t is given by

$$I_t = \beta I_{t-1} + (1 - \beta)(I_t^m + \mu), \quad (9)$$

beginning with the initial value $I_0 = I_0^m + \mu$. In equation (9), β is set as 0.8 following [Drehmann and Juselius \(2012\)](#), and I_t^m denotes the short-term interest rate.

For simplicity, we assume the average maturity for household debt to be 10 years, and the average maturity for non-financial corporate debt to be three years. The banking lending rate is used to calculate the debt service costs for both sectors. The results are reported in [Table 4](#) in the Appendix.

In [Table 4](#), we find that the DSRs for households are lower than 12 percent from 1985 to 2015; this suggests that a majority of Chinese households have comfortable or modest debt burdens. The DSRs for Chinese non-financial firms are between 20% and 55% during the sample period, which implies comparatively heavy burdens for non-financial firms. It needs to be stressed that these are average estimations; the potential vulnerabilities of non-financial private debt from the tail distribution are ignored.

Notwithstanding that the ratio of the debt-to-disposal income for households has increased dramatically since 2000 (from 6.62% in 2000 to 88.53% in 2015), the current ratio of 88.53% remains far lower than the average level of 110% in advanced countries, but higher than the average level of 42% in emerging countries.⁹ In addition, the modest DSRs ensure the sustainability of household debt in China.

The debt burdens (by DSR) of China's non-financial corporations have declined since 1998 from the peak of 55% but have risen again since 2010; it remained above 37% in 2015. Besides the heavy debt service burdens, the non-financial corporate debt had reached 173.92% of GDP by the end of 2015, which is one of the highest levels across countries and unsustainable.

Comparing the results from the DSR approach and the threshold approach, we find that both suggest that current household debt level is sustainable whereas current non-financial corporate debt level is unsustainable. Hence, a deleverage process is required

⁸ When home currency appreciates (capital inflows) and assets prices soar, agents maximize their net assets by increasing investment and productions or purchasing assets through borrowing. At the moment, the increase in the debt level seems sustainable due to the asset bubbles. However, if the currency appreciation reverses (capital outflows), the fall in the asset prices leads to shrinking of the net assets. When the net assets are negative, the debt level is unsustainable and the deleveraging process must occur.

⁹ According to MGI report (2015), these data are for 2014.

and more concerns should be accorded to the potential risk from the excess indebtedness of China's non-financial corporations.

5.3 Assessment on the sustainability of international debt

Because the share of international debt in overall debt in China is very low and declines over time, and because China has a huge stock of foreign exchange, fewer concerns have been given to the DSA for China's external debt. According to the IMF (2002), the standard thresholds of external debt sustainability indicators include the ratio of NPV of external debt to exports (the threshold value at 150%) and the ratio of NPV of external debt to government revenue (the threshold value at 250%). According to these two ratios, we conduct the assessment on China's external debt. The results are presented in Table 5 in the Appendix. Although we did not calculate the NPV of China's external debt to exports and government revenue,¹⁰ given that the ratios of short-term external debt to exports, fiscal revenue and aggregate foreign exchange reserves are 40.56%, 37.65% and 27.64%, respectively, in 2015, and the ratios of total external debt to exports, fiscal revenues and foreign exchange reserves are 62.40%, 57.62% and 42.52%, respectively, in 2015, it is reasonable to conclude that the ratios of nominal external debt to exports and the government revenue are comparatively significantly lower than the international standards (150%, 250%) for the external debt sustainability. Even if China's current account deteriorates and the exchange rate of RMB depreciates in the future, China's external debt burdens would be modest and sustainable in the near and medium term.

In addition, we can also assess the sustainability of China's external debt according to the DSR approach in terms of equations (8)–(9), in which the income (Y_t) denotes Chinese current account surplus (CA) or the foreign exchange income, and the debt service costs include the payback principal and interest of the external debt. Fortunately, China's State Administration of Foreign Exchange has calculated and provided the DSR for Chinese international debt. Column 9 in Table 5 presents the DSR for China from 1985 to 2015. It shows that the DSR for China's international debt had never exceeded 10% since 2000, suggesting a sustainable path for external debt in China.

6. Concluding remarks

Debt and leverage, whether at the micro or macro level, have important implications for economic sustainability and stability. Duo to the limitation of historical data, studies on the effects and sustainability of China's debt are scarce. In order to fill this urgent gap, we collect a comprehensive debt dataset for China, which covers the entire debt categories and spans the longest series to our knowledge. Relying on the newly constructed debt dataset, we have developed a set of indicators to describe and explain the structure of China's debt and its evolution.

