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Local Government Debt and Regional Competition in China

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Keywords: Local Government Debt, regional competition, government debt reform, Chinese economy
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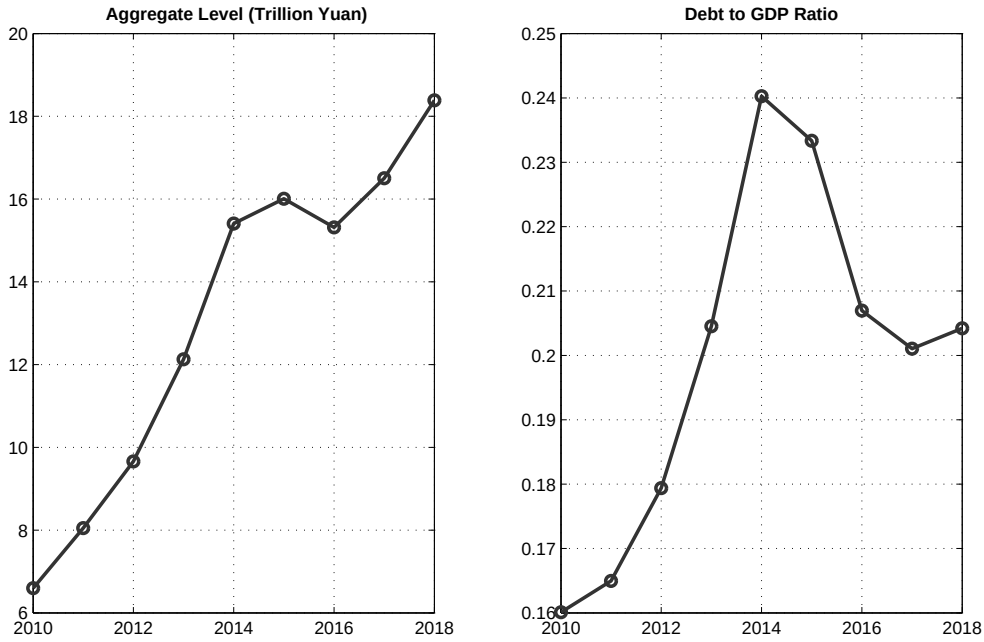
1 Introduction

Since its economic takeoff in the late 1970s, the Chinese economy has continued its rapid growth for over three decades. The so-called economic tournament among local governments associated with government-led investment is believed to play a key role in supporting China's long-standing growth miracle (Li and Zhou, 2005; Xu, 2011; Qian, 2017; Xiong, 2018). After the outbreak of the global financial crisis in 2008, the Chinese central government launched a massive fiscal stimulus package aiming to stabilize the whole economy. Local governments were approved to employ the debt instrument to finance their immense investment expenditures. As a consequence, local government debt has become one of the most important forces driving the leverage boom and the surge of the shadow banking sector in China during the past decade (Zhang and Barnett, 2014; Bai et al., 2016; Song and Xiong, 2018).

Figure 1: Aggregate Level of China's Local Government Debt



Notes: The left panel is the aggregate level of local government debt in nominal terms (trillion yuan). The right panel is the local government debt to GDP ratio. The aggregate debt series prior to 2014 is obtained by aggregating provincial-level local government debt.[1] The data source is the local government debt audit announcement. The debt series from 2014 to 2018 are from the official website of the Ministry of Finance. The nominal GDP series is from the National Bureau of Statistics. Due to data availability, the debt series only starts from 2010.

[1]Local government debt issued before 2014 usually took the form of one of six types: government bonds, bank loans, corporate bonds, build-transfer debt, trusts, and household loans. Local government debt for 2014 only contains the debt after the assessment process in that year. The debt series after 2014 contains outstanding debt assessed in 2014 plus newly issued local government bonds.

Figure 1 plots the aggregate level of China's local government debt from 2010 to 2018. From the left panel, it can be seen that local government debt presents a significant upward trend: the level of outstanding debt has doubled, growing from 6.6 trillion yuan in 2010 to 15.4 trillion yuan in 2014. As a result, the debt to GDP ratio swelled from 16% in 2010 to 24% in 2014 (the right panel). Starting from 2014, the central government launched a series of measures and regulations aiming to resolve the titanic local government debt burden. Section 2 provides a brief review of these policies. As a consequence, local government debt decelerates and presents a trend break in 2014, while the debt to GDP ratio shifts to a rapid decline.

Although the behaviors and economic consequences of regional competition among local governments have been well documented in the existing literature, the relationship between regional competition and local government debt has not been sufficiently studied by recent empirical research. To this end, we aim to empirically document the impact of GDP competition among local governments on the dynamics of local government debt.

To rationalize the behaviors of local governments, we first build up a simple decision model of local governors based upon prospect theory. Specifically, we introduce the GDP growth of the local economy relative to its competitors into the local governors' target function to characterize their career concern. A level of GDP growth that is behind (or ahead of) the competing regions' is considered to be a loss (or gain) for a typical local governor. According to prospect theory, the magnitude of the disutility derived from a loss is assumed to be greater than that of a gain. The local governor uses public investment financed through government debt as an instrument to steer the local economy. A local governor with weaker economic fundamentals than his peers' has more incentives to invest in public capital to boost the local economy. As a result, government debt in a region with lower GDP growth tends to grow faster than that of regions with more rapid GDP growth. Therefore, our theory implies an *asymmetric* effect of regional competition on local government debt. We then extend our baseline model by introducing the debt regulation policy that places a ceiling on government debt. Our analysis suggests that the negative relationship between the economic-growth gap and debt growth would be largely muted if the borrowing constraint binds. However, for those cities suffering from a relatively loose debt limit constraint, regional competition still plays a vital role in debt accumulation.

In December 2015, the Chinese central government implemented a top-to-bottom debt quota management system that strictly restrains local government debt. The implementation of this regulation provides a desirable identification to document the impact of regional competition on local government debt.

In our empirical analysis, we aim to test the predictions derived from our theoretical model based on prefectural-level local government debt from 2014 to 2018. We manually collect the debt data since information on local government debt has not been publicly available. Our

sample to some extent is comprehensive and unique, covering all of the prefectural-level cities in China except those in Xinjiang Province[2]. To further analyze the heterogeneous effect of the debt regulation policy, we also collect the debt quota data for 280 prefecture-cities from their annual fiscal budget reports.[3]

In the estimation, we utilize a variety of empirical techniques to verify the above hypothesis. We begin the baseline analysis based upon the debt dataset from 2014 to 2018 [4]. In our empirical specification, we introduce the dummy variable and the interaction item to capture the effect of the debt quota management policy implemented at the end of 2015. After controlling for a large number of standard regional characteristics, our econometric analysis shows that before the implementation of the debt regulation policy, the regional gap in GDP growth, defined as the difference between local GDP growth and that of of competitors, has a significant and negative impact on the change in local government debt. We further show that this negative impact is largely driven by those regions with GDP growth falling behind their competitors. That is, for a region with a lower GDP growth relative to its competitors (the regional gap in GDP growth is negative), the local government tends to issue more debt. However, for a region with GDP growth faster than its competitors, the relationship between the regional GDP growth gap and change in local government debt is substantially weakened and insignificant.

After the implementation of the debt regulation policy, our estimation results reveal that the relationship between the regional GDP growth gap and the change in local government debt is no longer significant. This finding indicates that the debt regulation policy implemented at the end of 2015 may effectively hamper the role of government debt in regional competition. In addition, we split our sample into three groups according to the tightness of the debt regulation constraint. Our analysis finds that local government debt negatively responds to the regional GDP growth gap for the group with loose debt constraints, though the magnitude and significance of the coefficient are both greatly reduced for the other two groups with tighter debt constraints. The above result indicates that the debt regulation policy implemented by the central government helps to mitigate the surge in local government debt, but that its influence depends on the tightness of fiscal constraints imposing on local governments. In summary, our empirical analysis confirms the predictions from our theoretical analysis. The spatial correlation model and sensitivity analysis suggest that the main findings are robust.

Competition among local governments in China has attracted much attention in the economics

[2]Our sample covers 96% (319 out of 333) of prefectural-level cities in China. Section 4 provides more details about the data.

[3]This sample covers almost 95% of the total local government debt. The rest are excluded for the lack of data.

[4]The dependent variable in our estimation is the change in government debt. As a result, the data we eventually use cover the years 2015 to 2018.

discipline. The existing literature can generally be divided into two strands based on economic and political perspectives. The first strand focuses on economic decentralization, especially fiscal decentralization. Local governments have autonomy and responsibility to develop the economy at the regional level in different ways, such as by constructing infrastructure and offering tax exemptions. Some studies, such as Qian and Weingast (1996, 1997); Qian and Roland (1998); Jin et al. (2005), argue that fiscal decentralization in China is a market-preserving fiscal federalism that will protect markets rather than plunder market wealth. Strengthened budget constraints due to the fiscal reform in 1994 force local governments to pursue revenue maximization to finance expenditure (Zhang, 2012). As a result, local governments have strong motivations to promote economic growth to expand tax bases through tax competition and expenditure competition. The second branch of the literature focuses on political centralization in China as the institutional root of government competition. Local governors are appointed by upper-level governments based largely on their performance in promoting economic growth. Hence, local governments have strong incentives to push the economy to achieve higher economic growth than other regions through the so-called tournament competition (Li and Zhou, 2005; Chen et al., 2005; Xiong, 2018). Xu (2011) defines this sort of institution in China as the regionally decentralized authoritarian (RDA) system, with decentralized economic governance and centralized political governance. In the RDA system, local competition, especially tax and expenditure competition, has become the norm among local governments seeking to promote economic development. Despite the different underlying institutional reasons for regional competition among local governments, these two branches of literature suggest that local governments' behavior can be essentially characterized by regional competition over GDP growth.

Excessive GDP competition among local governments may lead to serious debt problems. The massive increase in local government debt that resulted from the China's four-trillion RMB fiscal stimulus in 2008 has attracted wide attention and interest among researchers. Ang et al. (2015) study the urban construction investment bonds (UCIBs) issued by the Chinese local government and the factors that determine the bond yields. They find that government corruption positively affects the bond yields. Lu and Zhong (2018) study how intergovernmental fiscal transfers impact the issuance of UCIBs under China's unitary currency system. Their evidence shows that only special-purpose fiscal transfers matter for the issuance of UCIBs. Cong et al. (2017) find that the credit expansion induced by the fiscal stimulus was allocated relatively more towards state-owned, low-productivity firms than to privately owned, high-productivity firms. Gao et al. (2018) use a loan-level data set covering all major bank loans to local governments to study loan default behavior. Ru (2018) finds that government credit to state-owned enterprises crowds out private firms in the same industry, while helping private firms in downstream industries grow. Although the existing literature has found a negative relationship between public debt and long-

run growth, some studies on the Chinese economy argue that local government debt can promote regional economic growth at least in the short term, e.g., Wu (2014), which in turn improves the government's performance.[5] While there is much research and discussion on local government debt in China, empirical evidence on the relationship between the local government debt and regional competition is scarce.

Our paper is most closely related to Xiong (2018) and Huang et al. (2019). The former builds a growth model with a GDP tournament among local governments. The paper theoretically shows that local government competition leads to over-leverage caused by government debt. Complementary to Xiong (2018), our paper provides comprehensive empirical evidence that supports the argument derived from the theoretical analysis in Xiong's paper. Huang et al. (2019), based on data on loans and bonds issued by local government financing vehicles between 2006 and 2013, study the consequences of government debt on firm-level investment. They find that local public debt crowds out the investment of private firms, but without affecting state-owned enterprises. Instead of potential economic consequences, our empirical analysis focuses on the underlying driving force for local government debt.

Our paper could make several possible contributions to the existing literature. First, we construct a comprehensive data set of prefectural-level government debt in China, including the imformation of the debt stock from 2014 to 2018 and the debt quota from 2016 to 2018. Due mainly to data limitations, previous studies either use data on quasi-municipal bonds at the city level as a measure of local government debt (Ang et al., 2015; Lu and Zhong, 2018); focus on total local government debt without geographical segmentation (Zhang and Barnett, 2014); or employ prefectural-level data with limited coverage (Gao et al., 2018).[6] As we focus on regional competition among local governments, the estimation of regional interaction requires more comprehensive data for the total level of government debt. Because the government bond swap in China happened only in more recent years, we construct the data set of total level of government debt that covers all prefecture-level cities, except those in Xinjiang Province, from 2014 to 2018. The extensive coverage of Chinese cities in our data set allows us to comprehensively document the behavior of local government debt. Second, we employ the implementation of the debt regulation policy at the end of 2015 to identify the main mechanism through which regional competition affects local government debt. Our data show quite different patterns before and after the implementation of the policy and an asymmetric effect of regional competition on

[5]The ambiguous effect of government debt on economic growth is also documented by the literature for other advanced economies. For instance, Checherita-Westphal and Rother (2012) use data from twelve euro area countries and find a nonlinear impact of debt on growth and a negative impact on long-term growth. Eberhardt and Presbitero (2015) also confirm the existence of a nonlinear relationship between economic growth and local government debt.

