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NONLINEARITIES IN THE EFFECTS OF DEBT AND FISCAL POLICY: EVIDENCE FROM THE STATES

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Abstract

Evidence from a half century of experience by U.S. states identifies nonlinearities in the effects of debt and fiscal policy on growth. Effects are Keynesian for low to moderate levels of debt and stimulus but anti Keynesian for sufficiently high levels of debt or stimulus. Results are broadly consistent with those found in the cross-country studies of Adam and Bevan (2005) and Reinhart and Rogoff (2010).

Keywords: Fiscal policy, Stimulus, Debt, Deficit-finance, Growth

JEL Classification: A00, E00, H00

1. Introduction

Burgeoning levels of U.S. national debt, the 'Great Recession" and the largest peacetime fiscal stimulus in modern U.S. history have heightened further the recent intense interest in whether or not debt reduces the effectiveness of fiscal stimulus and, in particular, whether the effects of fiscal stimulus can be non-Keynesian. Based on a half century of evidence from U.S. states, this study extends recent cross-national investigations by Adam and Bevan (2005), Reinhart and Rogoff (2010, 2011) and others. We pursue answers to four questions: 1) Does the effect of fiscal stimulus depend on the initial stock of government debt? 2) Does the effect of stimulus decline and eventually turn negative as the level of debt rises? (3) Do the effects depend on the magnitude of the stimulus itself? 4) Does debt itself affect growth, independent of the size of the deficit?

We begin, in section 2, with a discussion of related papers and the motivation for the non-linear effects implicit in our questions. Data sources, summary statistics, and the empirical specification

employed in the paper are described in section 3. Results are presented and discussed in section 4. Section 5 concludes.

2. Motivation and related papers

The nonlinear effects implicit in our questions may be important for both theoretical and empirical reasons. Barro's model of endogenous growth (Barro, 1989) predicts nonlinearities that arise from the decreasing returns and increasing opportunity cost of investments in public capital. Judd (1987) extends the Barro (1989) model to demonstrate that the effects of fiscal stimulus can be either Ricardian or Keynesian, depending in part on the level of outstanding debt. One might also expect nonlinearity for practical reasons related to difficulties in spending a large amount of funds in productive ways in a limited amount of time.

Empirically, evidence of nonlinear fiscal effects is reported in cross-country studies by both Reinhart and Rogoff (2009, 2010), Adam and Bevan (2005) and in our own earlier work on sub-national states (Bania *et al*, 2007). In a sample spanning 44 countries (both advanced and developing) and 200 years, Reinhart and Rogoff identify a threshold level of debt (roughly 90% of GDP) above which debt tends to be growth-impeding. In contrast to Reinhart and Rogoff, Adam and Bevan focus on the deficit, finding evidence of a threshold effect in the deficit for a sample of 45 developing countries over the period 1970-1999. Deficits in excess of the threshold (1.5% of GDP) have a significant growth-impeding effect relative to deficits smaller than the threshold. Adam and Bevan also report some evidence of an interaction between debt and the deficit in their sample of countries. For example, high levels of debt appear to exacerbate the growth-impeding effects of deficits that exceed the threshold value of 1.5%. Bania *et al* (2007) reach conclusions regarding the deficit that are qualitatively similar to those of Adam and Bevan for U.S. states over the period 1957-2002. Estimates of non-linear (quadratic) growth equations produce 'growth hills', with growth positively related to the size of the deficit at low levels of the deficit, and negatively related at high levels of the deficit.

The present paper contributes new evidence that both strengthens and extends existing findings. As Reinhart and Rogoff (2010) note, there is considerable variation in the response of growth to debt across countries, which suggests corresponding variation in the threshold debt level across countries. That is, one would expect some countries in their sample to have threshold debt levels in excess of 90%, and some to have threshold's below 90%. Indeed, this paper shows that across subnational U.S. states, the threshold debt level decreases as the size of the deficit increases, suggesting that at least some of the variation in the response of growth to debt in cross-country studies may be due to endogenous debt thresholds. I.e., a high-debt country with a low current deficit will pay less of a growth penalty than a high-debt country with a high current deficit.

Like Adam and Bevan (2005), we find non-linear effects of deficits on growth and coefficient estimates consistent with a threshold level of the deficit above which higher deficits impede growth. However, while Adam and Bevan estimate a single, fixed deficit threshold for their cross-country

sample, we are able to calculate a threshold that is endogenous with respect to state-level debt. *Ceteris paribus*, states with lower stocks of outstanding debt will have higher deficit thresholds than states with higher stocks of debt. The present paper also represents a significant extension of our own earlier work (Bania *et al*, 2007), in which the growth effects of various components of the government budget constraint, including the deficit, are assumed to be independent of the outstanding stock of debt.

