PUBLIC DEBT AND ECONOMIC GROWTH: A QUICK LOOK AT THRESHOLD EFFECTS

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1 Introduction

The 2007-08 financial and economic crisis principally caused by the collapse of the US subprime market triggered economic recession in many countries. Governments and central banks of the developed world swiftly reacted by implementing substantial fiscal and monetary policy easing, coupled with State aid to the troubled financial sector. These actions no doubt helped contain the Great Recession but pro-cyclical discretionary fiscal expansion and the banking sector bail-outs led to an unprecedented rise in public debt-to-GDP ratios. Against this backdrop, Reinhart and Rogoff (2010) argued that an excessively high public debt (as a share of GDP) hampers economic activity. On the basis of descriptive statistics, they showed that there was a tipping point at 90 per cent of GDP: economic growth slows down sharply if the debt-to-GDP ratio exceeds 90 per cent of GDP. A number of recent papers investigated this issue and used more advanced statistical methods to analyse the non-linear negative relation between growth and public debt. Indeed, Cecchetti *et al.* (2011) find a threshold of about 85 per cent of GDP. Kumar and Woo (2010), Checherita and Rother (2010) and Baum *et al.* (2012) confirm the 90 per cent threshold.

The ambition of this note is to take a quick look at how robust the 90 per cent threshold is. In doing so, we use a subset of a variant of the Reinhart-Rogoff dataset. We estimate the bivariate relationship between growth and debt (and lagged debt) in a two-regime threshold model for a variety of thresholds. We also perform a robustness check of the 90 per cent threshold by jackknifing the sample, *i.e.*, dropping one country from the sample at a time. We find that the threshold may be different from 90 per cent, that it varies a lot whether we use contemporaneous or lagged debt and that the negative impact of debt on growth is sensitive to outlier observations.

2 Data and estimation issues

The main evidence in Reinhart and Rogoff (2010) is based on a sample of 20 industrialised countries for the period from 1946 to 2009. For this reason, we use in this note this subset of the Reinhart and Rogoff dataset. Reinhart and Rogoff (2010) do not give the sources of the data they use in their paper. But data on central government debt can be obtained from the data appendix of Reinhart and Rogoff (2011). Real GDP growth rates are available for a number of countries for the same time period from the Barro-Ursúa macroeconomic dataset (Barro and Ursúa, 2011). Matching these two datasets helps us reproduce the Reinhart and Rogoff dataset. The difference between their data and our dataset is that our data does not include Ireland but contains data for Switzerland. A marginal difference is that our dataset ends in 2010, while the data used in Reinhart and Rogoff (2010) stops in 2009. Table 1 below gives the differences.

Our estimation approach involves two steps. First, we estimate the linear bivariate relation between growth and debt (equation 1) and then go on to estimate threshold models (equation 2) with tipping points at 10, 15, 20, …, 90, 95, 100 per cent, …, 180 per cent of GDP).

$$\Delta y_t = \alpha + \beta\, debt_t + \varepsilon_t \qquad (1)$$

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The usual disclaimer applies.

Table 1

Data Coverage: Reinhart and Rogoff (2010) Versus the Dataset Used in the Paper

Country	Reinhart and Rogoff (2010)	Our Dataset, Which Uses Data from Reinhart and Rogoff (2011) for the Level of Central Government Debt and Barro and Ursúa (2012) for Real GDP Growth
Australia	1902-2009	1861-2009
Austria	1880-2009	1880-2009
Belgium	1835-2009	1847-2009
Canada	1925-2009	1871-2009
Denmark	1880-2009	1880-2009
Finland	1913-2009	1914-2009
France	1880-2009	1880-2009
Germany	1880-2009	1880-2009
Greece	1884-2009	1848-2009
Ireland	1949-2009	-
Italy	1880-2009	1862-2009
Japan	1885-2009	1872-2009
Netherlands	1880-2009	1814-2009
New Zealand	1932-2009	1831-2009
Norway	1880-2009	1880-2009
Portugal	1851-2009	1851-2009
Spain	1850-2009	1850-2009
Sweden	1880-2009	1801-2009
Switzerland	-	1880-2009
United Kingdom	1830-2009	1831-2009
USA	1790-2009	1791-2009

$$\Delta y_t = \begin{cases} \alpha_1 + \beta_1 \cdot debt_t + \varepsilon_t & if \quad debt < T \\ \alpha_2 + \beta_2 \cdot debt_t + \varepsilon_t & if \quad debt \geq T \end{cases} \tag{2}$$

where Δy is annual real GDP growth, *debt* stands for the central government debt-to-GDP ratio and T is the value of the debt threshold (10, 15, 20, …, 90, 95, 100, …, 180 per cent of GDP). Equations (1) and (2) are estimated for a pooled panel and with country fixed effects and for contemporaneous and lagged debt. Finally, equation (2) for the debt threshold equalling 90 per cent is jackknifed: one country is dropped from the sample at a time.