[6]The data in Gao et al. (2018) account for approximately 60% of all government debt as of 2013.

government debt. These facts have not been well documented in the related literature.

The rest of the paper is organized as follows. Section 2 briefly reviews the recent policies regarding local government debt. Section 3 builds a stylized economic model of local government debt and regional competition. Section 4 describes our data set on local government debt in detail. Section 5 conducts empirical analysis through various econometric specifications. Section 6 provides a set of robustness checks. Finally, Section 7 concludes.

2 Institutional Details about Regulatory Policies

In this section, we provide a brief introduction to the institutional details regarding the regulatory policies of local government debt. After the outbreak of the global financial crisis in 2008, the Chinese central government launched a four-trillion yuan fiscal stimulus package aiming to curb the economic slowdown. The major portion of stimulus expenditure was financed by local governments. To guarantee the success of the massive fiscal expansion, local governments were approved to use the debt instrument as a major external financing channel. As a result, the Chinese credit market expanded, leading to a leverage boom and the surge of the shadow banking sector. Being aware of the large financial risks, the Chinese central government decided to take a large step towards the resolution of its mounting local government debt burden.

Table 1: List of Recent Regulatory Policies

Date	Policy	Main Points
Aug. 2014	*New Budget Law*	Local gov. bond is the only financing channel.
Sept. 2014	*Opinions on Strengthening the Admin. of Local Gov. Debts*	1. Assess and clarify the repayment obligation. 2. Three-year debt-swap program.
Dec. 2015	*Opinions on the Implementation of Quota Management for Local Gov. Debt*	Top-to-bottom debt quota management system.
Nov. 2016	*Measures for Budget Management for Special and General Local Gov. Debt*	Sets specific practices for management of two types of local gov. debt.
Mar. 2017	*Measures for the Allocation of Newly Issued Debt Quota*	Specifies a concrete formula for computing the quota for newly issued debt.

During the years 2014 to 2017, the central government issued several regulations regarding the management of local government debt. We briefly introduce them in chronological order. Table 1 provides a summary of the related policies. In August 2014, the central government amended the budget law adopted in 1994. According to the new budget law, which is effective

from 2015, the local government bond market is the only platform through which local governments can raise debt. Thus, the new budget law established a legal framework for the local governments' direct financing channel. To accompany the new budget law, in September 2014, the State Council promulgated "*Opinions on Strengthening the Administration of Local Government Debts*" (hereafter *Opinion 1*) aiming to establish a standardized local government direct financing mechanism and the corresponding monitoring system. *Opinion 1* strictly restrains local governments' financing behaviors and clarifies the corresponding repayment obligations. After 2015, local governments will not repay new debts issued outside of the local government bond market. Additionally, *Opinion 1* sets a screening process to assess the outstanding debt (with six types) for which the local governments have repayment obligations. At the end of 2014, the Chinese government finished the screening process. The total amount of outstanding local government debt is approximately 15 trillion yuan as of the end of 2014. *Opinion 1* requires the local government to replace all outstanding non-government-bond debt with local government bonds through a three-year debt-swap program. Though "*Opinion 1*" sets out a general idea for managing local government debt, it does not provide a specific provision for controlling the size of local government debt.

In December 2015, the Ministry of Finance (MoF) issued "*Opinions on the Implementation of Quota Management for Local Government Debt*" (hereafter *Opinion 2*), which establishes a top-to-bottom debt quota management system to strictly control the ceiling on local government debt. "*Opinion 2*" stipulates that the State Council sets the quota (ceiling) of nationwide local government debt in the next year (outstanding debt in the last year plus newly issued debt) according to current economic conditions. The proposed debt quota is required to be approved by the National Congress. The MoF allocates the debt quota to each province according to the proposals from provincial governments. The provincial department of finance then allocates the quota assigned by the MoF to the prefectural-level cities after considering the credit risks and economic conditions of each city.

In November 2016, the MoF issued two measures regarding budget management for special and general local government debts.[7] These two measures are complementary to the new budget law and previous two "*Opinions*". They set specific practices for the management of the two types of local government debt, including allocation of the debt quota, budget management and monitoring of outstanding debt.

In March 2017, the MoF issued a measure for the quota allocation for newly issued local government debt. The regulation requires that the issuance of new government debt for a particular

[7]Special local government debt is used to finance municipal investments with capital return, including highways, railway stations, airports, etc. General local government debt is used to finance municipal projects without return, including kindergartens, museums, etc.

region (province, prefectural cities) strictly follow a complicated formula. The formula considers a set of local factors including economic fundamentals, demand for major (large-scale) municipal projects, debt risk, and adjustment factors for the debt management performance and specific applications of the local government. This regulation provides a concrete criterion for allocation of the quota for newly issued debt among local governments.

Obviously, "*Opinion 2*" and other related measures issued afterward implement strict regulations on the local government debt ceiling. As the regulation was issued at the end of 2015, it is supposed to be effective starting from 2016. Therefore, "*Opinion 2*" provides a desirable policy experiment to identify the impact of regional competition on local government debt. In the later empirical analysis, we document the dynamic relationship between prefectural-level government debt and the regional GDP growth gap. We find that regional competition in GDP growth significantly stimulates local government debt for the year 2015 and the relationship is largely weakened and becomes insignificant after the implementation of the debt regulation policy.

3 Theory

3.1 Baseline Model

This section aims to build a simple decision theory of local governors to model regional competition and local government debt. To keep the analysis transparent, we consider a two-period model, $t = \{1, 2\}$. Without loss of generality, we assume that the economy has two regions indexed by the subscript i. We label the region with stronger economic fundamentals (to be defined later) by $i = h$ and the region with weaker fundamentals as $i = l$.

In each period, the local government decides the public capital investment G_{it}. For analytical convenience, we assume that the public capital fully depreciates, i.e., G_{it} is the total stock of public capital in each period. Following Barro (1990) and Xiong (2018), we assume that the aggregate production function satisfies $Y_{it} = A_{it}G_{it}^{\alpha}$, where $\alpha \in (0, 1)$ and A_{it} is the technology that reflects the fundamental of region i. To make the analysis transparent, we specify that two regions have the same initial technology in period 1, i.e., $A_{i1} = A$ for $i = \{l, h\}$. Define the gross growth rate of technology in period 2 as $g_i^a = \frac{A_{i2}}{A}$. To capture the regional difference in economic growth, we further specify $g_h^a > g_l^a > 1$. This condition also implies the region h has a higher level of productivity (better fundamentals) in period 2, i.e., $A_{h2} > A_{l2}$.

Let H_{it}, $t = \{1, 2\}$, denote the fiscal balance of the local government in the beginning of each period. The public investment G_{it} can be financed from H_{it} and public debt D_{it} with an exogenous interest rate R.[8] For analytical convenience, we only consider intraperiod debt, in the

[8] If the local government is a net saver, the debt D_{it} is negative.

sense that the local government borrows in the beginning of the period and pays back the debt at the end of that period. In the baseline model, we do not consider any constraint on the public debt. Thus, the local government can achieve an optimal level of debt. In the extension, we will introduce the debt limit constraint, which is controlled by the central government.

The flow of funds constraint for the local government is

$$G_{it} = H_{it-1} + D_{it}, \text{ for } t = \{1, 2\}, \tag{1}$$

where the endowment or intial state of H_{it} is assumed to be identical across regions, i.e., $H_{i0} = H_0$ for $i = \{l, h\}$.

The budget constraint for the local government i is given by

$$C_{it} + H_{it} = \tau A_{it} G_{it}^{\alpha} - RD_{it}, \text{ for } t = \{1, 2\}, \tag{2}$$

where C_{it} is government consumption, τ is the tax rate, and RD_{it} is the interest payment. In addition, we assume that government consumption cannot be negative, i.e.,

$$C_{it} \geq 0. \tag{3}$$

In the baseline model, we follow Xiong (2018) to assume that the local government only cares about the flow of public consumption C_{it}. In particular, the objective function is $\sum_{t=\{1,2\}} \beta^{t-1} u(C_{it})$. We consider a risk-neutral government, so the utility is linear, i.e., $u(C_{it}) = C_{it}$. The optimization problem is

$$\max_{\{C_{it}, H_{it}, D_{it}, G_{it}, Y_{it}\}} \sum_{t=\{1,2\}} \beta^{t-1} C_{it}, \tag{4}$$

subject to (1), (2) and (3). The optimal decisions are summarized by the following proposition.

Proposition 1 *Assuming that the interest rate satisfies $R > 1/\beta$, the local government's optimal*

decisions for region i are given by

$$G_{it}^{*} = \left(\frac{\alpha\tau A_{it}}{R}\right)^{\frac{1}{1-\alpha}}, \tag{5}$$

$$Y_{it}^{*} = A_{it}\left(G_{it}^{*}\right)^{\alpha} = A_{it}^{\frac{1}{1-\alpha}}\left(\frac{\alpha\tau}{R}\right)^{\frac{\alpha}{1-\alpha}}, \tag{6}$$

$$H_{it}^{*} = \begin{cases} \tau\left(1-\alpha\right)Y_{it}^{*} + RH_{it-1}^{*} & for\ t=1 \\ 0, & for\ t=2 \end{cases}, \tag{7}$$

$$D_{it}^{*} = G_{it}^{*} - H_{it-1}^{*}, \tag{8}$$

$$C_{it}^{*} = \begin{cases} 0 & for\ t=1 \\ \tau Y_{it}^{*} - RD_{it}^{*}, & for\ t=2 \end{cases}, \tag{9}$$

where $H_{i0} = H_0$.

Proof. See Appendix A. ■

The optimal condition for government investment, (5), indicates that G_{it}^{*} increases with productivity A_{it}. Intuitively, the local government has an incentive to invest more when the fundamentals of the local economy are high. For fiscal balance H_{it}, it is straightforward to show that the local government will hold zero balance in the last period ($t = 2$). In addition, due to the condition $R > 1/\beta$ and the risk neutral utility, for $t = 1$ the local government opts to keep a minimal public consumption such that constraint (3) binds. This further gives the optimal decision (7).[9] Notice that since the two regions share the same value of their fundamentals in period 1, their optimal decisions are the same for $t = 1$, i.e.,

$$G_{h1}^{*} = G_{l1}^{*},\ Y_{h1}^{*} = Y_{l1}^{*},\ H_{h1}^{*} = H_{l1}^{*},\ D_{h1}^{*} = D_{l1}^{*}. \tag{10}$$

Furthermore, under the previous specification of the productivity process, i.e., $A_{it} = A$ and $g_h^a > g_l^a$, the region with higher TFP growth in period 2 would have higher public investment, aggregate output, fiscal balance and government debt, i.e., $G_{h2}^{*} > G_{l2}^{*}$, $Y_{h2}^{*} > Y_{l2}^{*}$, $H_{h2}^{*} > H_{l2}^{*}$, and $D_{h2}^{*} > D_{l2}^{*}$.

3.2 Local Government Competition

We now introduce the local government competition into the baseline framework. We assume that the local government cares not only about public consumption C_{it} but also about the GDP growth rate relative to other regions. To make the analysis more transparent, we particularly

[9] Moreover, (5) and (8) imply that if productivity is sufficiently high, i.e., $A_{it} > \left(H_{it-1}^{*}\right)^{1-\alpha}\frac{R}{\alpha\tau}$, the local government would be a net borrower, i.e., $D_{it}^{*} > 0$.

assume that in period 1, the local government has the same behaviors as in the equilibrium without regional competition. However, in period 2, the economy exogenously switches to the competition regime, so the objective function in period 2 becomes $C_{i2}+v\left(g_{i2}-g_{-i2}\right)$, where $v\left(x\right)$ characterizes the GDP target, which will be specified later; $g_{i2}=\frac{Y_{i2}-Y_{i1}}{Y_{i1}}$ is the GDP growth rate for region i in period 2; and g_{-i2} is the GDP growth in the counterpart region. Notice that the history of decisions faced by the local government in the beginning of period 2 is $\{G_{it}^{*},H_{it}^{*},D_{it}^{*}\}_{t=1}$, which is given by Proposition 1.[10] The decisions in period 2, $\{G_{it},H_{it},D_{it}\}_{t=2}$, are influenced by the regional competition, and deviate from the decisions in the baseline model.

To derive the optimal decisions in period 2, we start with the characterization of local government competition. In particular, we employ prospect theory regarding relative GDP growth. Specifically, $v\left(x\right)$ takes the form

$$v\left(x\right)=\begin{cases}\lambda^{+}x^{\sigma} & \text{if } x\geq 0\\ -\lambda^{-}\left(-x\right)^{\sigma} & \text{otherwise } x<0\end{cases}, \tag{11}$$

where $0<\sigma\leq 1$ and $0<\lambda^{+}<\lambda^{-}$. It is straightforward to show that $v'\left(x\right)>0$, which reflects that the local government cares about relative GDP growth. The case where GDP growth in the local economy leads that of the counterpart region is considered a gain, while the opposite case is considered a loss. The assumption $\lambda^{-}>\lambda^{+}$ reflects the loss aversion motive of the local government. That is, if local GDP growth is falling behind the other region, i.e., $x<0$, the local government may suffer a loss, with the magnitude larger than that in the case where local GDP growth is ahead of the other region's. The above loss aversion behavior in relative GDP growth provides a shortcut to model the GDP tournament among local governments.