By estimating fiscal response functions within a fiscal space framework, we have identified the long-run debt level (25.96%) and the maximum sustainable debt level (93.43%) for China's public debt. China's practical public debt level (debt-to-GDP

¹⁰ This is because the ratios of the external debt to GDP, exports and fiscal revenue are nearly stable and have gradually declined since 2005 in China. Refer to Table 5 in the Appendix.

percent) over time is between these two values; hence, we can conclude that China's public debt is sustainable in the near and medium term. We employ the threshold estimation and the DSR approach to assess the sustainability of non-financial private debt. The empirical results indicate that China's household debt level is sustainable, whereas the debt level for non-financial firms and thereby for the non-financial private sector are unsustainable. This suggests that China's non-financial corporate sector would face a severe deleveraging process in the future. By using the thresholds developed by the IMF, we confirm that China's external debt is sustainable at the moment and in the medium future. In sum, China's public debt and external debt are sound and sustainable in the near and medium term, but the non-financial corporate debt and thereby the non-financial private debt are unsustainable from 2009 onwards. Policymakers and regulators should be accorded more concern with highly indebted non-financial firms, local governments and shadow banks.

Looking ahead, further studies are necessary for exploring the connection between the debt level and China's economic growth, and the implications of China's debt for China's economic and fiscal stabilities.

Supplementary material

Supplementary data are available at *Cambridge Journal of Economics* online.

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Appendix Empirical Results for Sustainability Analysis

Table 1. Estimated fiscal reaction function for China (dependent variable: general government primary balance to GDP [percentage])

Independent Variables	Specification (1)	Specification (2)
Lagged debt	-0.155* # (0.098)	-0.065 (0.089)
Lagged debt square	0.021** (0.008)	0.015** (0.007)
Lagged debt cubic	-0.00046*** (0.0002)	-0.00036** (0.00015)
Output gap##	0.0262** (0.0098)	0.027*** (0.008)
Government expenditure gap##	-0.091*** (0.021)	-0.097*** (0.0115)
Inflation		0.0415*** (0.0144)
Financial crisis dummy		0.565* (0.282)
Adj. R-square	0.496	0.632

Source: Author estimation.

standard errors are reported in parentheses; ***, ** and * denote 1%, 5% and 10% significance, respectively.

The gap was estimated by H-P Filter. Lambda is taken as 100.

Table 2. Effects of non-financial private debt on economic growth (dependent variable: future average growth of real GDP per capita)

	(1)	(2)	(3)
Log real p.c. GDP	-0.021 (0.297)	-2.79 (1.80)	-0.99 (1.26)
National saving rate	0.212*** (0.04)	0.37*** (0.145)	-0.15 (0.14)
Population growth	-14.01*** (4.94)	35.64 (75.76)	111.58** (491)
Human capital	-0.013*** (0.003)	-0.02*** (0.005)	-0.019** (0.003)
Trade Openness	0.081*** (0.016)	0.046 (0.038)	-0.003 (0.028)
CPI inflation	0.092*** (0.028)	0.372*** (0.087)	0.36*** (0.053)
Financial index	0.038*** (0.013)	0.071*** (0.014)	0.148*** (0.017)
Private debt/GDP	-0.066*** (0.021)		
Household debt/GDP		-0.09 (0.07)	
Non-financial corporate debt/GDP			-0.19*** (0.03)
R square	0.90	0.96	0.98
Adj. R square	0.89	0.95	0.97

***, ** and * represent the significance at 1%, 5% and 10%, respectively.

Standard deviations are reported in the paragraphs.

Table 3. *Threshold levels for non-financial private debt*

Indicators	Private Debt/GDP	Household Debt/GDP	Non-Financial Corporate Debt/GDP
Threshold Level	116%***	19.10%	110.6%*
Bootstrap P-Value	0.000	0.138	0.068
Effects on Real Growth of P.C. GDP	>116%–0.113*** (0.035) <116%–0.028 (0.022)	N/A	>110.6%–0.177** (0.072) <110.6% N/A (Sample number <12)

***, ** and * denote the significance at 1%, 5% and 10%, respectively. Standard deviations are reported in the paragraphs.