3 Estimation results

Linear bivariate panel regressions show a negative link between growth and public debt but this effect does not seem to be statistically significant (Table 2). When imposing a threshold of 90 per cent of public debt, the estimation results show that the contemporaneous relation between growth and debt is strongly negative if public debt is lower than 90 per cent of GDP, whereas the relation breaks down above that threshold. Carrying out the estimations using alternative threshold values (from 10 to 180 per cent of GDP by steps of 5 per cent) does not change this picture: the coefficient estimates are never statistically significant in the upper regime (in which observed debt is above the debt threshold). In addition, in the range from 25 to 55 per cent of GDP, the coefficient estimates are not different from zero in any of the two regimes. Let us now pick the model from the many estimated models, which seems to fit best the underlying data. The models, which minimise the Schwarz and Akaike information criteria and for which the adjusted R-squared is the highest, are the ones with threshold values of 170 and 175 per cent of GDP. These results basically imply an almost linear relationship given that most observations for public debt are below these thresholds.

To check the robustness of the results, we re-estimated the same models using lagged public debt as a right-hand side variable (Table 2). The results are markedly different. First, for the 90 per cent threshold, the coefficient estimates are not only negative but also statistically significant in both regimes, even though they are very similar in size. Second, for turning points higher than 135 per cent of GDP, the coefficient estimate in the upper regime becomes insignificant. Finally, the threshold is at 20 per cent of GDP for the model for which the information criteria are the lowest and the adjusted R-squared the highest. This is quite different from the 170-175 per cent threshold finding. In addition, there is a positive relation between debt and growth below 20 per cent and it becomes negative only above this threshold.

In a second step, we jackknife the sample for the model with a 90 per cent debt threshold. Table 3 shows the sensitivity of the results to specific countries. In particular, if the Netherlands is taken out from the sample, the coefficient on contemporaneous debt becomes negative and statistically significant in the upper regime, *i.e.* when public debt exceeds 90 per cent of GDP. When lagged debt is used as a right-hand side variable, the results are more robust in terms of statistical significance. In all cases, the coefficients remain negative and significant in both regimes. Nevertheless, it is worth mentioning that the variability in the size of the coefficient estimates (measured by the range between the lowest and highest coefficient estimate) is considerable higher in the upper regime than in the lower regime.

4 Conclusions

The ambition of this note was to provide a quick robustness check with regard to the 90 per cent threshold. Using a subset of a variant of the Reinhart-Rogoff dataset including industrialised countries for 1946 to 2010, we found that the non-linear effect linking growth and public debt is not particularly robust. First, whether there is a strong negative link between growth and debt above 90 per cent and how large it is depends on model specification and the inclusion of specific countries in the sample. Second, a simple model selection shows that the 90 per cent threshold may be considerably lower or higher, depending again on model specification.