We now discuss the behaviors under the regional competition environment. Without loss of generality, throughout the analysis, we only focus on the optimal decisions for the region l with a weaker economic fundamental. Similar results can be applied to the other region h as well. In period 2, the optimization problem of the local government in region l is

$$\max_{\{C_{l2},H_{l2},G_{l2},D_{l2}\}}C_{l2}+v\left(g_{l2}-g_{h2}\right), \tag{12}$$

subject to (1) and (2).[11]

Under the regional competition, the optimal conditions for government investment are given

[10] Notice that due to having the same fundamentals in period 1, the two regions have the same optimal decisions in period 1, i.e., (10) is satisfied.

[11] As in the previous analysis, the fiscal balance in period 2 always satisfies $H_{i2}=0$. Therefore, the nonnegative constraint $C_{i2}\geq 0$ does not bind.

by

$$\alpha\tau A_{l2}G_{l2}^{\alpha-1}+v'\left(g_{l2}-g_{h2}\right)\frac{\partial g_{l2}}{\partial G_{l2}}=R, \tag{13}$$

where $\frac{\partial g_{l2}}{\partial G_{l2}}=\alpha\frac{A_{l2}G_{l2}^{\alpha-1}}{Y_{l1}}>0$. Moreover, since $v'(x)>0$, the optimal condition (13) indicates that, in comparison with the scenario without regional competition, the local government tends to invest more in period 2 because of the government's target on the regional GDP growth gap, $g_{l2}-g_{h2}$.

To further solve the optimal decisions in period 2, we first conjecture that region l is the one with lower GDP growth. Then, we verify it and derive the condition under which this is exactly the equilibrium.

The optimal condition (13) implies

$$G_{l2}=\left(\frac{\alpha\tau A_{l2}}{R}\right)^{\frac{1}{1-\alpha}}\left(1+\frac{\lambda^{-}}{\tau Y_{l1}^{*}}\right)^{\frac{1}{1-\alpha}}, \tag{14}$$

where $Y_{l1}^{*}=A_l\left(G_{l1}^{*}\right)^{\alpha}$. From the flow of funds constraint (1), government debt in region l is

$$D_{l2}=G_{l2}-H_{l1}=\left(\frac{\alpha\tau A_{l2}}{R}\right)^{\frac{1}{1-\alpha}}\left(1+\frac{\lambda^{-}}{\tau Y_{l1}^{*}}\right)^{\frac{1}{1-\alpha}}-H_{l1}^{*}, \tag{15}$$

where $H_{l1}^{*}=\tau\left(1-\alpha\right)Y_{l1}^{*}+RH_0$. Similarly, we can derive the optimal decisions for region h,

$$G_{h2} = \left(\frac{\alpha\tau A_{h2}}{R}\right)^{\frac{1}{1-\alpha}}\left(1+\frac{\lambda^{+}}{\tau Y_{h1}^{*}}\right)^{\frac{1}{1-\alpha}}, \tag{16}$$

$$D_{h2} = \left(\frac{\alpha\tau A_{h2}}{R}\right)^{\frac{1}{1-\alpha}}\left(1+\frac{\lambda^{+}}{\tau Y_{h1}^{*}}\right)^{\frac{1}{1-\alpha}}-H_{h1}^{*}. \tag{17}$$

Since $\lambda^{-}>\lambda^{+}>0$, it is straightforward to show that $G_{i2}>G_{i2}^{*}$ and $D_{i2}>D_{i2}^{*}$ for $i=\{l,h\}$, where G_{i2}^{*} and D_{i2}^{*} are, respectively, the optimal public investment and government debt for region i in the case where regional competition is absent.

The above analysis suggests that regional competition has a positive impact on local government debt regardless of the ranking of GDP growth. Therefore, we have the following hypothesis.

Hypothesis 1 *The local government tends to raise debt more aggressively under regional competition.*

Now we need to verify that in equilibrium the GDP growth rate for region l in period 2 is less than that in region h. In particular, to guarantee the condition $\frac{Y_{l2}}{Y_{l1}^{*}}<\frac{Y_{h2}}{Y_{h1}^{*}}$, the optimal condition

for the output implies that the growth rates of technology in period 2 must satisfy

$$\frac{g_l^a}{g_h^a} < \left(\frac{1 + \frac{\lambda^+}{\tau Y_{h1}^*}}{1 + \frac{\lambda^-}{\tau Y_{l1}^*}} \right)^{\alpha}. \tag{18}$$

Note that $\lambda^+ < \lambda^-$ and $Y_{l1}^* = Y_{h1}^*$ imply that $0 < \frac{1+\frac{\lambda^+}{\tau Y_{h1}^*}}{1+\frac{\lambda^-}{\tau Y_{l1}^*}} < 1$. Furthermore, under the above condition, it can be shown that in period 2 the change of public investment and government debt in region l is larger than that in region h,

$$\Delta G_{l2} > \Delta G_{h2} \text{ and } \Delta D_{l2} > \Delta D_{h2}. \tag{19}$$

From (19), we can infer that due to the relatively low GDP growth in period 2 (i.e., condition (18) is satisfied), the local government in region l will behave more aggressively in issuing new debt than the local government in region h. Then we have following hypothesis.

Hypothesis 2 *Under regional competition, the government in the region with relatively low GDP growth tends to raise more debt than that in the region with relatively high GDP growth.*

3.3 Debt Regulation

At the end of 2015, the central government implemented a regulatory policy aiming to set a ceiling on local government debt. To characterize this regulatory policy, we extend the previous model by introducing a debt ceiling constraint in period 2. In particular, the debt level cannot exceed a ceiling that is proportional to the fiscal balance in period 1,

$$D_{i2} \leq \theta_i H_{i1}, \text{ for } i = \{l, h\}. \tag{20}$$

The parameter $\theta_i \in (0, 1)$ captures the tightness of the regulation and varies across different regions. A smaller θ indicates a tighter debt limit regulation. Note that in this extended model, the optimal decisions in period 1 still satisfy (10).[12]

The optimal decisions crucially depend on the tightness of the borrowing constraint (20), i.e., whether the constraints bind or not. We consider the following two scenarios. Without loss of generality, we focus on region l. The analysis for region h is similar.

[12]Notice that as we assume that the economy suddenly switches to the regional competition regime, the optimal decision in period 1 remains the same as those in the first best case where regional competition is absent.

Case 1 θ is sufficiently large such that the borrowing limit constraint does not bind. In this case, local government decisions are essentially the same as those in the previous model, i.e., we can obtain the optimal conditions (14) - (17). This indicates that the local government debt may present a similar regional competition pattern to the previous model under a relatively loose debt quota constraint.

Case 2 θ is sufficiently small such that the borrowing constraint (20) binds, i.e. $D_{l2} = \theta H_{l1}$. From the flow of funds constraint (1), we have

$$G_{l2} = (1+\theta)\, H_{l1}. \tag{21}$$

From the optimal solution (14), to confirm that the borrowing constraint binds, we must have

$$\left(\frac{\alpha\tau A_{l2}}{Q}\right)^{\frac{1}{1-\alpha}} \left(1+\frac{\lambda^-}{\tau Y_{l1}^*}\right)^{\frac{1}{1-\alpha}} > (1+\theta_l)\, H_{l1}, \tag{22}$$

or equivalently

$$\theta_l < \bar{\theta}_l, \tag{23}$$

where $\bar{\theta}_l = \frac{1}{H_{l1}} \left(\frac{\alpha\tau A_{l2}}{Q}\right)^{\frac{1}{1-\alpha}} \left(1+\frac{\lambda^-}{\tau Y_{l1}^*}\right)^{\frac{1}{1-\alpha}} - 1$.

Similarly, for the region h, if the borrowing limit θ_h satisfies the condition $\theta_h < \bar{\theta}_h$, where $\bar{\theta}_h = \frac{1}{H_{h1}} \left(\frac{\alpha\tau A_{h2}}{Q}\right)^{\frac{1}{1-\alpha}} \left(1+\frac{\lambda^+}{\tau Y_{h1}^*}\right)^{\frac{1}{1-\alpha}} - 1$, the borrowing constraint for the local government in region h is binding, i.e., $D_{h2} = \theta_h H_{h1}$. Then, we have

$$G_{h2} \;=\; (1+\theta_l)\, H_{h1}. \tag{24}$$

Therefore, under the debt regulation condition $\theta_l < \bar{\theta}_l$ and $\theta_h < \bar{\theta}_h$, local government debt only reflects a correlation between H_{l1} and H_{h1}. In this scenario, local government debt provides limited information to identify the regional competition among local governments.

Hypothesis 3 *A tight debt limit regulation weakens the positive correlation between government debt and the regional GDP growth gap. When the limit constraint is relatively loose, the impact of regional competition on debt growth still exists.*

In the remaining part of the paper, we empirically test the above three hypotheses. Before setting up the formal econometric model, we first introduce the data of local government debt we will use in the empirical analysis.

4 Local Government Debt

4.1 Data Source of Local Government Debt

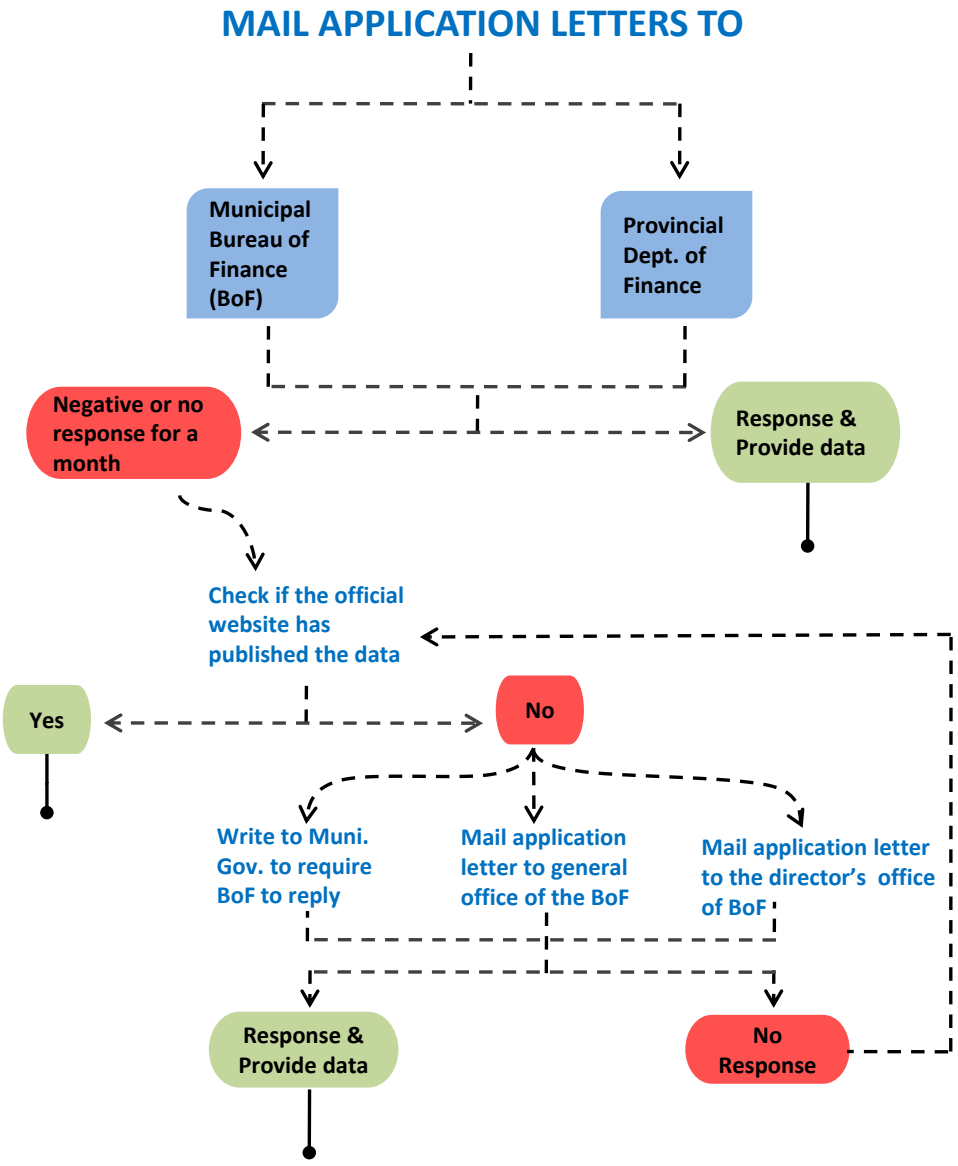
The key variable in our analysis is prefectural-level local government debt. The main channel in our empirical analysis is the strategic interactions (competition) among local governments at the same administrative level. This requires a full sample of data for the prefectural cities in China, which poses a major data collection challenge. According to the official regulation by the central government, local governments have an obligation to report information about the level of local government debt to the public. However, very few local governments strictly follow the central government's requirement to regularly report the corresponding information. Due to the lack of official data, we manually collect the government debt for each prefectural city.