Table 4. *Debt servicing costs for households and non-financial firms (percent)*

Period	Household Debt to Disposable Income	Firm Debt to Revenue	Lending Rate	DSR for Households	DSR for Non-Financial Firms
1985	26.34	60.09	5.76	3.54	22.38
1986	24.79		8.64	3.80	
1987	23.64		8.64	3.62	
1988	21.02		9.00	3.28	
1989	19.44		11.34	3.35	
1990	18.08	81.21	10.08	2.95	32.70
1991	17.48		10.08	2.85	
1992	15.79		8.64	2.42	
1993	13.33		9.36	2.11	
1994	10.25		10.98	1.74	
1995	8.39	98.27	10.98	1.42	40.20
1996	7.29	110.43	10.98	1.24	45.17
1997	6.89	121.29	10.08	1.13	48.84
1998	6.72	139.43	8.64	1.03	54.73
1999	6.47	143.06	6.39	0.90	53.91
2000	6.62	132.34	5.85	0.89	49.37
2001	18.11	122.20	5.85	2.44	45.59
2002	25.72	130.63	5.31	3.38	48.25
2003	32.19	120.62	5.31	4.23	44.55
2004	38.41	97.02	5.58	5.11	36.01
2005	37.95	82.86	5.58	5.05	30.76
2006	40.39	76.39	6.12	5.52	28.64
2007	44.75	71.48	6.84	6.32	27.16
2008	43.23	65.13	7.20	6.21	24.91
2009	55.90	80.55	5.31	7.35	29.75
2010	67.10	74.76	5.56	8.93	27.74
2011	69.23	71.35	6.06	9.43	26.72
2012	71.47	74.72	6.31	9.85	28.11
2013	78.43	77.39	6.00	10.66	28.95
2014	82.66	90.08	5.60	11.02	33.83
2015	88.53	104.09	4.35	11.11	37.98

Table 5. Sustainable indicators for China's external debt (percent)

Period	Total External Debt/GDP	Total External Debt/Exports	Total External Debt/Government Fiscal Revenue	Total External Debt/Foreign Exchange Reserves	Short-Term External Debt/ Government Fiscal Revenue	Short-Term External Debt/ Exports	Short-Term Debt/ Foreign Exchange Reserves	DSR for Total External Debt
1985	5.57	62.65	25.28	598.71				2.70
1986	7.71	73.88	37.68	1036.68				15.40
1987	9.23	76.47	51.11	1033.19				9.00
1988	9.81	84.27	63.16	1186.24				6.50
1989	11.35	99.70	73.18	744.14				8.30
1990	14.54	91.91	93.43	473.72	12.03	11.83	60.99	8.70
1991	14.96	85.99	104.49	278.92	17.78	14.63	47.46	8.50
1992	14.66	85.26	114.46	356.53	17.90	13.33	55.75	7.10
1993	13.59	91.72	111.45	394.22	18.07	14.87	63.90	10.20
1994	16.12	75.22	150.23	179.79	16.86	8.44	20.18	9.10
1995	14.45	71.20	142.03	144.83	15.88	7.96	16.19	7.60
1996	13.44	76.72	130.25	110.71	15.80	9.31	13.43	6.00
1997	13.60	71.52	125.34	93.62	17.36	9.91	12.97	7.30
1998	14.19	79.42	122.42	100.75	14.54	9.43	11.96	10.90
1999	13.88	77.79	109.84	98.16	10.98	7.78	9.81	11.20
2000	12.03	58.46	90.05	88.01	8.08	5.25	7.90	9.20
2001	15.18	76.40	102.69	95.82	42.31	31.48	39.48	7.50
2002	13.78	62.24	88.73	70.75	38.13	26.75	30.40	7.90
2003	13.21	50.03	83.61	54.40	39.17	23.44	25.49	6.90
2004	13.45	44.33	82.46	43.12	43.49	23.38	22.74	3.20
2005	12.78	38.20	75.61	36.21	43.77	22.11	20.96	3.10
2006	12.05	34.07	68.21	31.75	40.14	20.05	18.68	2.10
2007	10.52	30.39	55.40	25.47	33.54	18.40	15.42	2.00
2008	8.35	26.56	43.48	20.87	25.22	15.40	11.63	1.80
2009	8.38	35.68	42.72	17.87	25.84	21.58	10.81	2.90
2010	8.80	33.97	43.75	19.28	29.94	23.25	13.19	1.60
2011	8.95	35.53	42.15	21.85	30.38	25.61	15.75	1.70
2012	8.57	35.81	39.50	22.25	28.99	26.28	16.33	1.60
2013	8.80	38.18	40.54	22.59	31.78	29.93	17.71	1.60
2014	8.51	38.07	39.03	23.30	29.79	29.06	17.78	2.60
2015	12.80	62.40	57.92	42.52	37.65	40.56	27.64	5.00