Table 2

Estimation Results for Alternative Thresholds, 1946-2010

	Debt					Lagged Debt				
	Pooled Panel		Country Fixed Effects			Pooled Panel		Country Fixed Effects		
Linear model: $\Delta y_t = \alpha + \beta\, debt_t + \varepsilon_t$										
β	–0.007		–0.010			–0.007		–0.010		
Threshold Model: $\Delta y_t = \begin{cases} \alpha_1 + \beta_1 \cdot debt_t + \varepsilon_t & if \quad debt < T \\ \alpha_2 + \beta_2 \cdot debt_t + \varepsilon_t & if \quad debt \geq T \end{cases}$										
T	β_1	β_2	β_1		β_2	β_1	β_2	β_1	β_2	
10% of GDP	0.142 **	–0.004	0.132 *		–0.007	0.094 **	–0.011 **	0.086 *	–0.013 **	
15% of GDP	0.084 *	–0.002	0.067		–0.007	0.045	–0.010 **	0.032	–0.012 **	
20% of GDP	0.083 **	0.001	0.075 *		–0.004	**0.064** **	**–0.006** *	**0.058** **	**–0.009** **	
25% of GDP	0.050	–0.001	0.047		–0.005	0.028 *	–0.008 **	0.026 *	–0.011 **	
30% of GDP	0.028	–0.002	0.031		–0.006	0.003	–0.011 **	0.004	–0.012 **	
35% of GDP	0.014	–0.004	0.015		–0.007	–0.014	–0.013 **	–0.017	–0.015 **	
40% of GDP	0.004	–0.005	0.005		–0.007	–0.014	–0.013 **	–0.016	–0.014 **	
45% of GDP	–0.004	–0.006	0.000		–0.008	–0.019 **	–0.014 **	–0.019 *	–0.015 **	
50% of GDP	–0.009	–0.007	–0.007		–0.009	–0.024 **	–0.014 **	–0.024 **	–0.016 **	
55% of GDP	–0.012	–0.007	–0.014		–0.010	–0.017 **	–0.013 **	–0.019 **	–0.015 **	
60% of GDP	–0.019 *	–0.008	–0.021 *		–0.011	–0.024 **	–0.014 **	–0.026 **	–0.016 **	
65% of GDP	–0.025 **	–0.008	–0.026 **		–0.012	–0.027 **	–0.014 **	–0.027 **	–0.016 **	
70% of GDP	–0.025 **	–0.008	–0.027 **		–0.011	–0.027 **	–0.013 **	–0.027 **	–0.015 **	
75% of GDP	–0.023 **	–0.007	–0.024 **		–0.010	–0.027 **	–0.013 **	–0.026 **	–0.015 **	
80% of GDP	–0.022 **	–0.006	–0.024 **		–0.010	–0.019 **	–0.012 **	–0.017 **	–0.014 **	
85% of GDP	–0.024 **	–0.005	–0.026 **		–0.010	–0.019 **	–0.012 **	–0.017 **	–0.014 **	
90% of GDP	–0.023 **	–0.005	–0.026 **		–0.009	–0.020 **	–0.012 **	–0.019 **	–0.014 **	
95% of GDP	–0.023 **	–0.004	–0.027 **		–0.008	–0.021 **	–0.011 **	–0.020 **	–0.014 **	
100% of GDP	–0.023 **	–0.003	–0.029 **		–0.007	–0.020 **	–0.011 **	–0.021 **	–0.014 **	
105% of GDP	–0.023 **	–0.001	–0.030 **		–0.006	–0.020 **	–0.010 **	–0.022 **	–0.013 **	
110% of GDP	–0.020 **	0.002	–0.028 **		–0.002	–0.018 **	–0.010 **	–0.022 **	–0.011 **	
115% of GDP	–0.020 **	0.003	–0.029 **		0.000	–0.016 **	–0.010 **	–0.020 **	–0.012 **	
120% of GDP	–0.015 **	0.002	–0.024 **		0.000	–0.016 **	–0.010 **	–0.020 **	–0.011 **	
125% of GDP	–0.017 **	0.005	–0.026 **		0.003	–0.017 **	–0.009 *	–0.021 **	–0.009 **	
130% of GDP	–0.017 **	0.007	–0.026 **		0.005	–0.017 **	–0.008 *	–0.021 **	–0.009 *	
135% of GDP	–0.018 **	0.009	–0.027 **		0.007	–0.017 **	–0.007	–0.021 **	–0.009 *	
140% of GDP	–0.018 **	0.011	–0.027 **		0.009	–0.017 **	–0.007	–0.021 **	–0.008	
145% of GDP	–0.018 **	0.011	–0.027 **		0.009	–0.017 **	–0.007	–0.021 **	–0.008	
150% of GDP	–0.018 **	0.012	–0.025 **		0.010	–0.017 **	–0.006	–0.020 **	–0.008	
155% of GDP	–0.017 **	0.013	–0.025 **		0.011	–0.016 **	–0.007	–0.019 **	–0.008	
160% of GDP	–0.017 **	0.013	–0.025 **		0.011	–0.016 **	–0.007	–0.019 **	–0.008	
165% of GDP	–0.016 **	0.018	–0.023 **		0.017	–0.015 **	–0.006	–0.019 **	–0.006	
170% of GDP	**–0.016** **	**0.020**	**–0.024** **		**0.020**	–0.016 **	–0.004	–0.020 **	–0.003	
175% of GDP	**–0.016** **	**0.020**	**–0.024** **		**0.020**	–0.016 **	–0.004	–0.020 **	–0.003	
180% of GDP	–0.015 **	0.024	–0.022 **		0.024	–0.015 **	–0.004	–0.018 **	–0.004	

* and ** denote statistical significance at the 10 and 5 per cent levels, respectively. Shaded cells indicate the models which minimise the Schwarz and Akaike information criteria and for which the adjusted R^2 are the highest.