Figure 2 presents the detailed flow chart for our data collecting process. We first mail the application letters via the express mail service simultaneously to the municipal Bureau of Finance (BoF) in each prefectural city and the provincial department of finance for the data disclosure.[13] If we receive a negative response (i.e., our request is denied) or no response for one month, we proceed to the next step. Otherwise, we obtain the data for local government debt.[14] In the next step after not obtaining the data, we first check if the official website of each city has published the data we acquired. If not, we conduct the following three practices simultaneously: (i) write to the municipal government through the online government system to require the municipal BoF to provide the data; (ii) mail the application letter to the general office of the municipal BoF, which is responsible for the disclosure of government debt; and (iii) mail the application letter to the director's office of the municipal BoF. After doing the above practices, if we still do not receive a positive response, we go back to the step of "check if the official website has published the data" and repeat the loop. For most of the cases, after two or three rounds the local government would respond to our request and provide the data. We eventually obtain the debt data for all of the prefectural cities, excluding those in Xinjiang Province due to lack of data. Four directly administered municipalities (e.g., Beijing, Shanghai, Tianjin and Chongqing) are also excluded.

[13] For those cities that have already reported debt information publicly, we collect the data from the corresponding official website. The observations from 2014 to 2016 obtained in this way only account for 5% of the sample. With the improvement of debt disclosure system, we are able to collect over 95% observations of the sample in 2017 and 2018 from local governments' financial statement report.

[14] In our practice, there are three positive response cases: (i) the prefectural city directly provides the data; (ii) the provincial department of finance directly provides data for each city in that province; and (iii) the provincial department of finance requires each city to provide data.

Figure 2: Flow Chart for the Data Collection Process



4.2 Data Summary

Summary Statistics We now give a general picture of prefectural-level government debt. Table 2 presents the summary statistics for the total debt level and growth of debt for 2014-2018. It shows that the average level of total debt for a prefectural-level city is 36.14 to 44.18 billion yuan over 2014-2018. Government debt also presents large regional heterogeneity, with a standard deviation of approximately 43 billion yuan. The minimum level of debt is below 0.1 billion, while the maximum is approximately 265 billion yuan. In addition, the average growth rate of local government debt is approximately 3.5% in 2015 and 15.7% in 2018.[15] The large increase in average debt growth from 2016 to 2018 seems to be at odds with the debt regulation policy implemented by the central government at the end of 2015. In fact, the substantial expansion in the debt growth is mainly attributed to the increasing debt quotas from 2016 to 2018 and those cities with a looser debt limit. We will return to this point later.

Table 2: Summary Statistics of Government Debt

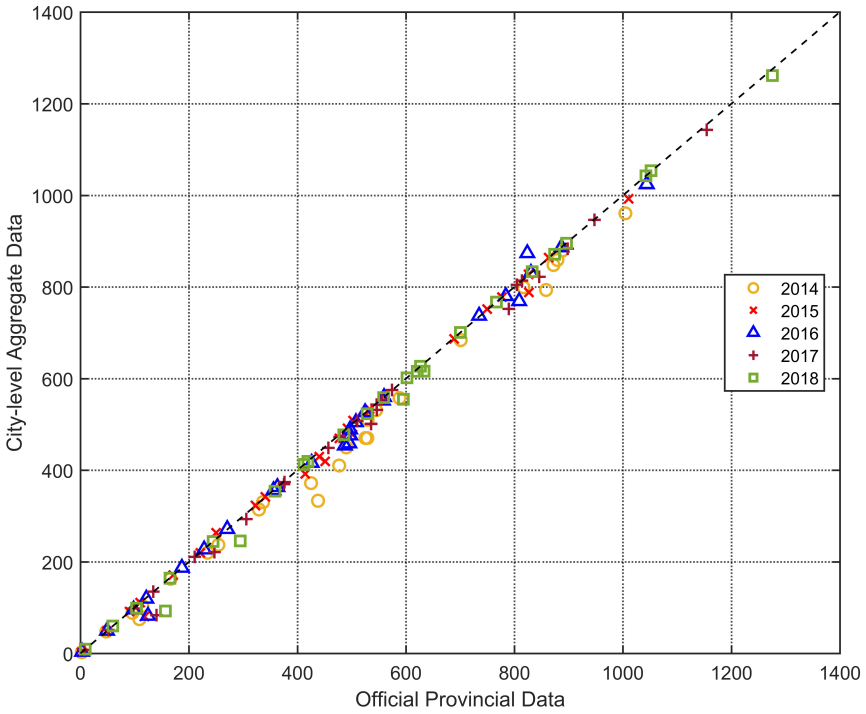
	Obs.	Mean	Std.	Min	p25	Median	p75	Max
Debt stock (100 million yuan)								
2014	317	361.4	432.9	0.89	114.7	218.8	419.4	2301.6
2015	317	363.8	430.5	0.60	123.8	222.1	412.9	2298.7
2016	317	379.6	433.2	2.50	136.7	239.7	432.2	2356.1
2017	317	398.6	435.6	3.18	147.4	265.7	456.6	2493.2
2018	317	441.8	465.9	3.18	172.9	293.1	522.6	2650.0
Debt growth rate								
2015	317	5.2%	15.1%	-50.8%	-1.1%	2.3%	7.3%	102.0%
2016	317	12.1%	30.8%	-26.7%	1.3%	6.8%	13.7%	363.3%
2017	317	12.6%	31.2%	-49.7%	1.4%	7.7%	17.2%	422.0%
2018	317	15.7%	15.5%	-33.2%	6.4%	12.3%	21.8%	127.5%

Some Discussions As we obtain the debt data through the nonofficial channel, one potential issue is that local governments may misreport their true level of debt. To further verify the quality of our data, we sum up the city-level debt to the province level and compare it with the provincial debt stock reported by the provincial governments.[16] Figure 3 scatter-plots the official reported debt stock versus city-level aggregation from our data for the years 2014-2018. It can

[15]The maximum debt growth in 2016 and 2017 are extremely high, 363.3% and 422% respectively. These extreme values correspond to Qamdo and Lhoka (two cities in Tibet). We will discuss the issue of extreme values later in the analysis.

[16]The provincial debt stock data are collected from the local government's financial accounts report and debt audit announcement.

Figure 3: Outstanding Provincial Debt: Official versus City-level Aggregation



Notes: This figure scatter-plots outstanding provincial debt for 2014-2018. The horizontal axis is for the provincial-level data collected from the government debt audit report. The vertical line is city-level data aggregated at the provincial level. The unit is 100 million yuan. Since our debt is for the prefectural-level city, to make two data sets comparable, for the officially reported outstanding debt we abstract the debt raised by the provincial governments.

be seen that the two data sets are very close to each other, indicating that our city-level data is largely consistent with the official reported data.

The summary statistics reported in Table 2 show that there is a significant increase in average debt growth from 2016 to 2018. This phenomenon seems to be at odds with the implementation of the regulation on local government debt at the end of 2015. As discussed in Section 2, the dynamics of local government debt after 2016 is primarily affected by the debt quotas allocated by the superior government. Appendix B reports the summary statistics of the level of debt quota and the *percentage of unused debt quotas* for prefectural level cities from 2016 to 2018.[17] It shows that the average level of debt quota increases from 44.5 billion in 2016 to 52.7 billion in 2018. The average percentage of unused debt quota is 15% in 2016 and 20.8% in 2018. This indicates

[17]The percentage of unused debt quota is the ratio of the level of unused debt quota to the total debt quota. The unused debt quota is the difference between the debt quota set by the superior government at the beginning of the current year and the debt outstanding at the end of the previous year. This variable indicates the maximum level of new debt the local government can issue in the current year. Appendix B provides more details.

that sizeable increases in the debt growth in 2016 compared to 2015 are probably due to large debt quotas allocated by the superior government. In addition, the percentage of unused debt quotas present considerable regional heterogeneity, with a standard deviation of approximately 10%. We further divide the whole sample into different subsamples according to the percentage of unused debt quotas at the beginning of the year. We find that the large expansion in debt mainly occurs among those cities with abundant unused debt quotas. In particular, average debt growth for these cities increases from 19.8% in 2016 to 26.2% in 2018. Meanwhile, those cities with low unused debt quotas experience much lower debt growth rates from 2016 to 2018. Thus, the debt regulation appears to asymmetrically influence the debt-issuing behaviors of local governments with different debt limits.

5 Econometric Model

Our empirical analysis aims to test Hypotheses 1 to 3 derived from the theory in Section 3. In the theoretical analysis, without loss of generality we consider a two-region model, and thus, the regional competition originates from one single competitor. In the empirical analysis, prefectural-level data are used. Therefore, we need to consider a more general scenario in which the regional competition faced by the local government comes from competing neighbor cities.

Denote i as the city and t as the year. Let D_{it} be the debt outstanding in the end of year t and y_{it} the net change of D_{it} for city i in year t, i.e., $y_{it} = D_{it} - D_{it-1}$. We use the net change in debt level instead of in growth rate mainly because the central government's regulatory policy targets the stock and level of newly issued government debt. In the robustness analysis, we normalize the debt by the local GDP and define the change of debt-to-GDP ratio as the dependent variable. The main results change little. Let g_{it} be the real GDP growth rate for city i in year t and Gap_{it} be the gap that indicates the GDP growth of city i relative to other regions in year t, i.e., $Gap_{it} = g_{it} - g_{-it}$, where $g_{-it} = \sum_{j \neq i} w^*_{ij} g_{jt}$ is a weighted average of i's neighbors, with the weight w^*_{ij} to be defined soon.[18] A negative value of Gap_{it} indicates that city i has low GDP growth relative to its competitors (or neighbors).

To define the competing (or neighboring) cities, we construct the following two different weight matrices denoted as W_κ, $\kappa = \{1, 2\}$. Table 3 describes the details of these two matrices. In particular, element w_{ij} measures the neighboring relationship between city i and city j. The larger w_{ij} is, the greater is the effect of city j on city i. The weight $w^*_{\kappa,ij}$, $\kappa = \{1, 2\}$, is computed from the row-normalized W_κ, i.e., $w^*_{\kappa,ij} = \frac{w_{\kappa,ij}}{\sum_{j \neq i} w_{\kappa,ij}}$. Therefore, it measures the relative importance of j to i among all of city i's neighbors.

[18] In Appendix C, we consider the case where local government targets the gap of nominal GDP growth instead of real GDP growth. The main findings remain valid.

Table 3: Setup of Weight Matrices in Estimation

W_1	Same province	$w_{1,ij} = \begin{cases} 1 \text{ if } i \text{ and } j \text{ are in the same province} \\ 0 \text{ otherwise} \end{cases}$
W_2	Province neighbor	$w_{2,ij} = \begin{cases} 1 \text{ if } i \text{ and } j \text{ are adjacent and in the same province} \\ 0 \text{ otherwise} \end{cases}$

Since the dataset on local government debt covers five years, from 2014 to 2018, we can construct the net change in debt for 2015 to 2018 and then obtain prefectural-level panel data. As discussed earlier, at the end of 2015, the central government announced a country-wide regulation that limits local government debt, to be implemented from 2016. This policy event allows us to employ the panel data to test Hypotheses 1 to 3 through various econometric methods.

5.1 Baseline Model

As discussed in Section 2, in December 2015 the Chinese government implemented a top-to-bottom debt quota management policy that strictly restrains the debt ceiling ("*Opinion 2*"), which is supposed to become effective in 2016. Therefore, we expect the relationship between government debt and the GDP growth gap to become weaker after 2016 than in 2015. To test this hypothesis, we start with the following specification

$$y_{it} = \beta_0 + \beta_1 D_{it-1} + \beta_2 g_{it-1} + \alpha Gap_{it-1} + \alpha_p \cdot Post_t \cdot Gap_{it-1} + x'_{it}\delta + u_i + v_t + \varepsilon_{it}, \tag{25}$$

In the above regression, we first control the lag of debt balance D_{it-1} and GDP growth rate g_{it-1}. $Post_t$ is a dummy variable, equal to zero if the year is 2015 and one otherwise. x_{it} is a set of standard control variables and ε_{it} is the error term. The control variables, according to the standard growth accounting literature, include government consumption (*goc*), household debt (*hhd*), nonfinancial corporate debt (*othd*), human capital (*hc*), and fixed asset investment (*inv*). To mitigate the potential endogeneity problem, in the regression we choose the lag term of *goc*, *hhd*, *othd* and *inv*. We also control the prefecture-level city fixed effect u_i and the year fixed effect v_t. To eliminate the impact of price factors, we take 2014 as the base year and make price adjustments to all nominal variables. Finally, all continuous variables in the regression are winsorized at the top and bottom 1% to remove the effect of outliers.

