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Debt and growth: Is there a constant tipping point? ☆

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ABSTRACT

This paper highlights the crucial role of a time-varying threshold effect of public debt on economic growth. Our contribution is twofold. First, we extend the constant-threshold regression kink model of Hansen (2017) by allowing for a time-varying, state-dependent threshold. Second, we apply our model to investigate the effect of debt on growth, using data from the U.S. over the period of 1791–2009. Our empirical results clearly support a nonlinear debt-threshold effect and the threshold is time-varying and state-dependent.

1. Introduction

Starting from the seminal work of Reinhart and Rogoff (2010), the linkage between public debt and economic growth has once again attracted much attention among academics and policymakers in recent years. According to Reinhart and Rogoff (2010), while the link between debt and growth seems relatively weak at "normal" debt levels, debt is notably associated with slow growth when exceeding 90% of GDP. The finding of Reinhart and Rogoff (2010) has gained support by several succeeding papers, including Cecchetti et al. (2011), Checherita-Westphal and Rother (2012) and Baum et al. (2013). However, the issue regarding whether there exists a debt threshold around 90% is far from settled. For example, Herndon et al. (2014) find that growth at the debt-to-GDP ratio over 90% is not much different from when the ratio is lower and Lee et al. (2017) reach a debt threshold not around 90% but around 30%. See also Egert (2015), Eberhardt and Presbitero (2015) and Chudik et al. (2017) for results against a universally applicable threshold effect.[1]

More recently, apart from the panel-data approach commonly employed in the debt-growth studies (including all the aforementioned papers), Hansen (2017) adds to the relevant literature via a novel time-series approach. Specially, Hansen (2017) develops a regression kink (RK) model with an unknown constant threshold (kink) to investigate the impact of debt on growth. The RK model is an extension of the widely applied regression discontinuity (RD) model (Card et al., 2017). Contrasting to the RD model, which estimates a "jump" in the outcome associated with a discontinuous jump of a policy variable, the RK model estimates a "kink" in the outcome associated with a continuous policy variable when the variable has a kink. Hence, in the RK model, the regression function is continuous but the slope has a discontinuity at a threshold point ("kink").

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[1] For a thorough review, please see Panizza and Presbitero (2013).

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Applying the RK model to long-span US time-series data over the period of 1791 to 2009, Hansen (2017) finds a growth slowdown when the debt/GDP ratio surpasses a threshold around 43–44%; however, the threshold effect is not significant when a formal test is applied.[2]

Given that the finding of Hansen (2017) is based on data covering a prolonged period (more than two centuries), one might concern whether assuming a constant threshold is practical. Moreover, suppose that the threshold is time-varying but being treated as a constant, it is hard to know if the modelling outcomes are still valid.[3] Allowing for a more flexible, possibly state-dependent, threshold is also called for owning to the observation of Dueker et al. (2013) that "usually high/low values of an economic variable may sometimes be best thought of in relative terms".[4] For example, the level of public debt may be best regarded as high or low not in absolute terms but relative to pertinent macroeconomic variables (covariates) that shape the state of an economy. As macroeconomic variables are typically time-varying, the associated assessing reference (threshold) is unlikely to be constant. Accordingly, the same level of debt-to-GDP ratio may be regarded as high under a certain condition but only moderate under other conditions.

In this paper, we aim to contribute to the debt-growth literature by addressing the vital role of a time-varying, state-dependent tipping point (threshold). To this end, we develop a modified RK model that extends the Hansen's RK model by allowing for a state-dependent threshold, which is treated as a function of informative covariates. Following Hansen (2017), we illustrate a standard approach in estimating the model and introduce two testing procedures for distinguishing between linear and threshold models and between constant and time-varying thresholds, respectively. We apply the proposed model to the data used in Hansen (2017) with a set of macroeconomic covariates to form the threshold function. Overall, our empirical results lean toward supporting the existence of a tipping point (threshold), above which debt becomes notably harmful for growth. Besides, our results show that, in general, a time-varying/state-dependent threshold is more suitable than a constant one.

Apparently, identifying debt-threshold determinants is challenging because the relevant literature is scant and indirect. In this paper, three possible covariates – growth, inflation, and the past debt/GDP ratio – are attempted. The choice of growth may be justified on the ground that public debt tends to be self-financed when growth is high. With regard to inflation, according to Cochrane (2011a), "The key reason serious inflation often accompanies economic difficulties is straightforward: Inflation is a form of sovereign default"; therefore, inflation may deteriorate the impact of debt to growth. However, default (via inflation) implies reducing the real burden and so high inflation is likely to ease negative growth effects of debt. Given these two opposing effects of inflation, the overall effect of inflation on debt-threshold is unclear.[5] Finally, considering the past debt/GDP ratio is based on the presumption that an economic variable is often viewed as high or low relative to its own recent past values. When public debt lingers at a certain level for a while, the perceived "normal" debt level (threshold) might shift toward to that level – particularly, if other macroeconomic conditions remain stable.

The remainder of this article is organized as follows. Section 2 introduces regression kink (RK) models with time-varying and state-dependent thresholds, describes least squares estimation of the model parameters, and discusses test statistics for threshold effect and threshold constancy. Sections 3 presents the main empirical results. Section 4 provides the results of robustness check, and Section 5 concludes.

2. The methodology

In this section, we first extend the regression kink (RK) model of Hansen (2017) by allowing for a time-varying, state-dependent threshold. We then illustrate the estimation procedure and propose test statistics for threshold effect and threshold constancy.

2.1. Regression kink with a state-dependent threshold

Let y_t be the real GDP growth rate in year t, x_t be the debt-to-GDP percentage from the previous year, and $\boldsymbol{z}_t$ be a set of control variables. Our regression kink model with a state-dependent threshold can be represented by

$$y_t = \beta_1(x_t - \gamma_t)_- + \beta_2(x_t - \gamma_t)_+ + \boldsymbol{\beta}_3'\boldsymbol{z}_t + e_t, t = 1, 2, \ldots, T, \tag{1}$$

where y_t, x_t and e_t are scalars, and $\boldsymbol{z}_t$ is a l-dimensional vector that includes an intercept. $(x_t - \gamma_t)_- = min[x_t - \gamma_t, 0]$ and $(x_t - \gamma_t)_+ = max[x_t - \gamma_t, 0]$ denote the negative part and positive part of $x_t - \gamma_t$, respectively. γ_t is a time-varying threshold (tipping point), which is specified as a function of informative covariates, e.g., a linear combination of the elements of a k-dimensional vector $\boldsymbol{q}_t = (q_{1,t}, \ldots, q_{k,t})'$ of observable exogenous or predetermined variables

$$\gamma_t = \gamma_0 + \boldsymbol{\gamma}_1'\boldsymbol{q}_t \tag{2}$$

[2] See Lin (2014) for a similar finding when a very different empirical framework is considered.

[3] In Appendix A, our Monte Carlo simulations show that overlooking the possible nature of a threshold would lead to seriously biased estimates. Furthermore, the direction and the magnitude of the bias depend on the setting of the involving time-varying threshold parameters.

[4] To the best of our knowledge, Dueker et al. (2013) is the only paper that employs a varying threshold. Dueker et al. (2013) propose a smooth transition autoregressive (STAR) model with a time-varying/state-dependent threshold and apply the model to the dynamics of U.S. short-term interest rates.

[5] We thank the anonymous referee to raise this point to us. For further discussions on the relation between debt and inflation, please see Cochrane (2011a,b).