Table 3

Estimation Results for the Jackknifed Sample (Debt Threshold-90% of GDP), 1946-2010

	Debt								**Lagged Debt**							
	Pooled Panel				**Country Fixed Effects**				**Pooled Panel**				**Country Fixed Effects**			
Threshold Model: $\Delta y_t = \begin{cases} \alpha_1 + \beta_1 \cdot debt_t + \varepsilon_t & if \quad debt < T \\ \alpha_2 + \beta_2 \cdot debt_t + \varepsilon_t & if \quad debt \geq T \end{cases}$, T=90%																
Country Excluded	β_1		β_2		β_1		β_2		β_1		β_2		β_1		β_2	
AUS	–0.025	**	–0.005		–0.028	**	–0.010		–0.025	**	–0.011	**	–0.026	**	–0.015	**
AUT	–0.020	**	–0.003		–0.023	**	–0.008		–0.020	**	–0.008	**	–0.020	**	–0.012	**
BEL	–0.024	**	–0.007		–0.026	**	–0.010		–0.024	**	–0.009	**	–0.024	**	–0.012	**
CAN	–0.022	**	–0.004		–0.027	**	–0.009		–0.022	**	–0.009	**	–0.024	**	–0.013	**
DNK	–0.022	**	–0.005		–0.026	**	–0.009		–0.023	**	–0.010	**	–0.024	**	–0.013	**
FIN	–0.023	**	–0.005		–0.027	**	–0.009		–0.024	**	–0.010	**	–0.025	**	–0.013	**
FRA	–0.021	**	–0.004		–0.024	**	–0.008		–0.021	**	–0.009	**	–0.021	**	–0.012	**
DEU	–0.022	**	–0.004		–0.024	**	–0.008		–0.022	**	–0.009	**	–0.021	**	–0.012	**
GRC	–0.021	**	–0.003		–0.023	**	–0.007		–0.020	**	–0.008	**	–0.021	**	–0.011	**
ITA	–0.024	**	–0.002		–0.026	**	–0.005		–0.024	**	–0.008	**	–0.024	**	–0.010	**
JPN	–0.017	**	0.000		–0.018	**	–0.003		–0.017	**	–0.006	*	–0.015	**	–0.007	*
NLD	–0.028	**	–0.017	**	–0.030	**	–0.024	**	–0.025	**	–0.014	**	–0.024	**	–0.017	**
NZL	–0.023	**	–0.003		–0.029	**	–0.008		–0.021	**	–0.009	**	–0.023	**	–0.013	**
NOR	–0.024	**	–0.005		–0.028	**	–0.010		–0.023	**	–0.010	**	–0.025	**	–0.013	**
PRT	–0.020	**	–0.004		–0.023	**	–0.008		–0.020	**	–0.009	**	–0.020	**	–0.012	**
ESP	–0.022	**	–0.004		–0.026	**	–0.009		–0.022	**	–0.009	**	–0.023	**	–0.013	**
SWE	–0.023	**	–0.005		–0.027	**	–0.009		–0.023	**	–0.010	**	–0.024	**	–0.013	**
GBR	–0.022	**	–0.002		–0.026	**	–0.009		–0.022	**	–0.010	**	–0.024	**	–0.015	**
USA	–0.023	**	–0.003		–0.028	**	–0.008		–0.022	**	–0.009	**	–0.023	**	–0.012	**
CHE	–0.027	**	–0.006		–0.029	**	–0.010		–0.026	**	–0.011	**	–0.024	**	–0.013	**
MIN	**–0.028**		**–0.017**		**–0.030**		**–0.024**		**–0.026**		**–0.014**		**–0.026**		**–0.017**	
MAX	**–0.017**		**0.000**		**–0.018**		**–0.003**		**–0.017**		**–0.006**		**–0.015**		**–0.007**	

* and ** denote statistical significance at the 10 and 5 per cent levels, respectively.

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