To test Hypothesis 2, we generalize the above model to incorporate the asymmetric responses

Table 4: Definition of Variables in the Estimation

Variable	Definition	Unit
D_{it}	Debt outstanding	100 million yuan
y_{it}	Net debt: $D_{it} - D_{i,t-1}$	100 million yuan
$Post_t$	Year dummy: $= 0$ if year$=$ 2015, one otherwise	
g_{it}	real GDP growth rate	%
goc_{it}	Government consumption	100 million yuan
hhd_{it}	Household debt	100 million yuan
$othd_{it}$	Nonfinancial corporate debt	100 million yuan
hc_{it}	Human capital	10,000 people
inv_{it}	Fixed asset investment	100 million yuan
Gap_{it}	Gap in GDP growth rate: $g_{it} - \sum_{j \neq i} w^*_{ij} g_{jt}$	%
Gap^+_{it}	Positive gap in GDP growth rate: $Gap_{it} \cdot \mathbf{1}(Gap_{it} > 0)$	%
Gap^-_{it}	Negative gap in GDP growth rate: $Gap_{it} \cdot \mathbf{1}(Gap_{it} < 0)$	%

of government debt to the GDP growth gap, and build the following econometric model:

$$\begin{aligned} y_{it} = \beta_0 + \beta_1 D_{it-1} + \beta_2 g_{it-1} + \alpha_1 Gap^-_{it-1} + \alpha_{1p} \cdot Post_t \cdot Gap^-_{it-1} \\ + \alpha_2 Gap^+_{it-1} + \alpha_{2p} \cdot Post_t \cdot Gap^+_{it-1} + x'_{it}\delta + u_i + v_t + \varepsilon_{it}. \end{aligned} \tag{26}$$

In particular, the variable Gap^-_{it-1} (Gap^+_{it-1}) indicates the growth gap when region i has relatively low (high) GDP growth in the period $t-1$. Other controls are the same as those in (25).

Hypothesis 1 reveals that, holding other factors constant, when the GDP growth gap Gap^-_{it-1} decreases or becomes more negative, local government debt tends to increase. Therefore, we test $H_0 : \alpha = 0$ vs $H_1 : \alpha < 0$. For Hypothesis 2, holding other factors constant, the government reacts more to a negative GDP growth gap than a positive one. Therefore, we test $H_0 : \alpha_1 = 0$ vs $H_1 : \alpha_1 < 0$ and $H_0 : \alpha_2 = 0$ vs $H_1 : \alpha_2 \neq 0$. For Hypothesis 3, a tight debt limit regulation may dampen the correlation between government debt and regional competition. Therefore, we examine whether the coefficients of the interaction items have opposite signals, i.e., $H_0 : \alpha_{1p} = 0$ vs $H_1 : \alpha_{1p} > 0$ or $H_0 : \alpha_{2p} = 0$ vs $H_1 : \alpha_{2p} > 0$.

Table 5 reports the empirical estimates for our baseline model. The table contains two blocks for the two different weight matrices. Each block has two columns that report the estimation results for specifications (25) and (26), respectively. We illustrate the results taking weight matrix W_1 as an example. A similar analysis can be applied to W_2.

The first column in the case of W_1 shows that the gap in GDP growth over the past year has a significant and negative impact on local government debt. This means that before implementing the debt regulation policy, local government debt negatively responds to GDP growth relative

Table 5: Estimation Results for Baseline model

Weight	W_1		W_2	
	y_{it}	y_{it}	y_{it}	y_{it}
Gap_{it-1}	-0.755^{**}		-0.791^{**}	
	(-2.46)		(-2.33)	
$Gap_{it-1} \cdot Post_t$	0.489		0.362	
	(1.64)		(1.22)	
Gap^{-}_{it-1}		-1.511^{***}		-1.428^{***}
		(-3.01)		(-2.94)
$Gap^{-}_{it-1} \cdot Post_t$		1.013^{**}		0.964^{**}
		(2.28)		(2.42)
Gap^{+}_{it-1}		0.289		-0.077
		(0.36)		(-0.09)
$Gap^{+}_{it-1} \cdot Post_t$		-0.166		-0.303
		(-0.22)		(-0.45)
D_{it-1}	-0.309^{***}	-0.309^{***}	-0.308^{***}	-0.310^{***}
	(-4.42)	(-4.43)	(-4.39)	(-4.40)
g_{it-1}	0.030	0.079	0.094	0.141
	(0.12)	(0.30)	(0.44)	(0.67)
exp_{it-1}	1.197^{**}	1.150^{**}	1.200^{**}	1.160^{**}
	(2.30)	(2.25)	(2.29)	(2.23)
hhd_{it-1}	0.024^{*}	0.024^{*}	0.024^{*}	0.024^{*}
	(1.98)	(1.98)	(1.97)	(1.96)
$othd_{it-1}$	0.002	0.003	0.003	0.003
	(0.27)	(0.28)	(0.29)	(0.29)
hc_{it}	0.406	0.392	0.414	0.396
	(0.65)	(0.64)	(0.66)	(0.64)
inv_{it-1}	0.500^{***}	0.496^{***}	0.502^{***}	0.501^{***}
	(11.97)	(11.59)	(12.25)	(12.21)
City FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Observations	$1,272$	$1,272$	$1,272$	$1,272$
$\mathbf{R}^2$	0.394	0.395	0.394	0.396

Notes: *, ** and *** denote significance at the 10%, 5%, and 1% level, respectively. t values based on the robust standard errors clustered at province level are reported in parentheses. The main results are similar if errors are clustered at prefectural-city level. Appendix C gives more details. We also conduct various estimations as robustness analysis. The main pattern remains unchanged. See Section 6 for more details.

to its competitors (cities in the same province) regardless of whether the local GDP growth rate is above or below the average of its competitors. This result confirms our Hypothesis 1, that local governments tend to raise more debt under regional competition. The second column in the case of W_1 shows that the negative correlation between government debt and the GDP growth gap mainly comes from the responses of those cities with relatively lower GDP growth before 2016. Specifically, if city i has lower GDP growth than its competitors, i.e., $Gap^{-}_{it-1} < 0$, the local government tends to issue more debt than its counterparts. In turn, for a city with a GDP growth rate leading that of its competitors, i.e., $Gap^{+}_{it-1} > 0$, the response of debt to relative GDP growth is not significant. The above results confirm Hypothesis 2 that under the regional competition, the government in the region with relatively low GDP growth tends to issue more debt than other cities. The second block shows that the above results are robust for the alternative weight matrix W_2.

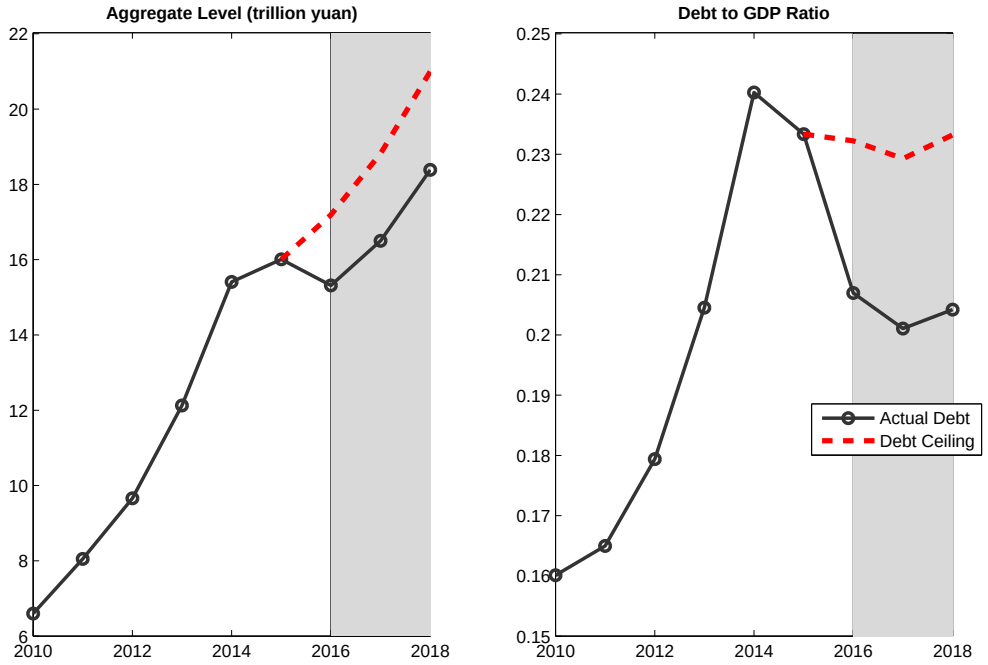
Furthermore, the second column in the first block also shows that the coefficient of the interaction item $Post_t \cdot Gap^{-}_{it-1}$ is significantly positive and with a similar magnitude to that of Gap^{-}_{it-1}. This result indicates that the regulation on debt limits may influence local governments' debt financing in response to the regional competition. We further test the null hypotheses $\alpha_1 + \alpha_{1p} = 0$ and $\alpha_2 + \alpha_{2p} = 0$, the results show that we cannot reject both of them. This implies that the response of local government debt to the GDP gap is substantially reduced after implementing the debt regulation policy. As the local government competition is mainly reflected by the term Gap^{-}_{it-1}, the above results confirm Hypothesis 3, that a tight debt limit regulation may dampen the correlation between government debt and regional competition. The second block shows that the above results are robust for the alternative weight matrix W_2.

In addition to the key variables, our estimation also finds that outstanding debt and economic conditions in the past year have significant impacts on the change in local government debt in the current year. In particular, a higher level of outstanding debt in the last year significantly reduces the size of the newly issued debt in the current period, indicating that the scale of existing debt may put pressure on the issuing of new debt. Moreover, the coefficient of the lag of GDP growth g_{it-1} and other controls in x_{it} are jointly significant. This result suggests that issuing debt relies on the fundamentals of the local economy in the last period, which is in line with our analysis in the theory section.

One potential issue for the above analysis is whether the debt limit regulation can provide strong identification. As the new budget law and the "*Opinion 1*" issued in 2014 already sent a strong signal on the policy stance for tight debt management, it could be possible that local governments, especially at the provincial level, control their newly issued debts from 2015, one year before the implementation of the debt limit regulation policy. We do not have direct evidence to rule out this possibility, but fortunately the MoF reports the annual nationwide debt quota

and actual outstanding debt from 2015 to the most recent year. The difference between these two series indirectly reflects the timing and the extent to which local governments control their outstanding debt.

Figure 4: Actual Debt Stock and Debt Ceiling at Aggregate Level



Notes: The actual outstanding local government debt at the aggregate level (solid line) is the end-of-year outstanding debt. The debt ceiling (red dashed line) is the debt quota (for both outstanding and newly issued debt) set by the State Council. The actual outstanding debt series comes from the same source as that in Figure 1. The debt ceiling series is from the official website of the Ministry of Finance: *http://www.mof.gov.cn/zhengwuxinxi/caizhengshuju/*. The grey shaded area indicates the periods when the debt quota management policy ("*Opinion 2*") is implemented.

Figure 4 shows that outstanding end-of-year debt in 2015 is coincident with the debt quota (ceiling) set by the State Council. However, starting from 2016 the outstanding debt is significantly below the debt ceiling, indicating that local governments start to tightly control their debt following the central government's regulatory policy. The above analysis provides indirect evidence to support our identification strategy in the baseline estimation.

5.2 Heterogeneous Effects of the Debt Regulation

The main results in Tables 5 suggest that the regulatory policy depresses the effect of regional competition on the local government debt. Meanwhile, the regional heterogeneity in debt quota may provide additional variations to study the relationship between the regional competition and the local government's debt issuing behaviors. Our theory predicts that for those regions with

loose debt limit, the regional competition has larger impact on the debt new issuing, whereas the effect would be substantially dampened if the debt limit is sufficiently tight.

To conduct the empirical exercise, we collect the debt quota data through the annual fiscal budget reports of prefecture cities. Our sample covers 280 prefecture-cities, accounting for 95% of the total local government debt, and provides us sufficient variations to analyze the impact of the debt limit policy.

We use the percentage of unused debt quota discussed in Section 4.2 to measure the tightness debt limit imposed by the debt regulatory policy. The unused debt is the difference of debt quota, $Quota_{it}$, set by the superior government at the beginning of the current year and the debt outstanding at the end of the previous year D_{it}. The percentage of unused debt quota, ω_{it}, is defined as $\min\left\{\frac{Quota_{it}-D_{it-1}}{Quota_{it}}, 0\right\}$. A city with a large value of ω_{it} means that the local government can issue more new debt in the current year, or they are facing looser debt-financing constraints.

We divide the whole sample into three subsamples, top 30%, bottom 30% and the rest, according to the value of ω_{it} from 2016 to 2018. We then estimate similar regression equations to (25) and (26) in the baseline analysis. The only difference is that we drop the interaction terms between the $Post_t$ dummy and the GDP gap.

Table 6 reports the estimation results for different subsamples. We find that debt issuing still presents a strong pattern of regional competition for those cities with loose debt-financing constraints. In contrast, the above pattern becomes insignificant for the other two subsamples with tight debt-financing constraints. This result confirms the main findings in the baseline analysis, i.e., a debt regulatory policy can mitigate the impact of regional competition on the local government debt issuing. However, the regulatory policy is effective only the resulting debt limit constraint is sufficiently tight. In Appendix C, we conduct a similar exercise with alternative thresholds for constructing subsamples, and the main results change little.

6 Further Discussion

6.1 Placebo Test

We conduct a placebo test for the baseline estimation. In particular, we randomly assign the GDP gap Gap_{it} to each city, where the gap is drawn from a normal distribution with the mean and variance inferred from the data. For other variables used in our baseline regressions, we keep the same values as those in the data. Given the newly constructed sample, we conduct the same estimation as in the baseline analysis. We repeat the above procedure 10,000 times. Eventually, we obtain 10,000 estimated coefficients for Gap_{it}, Gap_{it}^{-} , Gap_{it}^{+} and their corresponding interaction items which capture the effect of debt limit policy.

Table 6: Heterogenous Effects of the Debt Regulation

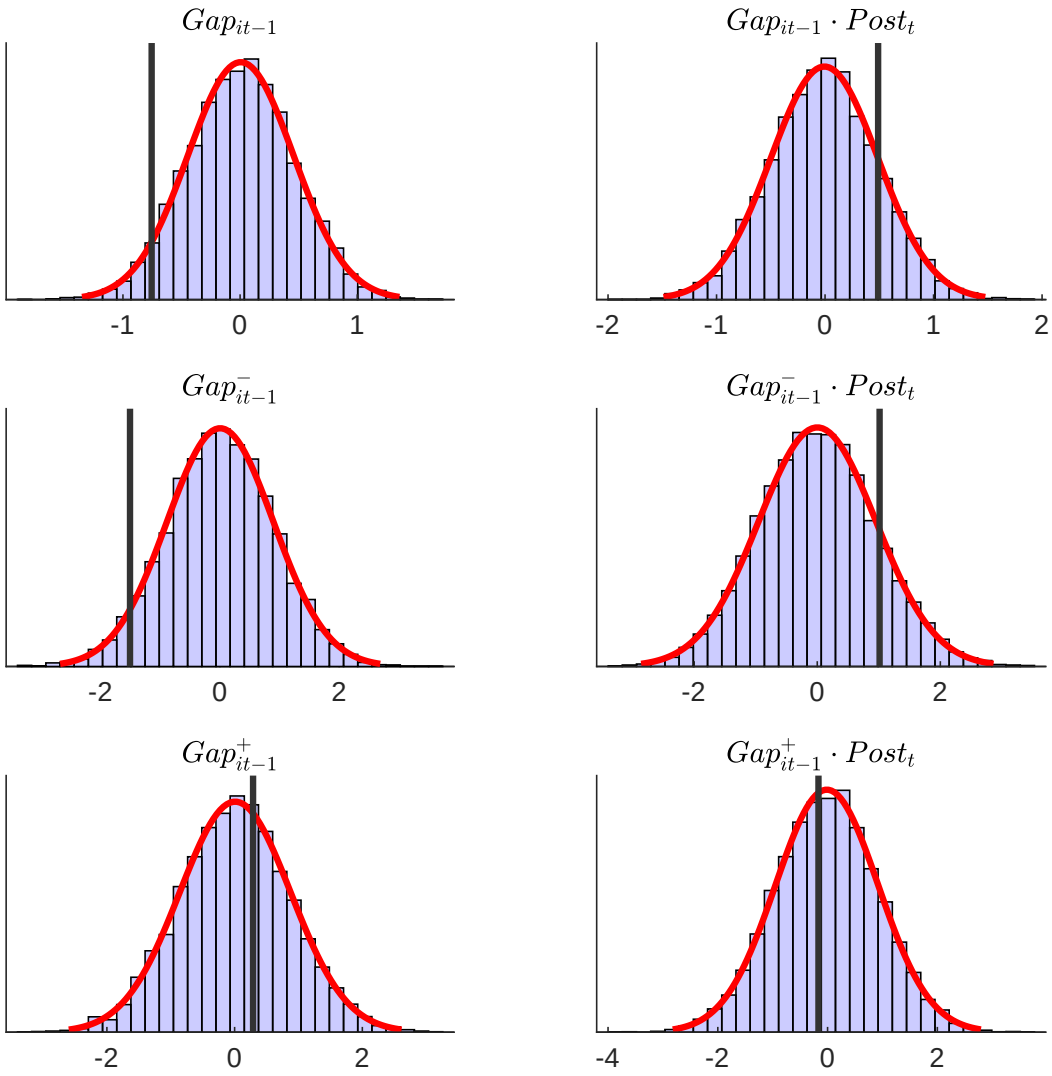
Group	Loose		Moderate		Tight	
	y_{it}	y_{it}	y_{it}	y_{it}	y_{it}	y_{it}
Gap_{it-1}	-0.904^{***}		-0.485		-0.366	
	(-3.10)		(-0.92)		(-0.94)	
Gap^{-}_{it-1}		-1.498^{**}		-1.381		-0.914
		(-2.70)		(-1.33)		(-1.64)
Gap^{+}_{it-1}		-0.496		0.291		0.485
		(-1.02)		(0.46)		(0.47)
D_{it-1}	-0.153	-0.158	-0.144	-0.157	-0.144	-0.141
	(-1.14)	(-1.19)	(-0.75)	(-0.87)	(-0.97)	(-0.96)
g_{it-1}	0.783^{**}	0.873^{**}	-0.206	-0.010	-0.368	-0.330
	(2.21)	(2.16)	(-0.44)	(-0.02)	(-0.92)	(-0.86)
Other Controls	yes	yes	yes	yes	yes	yes
City FE	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
Observations	252	252	336	336	252	252
$\mathbf{R}^2$	0.360	0.363	0.304	0.311	0.196	0.200

Notes: The dependent variable is the change in outstanding government debt. The estimation uses the weighting matrix W_1. The control variables are the same as those in the baseline estimation. We divide the whole sample into three subsamples according to the value of the percentage of unused debt quotas. We label the top 30%, bottom 30% and the rest subsamples as "Loose","Tight" and "Moderate", respectively. Each block reports the estimation result based on the corresponding subsamples. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. t values based on the robust standard errors clustered at the province level are reported in parentheses. The main results are similar if errors are clustered at the prefectural-city level. To save space, we do not report the results for controls.

Figure 5 plots the histogram of the estimated coefficients obtained from the above procedure for the weight matrix W_1. From the figure, we can see that all six estimated coefficients present a normal distribution pattern based on the constructed sample, and the estimation values concentrate on the zero mean. To compare, we also add our baseline estimation value (see the black lines) to the same figure. The results show that our estimations for Gap_{it}, Gap^{-}_{it} and their corresponding interaction items are on the bottom tail of the corresponding distributions, which are significantly different from the zero. Meanwhile, the estimations for Gap^{+}_{it} and $Gap_{it-1} \cdot Post_t$ are close to the mean of the distribution, which are not significantly different from zero. This result implies that the variations in the GDP gap in our baseline analysis provide essential information to identify the asymmetric impact of regional competition on local government debt dynamics and how the debt-quota management policy influence this impact.[19]

[19]We also conduct a similar exercise for W_2. Since the pattern is similar to that based on W_1, we do not report the result to save space.

Figure 5: Distribution of Estimated Coefficients after Random Sampling



Notes: This figure plots the distribution of the estimated coefficients for Gap_{it}, Gap^{-}_{it} , Gap^{+}_{it} and their corresponding interaction items, $Gap_{it-1} \cdot Post_t$, $Gap^{-}_{it-1} \cdot Post_t$, $Gap^{+}_{it-1} \cdot Post_t$. Each estimated value is obtained based on a sample with a randomly assigned Gap_{it} based on W_1. We repeat the estimation procedure 10,000 times, and construct the histogram of the estimation values. In addition to the regional GDP growth gap, other variables used in the estimation are the same as those in the data used in Section 5.1. The red line is the curve fitted by a normal distribution. The black vertical line indicates the estimation value based on W_1 in our baseline estimation.

6.2 Dynamic Effects of Quota Management Policy

Our difference-in-difference identification assumes that the government competition causes significant impact on the local government debt issuing for those cities with relatively lower GDP growth in the pre-2015 periods, but has little effect on the debt after the new regulation on the quota of outstanding debt were put in place. To examine the validity of our identification assumption, we estimate the empirical model

$$y_{it} = \beta_0 + \beta_1 D_{it-1} + \beta_2 g_{it-1} + \sum_{\tau} \alpha_\tau \cdot \mathbf{1}_\tau \cdot Gap_{it-1} + x'_{it}\delta + u_i + v_t + \varepsilon_{it}, \tag{27}$$

$$\begin{aligned} y_{it} = \beta_0 + \beta_1 D_{it-1} + \beta_2 g_{it-1} + \sum_{\tau} \left(\alpha_{1\tau} \cdot \mathbf{1}_\tau \cdot Gap^{-}_{it-1} + \alpha_{2\tau} \cdot \mathbf{1}_\tau \cdot Gap^{+}_{it-1}\right) \\ + x'_{it}\delta + u_i + v_t + \varepsilon_{it}, \end{aligned} \tag{28}$$

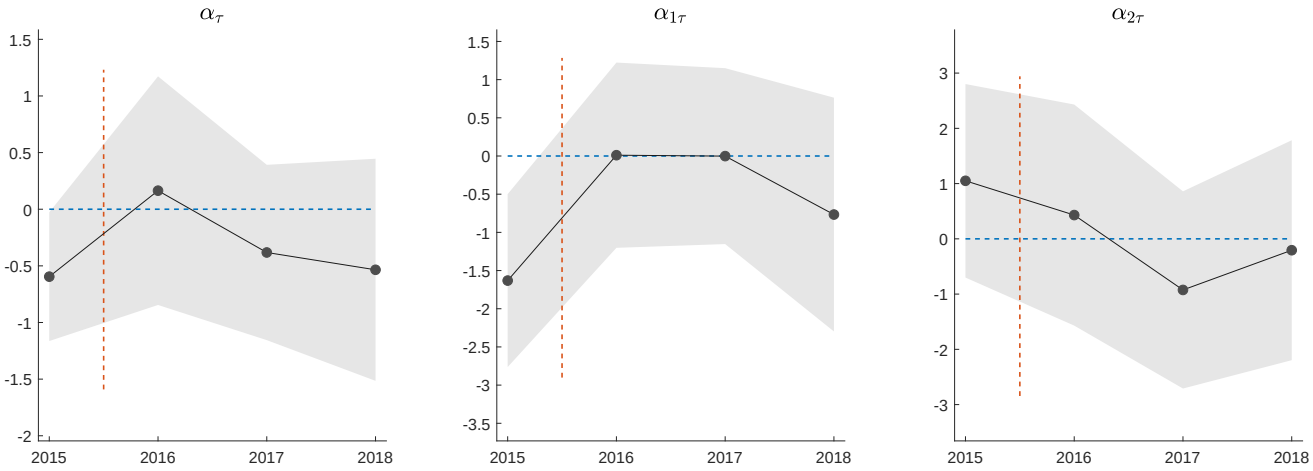
where $\tau \in \{2015, ..., 2018\}$ denotes the year, $\mathbf{1}_\tau$ is a dummy variable, which is equal to one in the year of τ and zero otherwise. The other variables have the same definitions as in the baseline model specified in (25) and (26). The parameter α_τ and $\alpha_{j\tau}$ $(j = 1, 2)$ measure the marginal effects of the government competition on the local government debt issuing in year τ.

The results imply that the debt quota management policy implemented in 2016 and after effectively dampens the impacts of GDP tournament on the issuance of local government debt, validating our identification assumption and confirming Hypothesis 3. Figure 6 shows the point estimates of α_τ and $\alpha_{j\tau}$ along with the 95% confidence bands. The figure shows that the estimated values of α_τ and $\alpha_{1\tau}$ are significantly negative in 2015 and turn to be insignificant in 2016-2018 after the debt quota management policy takes effective. In addition, the magnitude of α_τ and $\alpha_{1\tau}$ turn more negative in 2017-2018. This pattern indicates that though the debt quota management system dampens the mechanism caused by the regional competition from 2016 to 2018, the constraints on the debt issuance might be loosened gradually.

6.3 Robustness

Alternative Definition of Dependent Variable In order to eliminate possible endogenous problems, we rescale the debt outstanding by the local GDP and define the difference of debt-to-GDP ratio as the dependent variable, i.e., $y_{it} = \frac{D_{it}}{GDP_{it}} - \frac{D_{it-1}}{GDP_{it-1}}$. We also take the logarithmic form for all control variables (except GDP growth rate g_{it-1}) to remove the possible influence caused by different units of measurement. The definitions of other variables are the same as those in the baseline model. The first block in Table 7 presents the main results. The table shows that our main results in the baseline estimation remain valid.

Figure 6: Dynamic Effects of Debt Quota Management Policy



Notes: This figure plots the estimated dynamic effects of debt quota management policy. α_τ, $\alpha_{j\tau}$ $j = 1, 2$ indicate how does the debt quota management policy affect the responses of debt issuing to the regional competition in year τ as shown in (28). The shade area is the 95% confidence interval.

Incorporating More Controls We extend the baseline estimation model by considering more controls to rule out other competing channels. In addition to the standard elements controlled in the baseline estimation, other potential channels may affect local governments' debt issuance. A city with relatively low GDP growth may obtain more support from the upper-level government, reducing the fiscal pressure on the local government and thus increasing their incentive to issue debt. In our extension, we use the ratio of government budgetary income and expenditure to indicate fiscal pressure. Second, the degree of fiscal decentralization may positively impact the GDP growth rate. Meanwhile, cities with a higher degree of fiscal decentralization may bear more public affairs than others and have to issue more debt to solve the imbalance between fiscal revenue and expenditure responsibilities. Thus, in the extension, we consider the degree of fiscal decentralization, measured by the proportion of the prefecture's public budget expenditure in provincial budget public expenditure. The second block in Table 7 reports the estimation results. It shows that the coefficients of the ratio of budgetary income and expenditure and the degree of fiscal decentralization are neither significant, indicating that the channels mentioned above may not work. In addition, despite incorporating more controls, the main findings in the baseline model remain valid.

Excluding Observations with Extreme Values The outstanding debt in four autonomous regions, including Tibet, Inner Mongolia, Guangxi, and Ningxia, increases much faster relative to other regions. The average level of debt growth is approximately twice as large as those in other cities. In particular, in 2016 and 2017, two sequential years after the implementation of the

Table 7: More Estimation Results for Robustness

	y_{it}	y_{it}	y_{it}	y_{it}	y_{it}	y_{it}
Gap_{it-1}	-0.106^{***}		-0.745^{**}		-0.890^{**}	
	(-2.80)		(-2.45)		(-2.57)	
$Gap_{it-1} \cdot Post_t$	0.066^{***}		0.493^{*}		0.539	
	(3.17)		(1.72)		(1.69)	
Gap^{-}_{it-1}		-0.166^{***}		-1.476^{***}		-1.701^{***}
		(-3.70)		(-3.00)		(-2.88)
$Gap^{-}_{it-1} \cdot Post_t$		0.139^{***}		1.005^{**}		1.143^{**}
		(3.46)		(2.35)		(2.32)
Gap^{+}_{it-1}		-0.021		0.251		0.246
		(-0.29)		(0.31)		(0.28)
$Gap^{+}_{it-1} \cdot Post_t$		-0.023		-0.135		-0.211
		(-0.47)		(-0.18)		(-0.27)
D_{it-1}	-2.925^{**}	-2.894^{**}	-0.308^{***}	-0.309^{***}	-0.328^{***}	-0.329^{***}
	(-2.70)	(-2.67)	(-4.43)	(-4.44)	(-4.28)	(-4.29)
g_{it-1}	0.029	0.029	-0.001	0.050	0.071	0.112
	(0.73)	(0.77)	(-0.00)	(0.19)	(0.24)	(0.36)
FiscalDec_{it-1}			-2.609	-2.631		
			(-0.69)	(-0.70)		
FiscalPre_{it-1}			-0.825	-0.667		
			(-0.71)	(-0.58)		
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,272	1,272	1,272	1,272	1,120	1,120
R-squared	0.172	0.177	0.395	0.397	0.406	0.407

Notes: This table reports more results for the robustness analysis. The first block corresponds to the estimation where the dependent variable y_{it} is the change in the debt-to-GDP ratio. The second block corresponds to the estimation for more control variables. In the first block, we take the logarithmic form for all control variables (excluding the GDP growth rate g_{it-1}). In the second block, we add two controls: the ratio of budgetary income to expenditure ($FiscalPre$) to measure the government's fiscal pressure and the proportion of the prefecture city's public expenditure in provincial public expenditure to measure the extent of the fiscal decentralization ($FiscalDec$). The other specifications are the same as those in Table 5. The third block reports the results for the estimation with the sub-sample that excludes the observations of four autonomous regions including, Tibet, Inner Mongolia, Guangxi and Ningxia. In all three of exercises, we use the weight matrix W_1. The results for the weight matrix W_2 change little. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. t values based on the robust standard errors clustered at the province level are reported in parentheses. The main results are similar if errors are clustered at the prefectural-city level. To save space, we do not report the results for controls.

debt quota management policy, the average debt growth in four autonomous regions is nearly three times higher than that of other regions. This suggests that cities in autonomous regions may face a looser regulation than other cities. To remove the possible impact of extreme values on the estimation results, we conduct the baseline estimation using the sample excluding the observations for the four autonomous regions. The third block in Table 7 reports the estimation results with the weight matrix W_1. It can be seen that the local governments of those regions with relatively low GDP growth issue more debt comparing to other regions. The effect is largely mitigated when the debt quota management policy is put in place. This result indicates that the main findings in the baseline estimation is robust for the sub-sample excluding observations of autonomous regions.

6.4 Spatial Correlation

In our baseline estimation, there exists a significant relationship between local government debt and relative GDP growth. The spatial correlation we obtained is also supposed to be captured by geographic spillover effects. To confirm this conjecture, we estimate an extended model by introducing spatial correlation of local government debt.

In our extended econometric model, we particularly construct a spatial autoregressive model to estimate the spatial correlation between local government debt and the regional GDP growth gap. In particular, we introduce an extra term that captures the geographic spillover effect to our previous econometrics models (25) and (26). The extended spatial autoregressive models become:

$$\begin{aligned} y_{it} = {} & \beta_0 + \beta_1 D_{it-1} + \beta_2 g_{it-1} + \rho \textstyle\sum_{j \neq i} w^*_{ij} y_{jt} + \alpha Gap_{it-1} + \alpha_1 \cdot Post_t \cdot Gap_{it-1} \\ & + x'_{it}\delta + u_i + v_t + \varepsilon_{it}, \end{aligned} \tag{29}$$

$$\begin{aligned} y_{it} = {} & \beta_0 + \beta_1 D_{it-1} + \beta_2 g_{it-1} + \rho \textstyle\sum_{j \neq i} w^*_{ij} y_{jt} + \alpha_1 Gap^-_{it-1} + \alpha_{1p} \cdot Post_t \cdot Gap^-_{it-1} \\ & + \alpha_2 Gap^+_{it-1} + \alpha_{2p} \cdot Post_t \cdot Gap^+_{it-1} + x'_{it}\delta + u_i + v_t + \varepsilon_{it}, \end{aligned} \tag{30}$$

where $\sum_{j \neq i} w^*_{ij} y_{jt}$ is the weighted average of the newly issued debt for city i's neighboring or competing cities; weight w_{ij} has the same definition as that in the baseline estimation; the parameter ρ measures the neighboring relationship between city i and its competitors; and other specifications are exactly the same as those in the baseline model. The standard assumptions, $\varepsilon_{it} \sim N(0, \sigma_i^2)$ and $\mathbf{E}(\varepsilon_i \varepsilon_j) = 0$ for $i \neq j$, are applied in this case. For the spatial weight matrix, we use W_1 and W_2 respectively to describe the geographic relationship among competing cities.

Table 8 reports the main estimation results for key variables under two types of weight matrices. Each block reports the results for one particular weight matrix, where different econometric specifications are estimated. Take the first block for W_1 as an example. In the first column, we

Table 8: Estimation Results for the Spatial Autoregressive Model

Weight	W_1			W_2		
	y_{it}	y_{it}	y_{it}	y_{it}	y_{it}	y_{it}
$\sum_{j\neq i} w^*_{ij} y_{jt}$	0.359^{***}	0.362^{***}	0.359^{***}	0.176^{***}	0.176^{***}	0.173^{***}
	(5.51)	(5.63)	(5.56)	(4.02)	(4.11)	(4.07)
Gap_{it-1}		-0.882^{***}			-0.802^{**}	
		(-2.82)			(-2.41)	
$Gap_{it-1} \cdot Post_t$		0.498			0.358	
		(1.64)			(1.18)	
Gap^-_{it-1}			-1.158^{***}			-1.228^{***}
			(-2.73)			(-2.94)
$Gap^-_{it-1} \cdot Post_t$			0.596^{*}			0.807^{**}
			(1.74)			(2.27)
Gap^+_{it-1}			-0.511			-0.325
			(-0.71)			(-0.40)
$Gap^+_{it-1} \cdot Post_t$			0.366			-0.134
			(0.49)			(-0.20)
D_{it-1}	-0.308^{***}	-0.309^{***}	-0.309^{***}	-0.302^{***}	-0.302^{***}	-0.303^{***}
	(-4.87)	(-4.90)	(-4.89)	(-4.57)	(-4.56)	(-4.56)
g_{it-1}	-0.094	0.165	0.194	-0.119	0.140	0.166
	(-0.76)	(0.70)	(0.80)	(-0.93)	(0.68)	(0.84)
Other Controls	yes	yes	yes	yes	yes	yes
City FE	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
Observations	1,276	1,276	1,276	1,276	1,276	1,276
$\mathbf{R}^2$	0.033	0.034	0.034	0.042	0.043	0.041

Notes: The dependent variable is the change in outstanding government debt. The control variables are the same as those in the baseline estimation. *, ** and *** denote significance at the 10%, 5%, and 1% level, respectively. t values based on the robust standard errors clustered at province level are reported in parentheses. The main results are similar if errors are clustered at prefectural-city level. The linear interpolation method is used for two missing observations. To save space, we do not report the results for controls. The spatial autoregressive model is estimated by the MLE method.

estimate a standard spatial autoregressive model for government debt where local competition is not considered. In the second and third columns, we estimate the extended version of baseline specifications (25) and (26), where the GDP growth gap is considered. The first column in the block with weight matrix W_1 shows that local government debt presents a strong regional correlation. The coefficient ρ is significantly positive. This implies that the government in one region tends to increase debt if its competing cities raise more debt. Furthermore, the second and third columns show that after the term of local government competition (i.e., the GDP growth gap) is added to the estimation, the regional spillover coefficient ρ remains significant. Meanwhile, the coefficients of government competition, Gap_{it-1} and Gap^{-}_{it-1} are still significant, though the magnitude is slightly changed. In addition, the coefficient of the interaction term $Post_t \cdot Gap^{-}_{it-1}$ is significantly positive, indicating that the impact of regional competition on debt accumulation is greatly weakened after the debt regulation policy becomes effective. This pattern confirms that our main findings in the baseline estimation are also supported by an alternative econometric model where the geographic spatial correlation among local government debt is considered. We also apply the spatial econometric model to the case of generalized specification. The results are generally consistent with those findings in Section 5.1 and 6.4. Appendix C provides more details.

7 Conclusion

Chinese local government debt issuance has accelerated in the last decade. What force is driving the debt dynamics remains an open question. In this paper, we aim to empirically study the impact of competition between local governments on the dynamics of local government debt. We first construct a simple decision model of local governors based on prospect theory to characterize the regional competition among local governments. GDP growth relative to other regions (competitors) is introduced into the local governor's utility function to capture his career concern. GDP growth that is behind (or ahead of) competitors' is considered a loss (or gain). Prospect theory implies that the local governor with weaker economic growth would have a stronger incentive to increase public investment financed by government debt. As a result, the regional GDP growth gap, defined as the difference between local GDP growth and that of competitors, negatively affects the issuance of local government debt. We then introduce a debt regulatory policy implemented by the Chinese central government at the end of 2015 to our baseline model. We show that the policy can effectively dampen the impact of regional competition on local government debt by imposing a strict enough borrowing constraint. However, the debt constraints from the regulation policy are time-variant and present spatial heterogeneity. For regions with loose debt constraints, the policy may not sufficiently impede regional competition.

To test our theoretical predictions, we construct a comprehensive data set of prefectural-level local government debt from 2014 to 2018 and debt quota from 2016 to 2018. Our sample covers all Chinese prefectural-level cities except those in Xinjiang province. We construct the baseline model by introducing the dummy variable of the implementation of the debt quota management policy. After controlling a considerable number of standard city-level indicators, our empirical analysis indicates that the regional GDP growth gap has a significant and asymmetric effect on the change in local government debt. For those regions with GDP growth below their competitors, the effect is significant and negative, while for those with relatively rapid GDP growth, the effect is insignificant. Meanwhile, we find that the debt regulation policy does dampen the impact of regional competition by imposing borrowing constraints on local governments. Furthermore, we divide the full sample from 2016 to 2018 into three groups according to the tightness of debt limit constraints and repeat the above regression. The results show, when the debt limit constraint imposed by the debt regulation policy becomes relatively loose, the expansionary effect of regional competition on local government debt will not be sufficiently restrained. Therefore, our empirical analysis confirms previous theoretical predictions. The aforementioned results remain robust for various sensitivity analyses.

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Appendix

A Proof of Proposition 1

To solve the problem, we first substitute government consumption C_{it} with (2) and debt D_{it} with (1), i.e., $C_{it} = \tau A_{it} G_{it}^{\alpha} - RG_{it} + RH_{it-1} - H_{it}$ and $D_{it} = G_{it} - H_{it-1}$. Then, the constraint (3) can be rewritten as

$$H_{it} \leq \tau A_{it} G_{it}^{\alpha} - RG_{it} + RH_{it-1}, \text{ for } t = 1, 2. \tag{A.1}$$

Let μ_{it} denote the Lagrangian multiplier for the constraint A.1. The optimal conditions for G_{it} and H_{it} are

$$R = \alpha \tau A_{it} G_{it}^{\alpha - 1}, \tag{A.2}$$

$$\mu_{it} = \begin{cases} \beta R - 1, & \text{for } t = 1, \\ 0, & \text{for } t = 2. \end{cases} \tag{A.3}$$

From (A.2) we can immediately solve the optimal government investment, which is $G_{it}^{*} = \left(\frac{\alpha \tau A_{it}}{R}\right)^{\frac{1}{1-\alpha}}$.

It is straightforward to show that the condition $R > 1/\beta$ guarantees $\mu_{it} > 0$ for $t = 1$. Thus, the condition (A.1) holds with equality for $t = 1$. For H_{i2}, we immediately have $H_{i2} = 0$. This gives the optimal decision for the fiscal balance H_{it} (A.1). The optimal output Y_{it}^{*} and debt D_{it}^{*} can be immediately obtained through the production function and the flow of funds constraint.[20]

B Data

In this section, we provide a detailed data description for the set of variables used in the estimations.

- Control variables in baseline estimations as listed in Table 4. All the variables are at the prefectural city level from 2014 to 2018.

    1. **Debt outstanding**, D_{it}, is the level of outstanding local government debt at the end of year. The data collection procedure is described in Section 4. The unit is 100 million yuan.
    2. **Net change of debt**, y_{it}, is the change in debt level, i.e., $D_{it} - D_{i,t-1}$. The unit is 100 million yuan.

[20] To be rigorous, to guarantee that the limit of H_{i2} under the optimal decision $\tau A_{i2} G_{i2}^{\alpha} - RG_{i2} + RH_{i1}$ is greater than zero, we need the parameter τ to be not too large and H_0 not too small.

3. **GDP growth rate**, g_{it}, is the growth rate of real GDP (nominal GDP deflated by the local inflation rate). The unit is percentage. Source: China City Statistical Yearbook.
4. **Government consumption**, goc_{it}, is the local government's expenditure on public service. The unit is 100 million yuan. Source: China City Statistical Yearbook and application from the municipal bureau of finance.
5. **Household debt**, hhd_{it}, is the level of debt in the household sector. The unit is 100 million yuan. Source: application from the regional branch of People's Bank of China.
6. **Nonfinancial corporate debt**, $othd_{it}$, is the level of debt in the nonfinancial corporate sector. The unit is 100 million yuan. Source: Application from the regional branches of People's Bank of China.
7. **Human capital**, hc_{it}, is measured by the number of students in ordinary secondary schools. The unit is 10,000 people. Source: China City Statistical Yearbook.
8. **Fixed asset investment**, inv_{it}, is the level of total fixed asset investment. The unit is 1 trillion yuan. Source: China City Statistical Yearbook.

- Variables used in other estimations.

1. **Percentage of unused debt quota (%)** is the ratio of unused debt quota to the total debt quota, which is defined as $\omega_{it} = \min\left\{\frac{Quota_{it}-D_{it-1}}{Quota_{it}}, 0\right\}$, where D_{it-1} is the debt outstanding at the end of the previous year and $Quota_{it}$ is the debt quota allocated by the superior government at the beginning of the current year. This variable indicates the maximum level of new debt the local government can issue in the current year. Table B.1 reports the summary statistics for the level and the percentage of unused debt quotas. Table B.2 also reports the summary statistics of the debt growth for subsamples with different unused debt quotas.
2. **Fiscal pressure** is defined as the ratio of government income and expenditures. The former is measured by the general public budgetary income. The latter is measured by the general public budget expenditure. A larger value indicates the local government faces looser fiscal pressure. Source: China City Statistical Yearbook.
3. **Fiscal decentralization**, is defined as the ratio of the prefectural-city's general public budget expenditure and provincial general budget public expenditure. Source: China City Statistical Yearbook.

Table B.1: Summary Statistics of Debt Quotas

	Obs.	Mean	Std.	Min	p25	Median	p75	Max
Debt quota (100 million yuan)								
2016	280	444.9	487.5	20.4	164.6	280.7	507.3	2596.0
2017	280	475.6	496.8	31.3	188.0	306.2	542.2	2657.2
2018	280	526.7	530.8	45.9	217.3	343.9	590.8	2808.3
Percentage of unused debt quota								
2016	280	15.0%	10.4%	0.0%	8.2%	13.4%	21.7%	56.8%
2017	280	17.2%	10.8%	0.0%	9.9%	16.0%	22.8%	64.6%
2018	280	20.8%	10.1%	0.0%	13.9%	20.2%	27.0%	69.5%

Table B.2: Summary Statistics of Government Debt for Subsamples

	Obs.	Mean	Std.	Min	p25	Median	p75	Max
Cities with large unused debt quotas								
2016	84	19.8%	16.4%	-19.8%	9.7%	18.8%	27.1%	89.4%
2017	84	21.2%	20.0%	-8.4%	9.8%	19.0%	25.0%	151.2%
2018	84	26.2%	14.9%	-0.9%	16.0%	25.8%	32.3%	80.9%
Cities with moderate unused debt quotas								
2016	112	6.3%	5.9%	-8.0%	2.3%	6.9%	10.4%	25.3%
2017	112	8.3%	7.7%	-12.3%	4.0%	8.0%	13.6%	24.7%
2018	112	13.6%	7.9%	-6.4%	7.6%	12.8%	18.8%	32.2%
Cities with low unused debt quotas								
2016	84	0.8%	6.1%	-26.7%	-1.6%	1.0%	4.4%	15.4%
2017	84	0.4%	6.1%	-26.3%	-2.3%	0.2%	4.8%	12.9%
2018	84	5.8%	5.1%	-7.0%	2.1%	5.9%	9.9%	17.0%

Notes: We divide the whole sample into three groups according to the percentage of unused debt quotas at the beginning of the current year. The cities with large unused debt quotas refer to those with the percentage of unused debt quotas in the top 30%. The cities with low unused debt quotas refer to bottom 30% group. The rest group is defined as cities with moderate unused debt quotas.

C More Robustness

Nominal GDP Target In the baseline model, we use GDP in real terms to compute the output gap. It is possible that when making their decisions, local governments only consider nominal GDP as their target. Considering this, we conduct the same empirical analysis as those in baseline estimations by using nominal GDP. Table C.1 reports the main results. The table shows that local government debt again strongly correlates with GDP competition even with the nominal GDP target. The pattern becomes much weaker and insignificant after 2016. Therefore, our baseline analysis is fairly robust.

Table C.1: Estimation Results for Baseline Model with Nominal GDP Target

Weight	W_1		W_2	
	y_{it}	y_{it}	y_{it}	y_{it}
Gap_{it-1}	-0.577^{**}		-0.638^{**}	
	(-2.07)		(-2.00)	
$Gap_{it-1} \cdot Post_t$	0.466		0.322	
	(1.62)		(1.13)	
Gap^{-}_{it-1}		-1.390^{***}		-1.420^{***}
		(-3.26)		(-3.41)
$Gap^{-}_{it-1} \cdot Post_t$		1.076^{**}		1.027^{**}
		(2.38)		(2.64)
$Gap^{+}_{it-1} \cdot Post_t$		0.562		0.272
		(0.67)		(0.31)
$Gap^{+}_{it-1} \cdot Post_t$		-0.310		-0.499
		(-0.41)		(-0.74)
D_{it-1}	-0.309^{***}	-0.310^{***}	-0.309^{***}	-0.311^{***}
	(-4.41)	(-4.44)	(-4.40)	(-4.43)
g_{it-1}	-0.064	-0.019	0.032	0.092
	(-0.25)	(-0.07)	(0.15)	(0.44)
Other Controls	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	1,272	1,272	1,272	1,272
R-squared	0.393	0.395	0.394	0.395

Notes: All the specifications are the same as those in Table 5, except we replace the real GDP growth Gap with the nominal one. *, ** and *** denote significance at the 10%, 5%, and 1% level, respectively. t values based on the robust standard errors clustered at province level are reported in parentheses. The main results are similar if errors are clustered at prefectural-city level. To save place, we do not report results for other controls.

Errors Clustered at Prefectural-city Level We present t values based on the robust standard errors clustered at the province level in the baseline analysis. One potential concern is that the error items for different observations in the same province may not be correlated. We cluster the robust standard errors at the prefectural-city level to check the robustness. Table C.2 reports the main results. From the table, we see that the significance of coefficients is generally unchanged, indicating that our findings in the baseline analysis are robust.

Table C.2: Estimation Results for Baseline Model
(Errors Clustered at Prefectural-city Level)

Weight	W_1		W_2	
	y_{it}	y_{it}	y_{it}	y_{it}
Gap_{it-1}	-0.755^{**}		-0.791^{**}	
	(-2.06)		(-2.56)	
$Gap_{it-1} \cdot Post_t$	0.489		0.362	
	(1.46)		(1.20)	
Gap^{-}_{it-1}		-1.511^{***}		-1.428^{***}
		(-3.39)		(-3.33)
$Gap^{-}_{it-1} \cdot Post_t$		1.013^{***}		0.964^{***}
		(2.60)		(2.60)
Gap^{+}_{it-1}		0.289		-0.077
		(0.41)		(-0.12)
$Gap^{+}_{it-1} \cdot Post_t$		-0.166		-0.303
		(-0.23)		(-0.48)
D_{it-1}	-0.309^{***}	-0.309^{***}	-0.308^{***}	-0.310^{***}
	(-4.88)	(-4.87)	(-4.84)	(-4.84)
g_{it-1}	0.030	0.079	0.094	0.141
	(0.13)	(0.33)	(0.49)	(0.72)
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	1,272	1,272	1,272	1,272
R-squared	0.394	0.395	0.394	0.396

Notes: The all specifications are the same as those in Section 5.1. *, ** and *** denote significance at the 10%, 5%, and 1% level, respectively. t values based on the robust standard errors clustered at prefectural-city level are reported in parentheses.

Alternative Thresholds for Debt Quota In Section 5.2, we further document the heterogeneous effects of the debt regulation on the local government debt issuing. In the estimation, we divide the full sample into three categories ("loose", "moderate", and "tight") according to the tightness of the debt financing constraint, measured by the percentage of unused debt quota. We use the top 30 percentile and the bottom 30 percentile of "the percentage of unused debt quota" as two thresholds. To study the robustness, we employ the 50 percentile of the percentage of unused debt quota to group the sample into "Tight" (below medium) and "Loose" (above medium) categories. We then re-do the same estimation as that in Table 6. Table C.3 reports the main results. It shows that estimates for the key variables present very similar results as those in the baseline model. For those cities facing loose constraints, the regional competition of GDP growth causes an asymmetric impact on local government debt. Meanwhile, the above pattern strongly dampens for those cities with tight debt financing constraints. The above finding indicates that a tighter debt quota management does depress the response of local government debt to the GDP competition, conforming to the analysis in Section 5.2.

Table C.3: Estimation Results for Alternative Thresholds of Debt Quota

Group	Loose (above medium)		Tight (below medium)		Full Sample	
	y_{it}	y_{it}	y_{it}	y_{it}	y_{it}	y_{it}
Gap_{it-1}	-0.592		-0.086		-0.024	
	(-1.54)		(-0.20)		(-0.07)	
Gap^{-}_{it-1}		-1.314^{**}		0.620		-0.204
		(-2.78)		(0.77)		(-0.36)
Gap^{+}_{it-1}		0.125		-1.117		0.185
		(0.19)		(-0.77)		(0.29)
D_{it-1}	-0.005	-0.005	-0.263^{*}	-0.267^{*}	-0.322^{***}	-0.322^{***}
	(-0.05)	(-0.04)	(-1.90)	(-1.90)	(-4.10)	(-4.10)
g_{it-1}	0.176	0.274	-0.694^{*}	-0.786^{*}	-0.411	-0.386
	(0.39)	(0.60)	(-1.79)	(-1.78)	(-1.48)	(-1.34)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	420	420	420	420	840	840
R-squared	0.320	0.325	0.322	0.324	0.388	0.389

Notes: The dependent variable is the change in outstanding government debt. The estimation uses the weighting matrix W_1. The control variables are the same as those in the baseline estimation. We divide the whole sample into two subsamples according to the value of the percentage of unused debt quotas, ω_{it}. We label the top 50% and bottom 50% as "Loose" and "Tight", respectively. Each block reports the estimation result based on the corresponding subsamples. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. t values based on the robust standard errors clustered at the province level are reported in parentheses. The main results are similar if errors are clustered at the prefectural-city level. To save space, we do not report the results for controls.