Finally, as in Bania *et al* (2007), but in contrast to the empirical studies of Adam and Bevan (2005) and Reinhart and Rogoff (2009, 2010), this study employs subnational data from U. S. states. Subnational states of a large country offer several attributes useful in identifying nonlinear effects of fiscal policy. For example, they i) often provide the substantial variation needed to identify nonlinearities, while ii) also sharing similar legal and political systems, and iii) are small economies subsumed within a large common currency area. These attributes make them a useful quasi-experimental environment in which to study the effects of fiscal policy. Of course, some attributes of our data suggest caution in applying the results in other contexts. For example, states share well-integrated, highly mobile markets for capital and labor; they are not able to monetize their debt; and all but one state (Vermont) has some form of constitutional limitation on deficits.

3. Data and empirical specification

We rely on data for 49 states at five-year intervals over the half century from 1957 to 2007. We omit Alaska due to the dominance of the Alaska pipeline and the consequent outlying variances in fiscal variables relative to other states. Five-year interval data allows a longer observation period than the available higher-frequency annual data, which for state and local public expenditures only begins in 1977, and has the advantage of increased power to identify middle-frequency factors related to intermediate-run variations in growth.

The data for state and local government fiscal variables are taken from the Census of Governments. Related economic, demographic, and other data for corresponding years are from the Bureau of Labor Statistics or the Department of Commerce (for personal income). Table 1 reports summary statistics for the 441 observations of the five-year-interval data used to estimate equation (1).

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Table 1 - Summary Statistics (49 states, 1957-2007)

	GROWTH[a]	DEFICIT[b]	DEBT	TAXES	FED	UR
Mean	12.1	8.33	17.27	10.07	3.57	5.93
Median	11.39	8.32	16.63	10.01	3.37	5.58
Maximum	30.14	11.59	42.69	17.75	7.68	15.45
Minimum	-9.93	0.00	4.52	7.13	0.91	2.00
Std. Dev.	5.56	0.99	5.61	1.33	1.27	2.11
# Obs.	441	441	441	441	441	441

[a]GROWTH is the change in the log of real per capita personal income.
[b]DEFICIT, DEBT, TAXES and FED are percentages of state personal income.

Our baseline regression equation for the log-change in real personal income in a state is expressed by equation (1). We rely on a difference-in-differences empirical specification with fixed state and period effects. Thus, the specification incorporates state-specific trends for growth and period-specific effects common to all states. To address simultaneity issues, we rely primarily on a recursive structure, with beginning-of-period predetermined explanatory variables, as well as controls for state-level cyclical influences.

$$y_{it} = c + c_i + c_t + b_1 d_{i(t-1)} + b_2 d_{i(t-1)}^{\ 2} + b_3 D_{i(t-1)} + b_4 D_{i(t-1)} d_{i(t-1)} + b_5 D_{i(t-1)}^{\ 2} + B_1 X_{i(t-1)} + B_2 Z + e_{it} \qquad (1)$$

y_{it} is growth, the log-change in real personal income per capita for state i in period t; c is a fixed intercept, c_i is a state-specific intercept common to all periods, and c_t is a period-specific intercept common to all states; d and D, respectively, are the budget deficit and outstanding debt[1]; bs are coefficients for the deficit and debt variables; Bs are vectors of coefficients for other components of the government budget constraint in period t-1 (denoted by X) and state-specific time-varying cyclical controls (denoted by Z); and e_{it} is a random error unique to state i in period t. All fiscal variables are expressed as percentage points of state personal income.

In order to account for potential non-linearities in the effects of debt and fiscal policy on growth, we interact debt and the deficit in the specification *and* enter each variable separately as a second-order polynomial. This approach is more flexible than that employed by Adam and Bevan (2005) or Reinhart and Rogoff, and allows us to identify the dependence of the debt and deficit threshold values on other variables entering the model.

To account for the government budget constraint, we explicitly include the lagged deficit, taxes, and federal intergovernmental transfers in all regressions. These three variables account for over 75% of state revenues in post-war U.S. data. Residual revenue sources, which are heterogeneous in nature and often restricted in use (e.g. state payroll taxes and assessments), are omitted along with total expenditures. Hence, for linear effects, a change in any explicitly included category of the

[1]To avoid negative values for the deficit, we subtract the smallest (i.e., most negative) state deficit in the sample from each state's deficit, so that transformed values are relative to the most negative deficit.

government budget constraint (deficit, taxes, or federal transfers) requires a compensating change in the omitted category, in this case government spending or (though unlikely) one of the residual revenue sources noted above. In theoretical terms, eliminating a budget category introduces the budget constraint into the model, as in Barro (1989). Empirically, it avoids linear dependence among elements of the government budget constraint, as discussed in Adam and Bevan (2005), Bania et al. (2007), Bleaney et al. (1999), and Mofidi and Stone (1990).

Period fixed effects control for cyclical co-variation in growth and fiscal policy common to all states. State-specific cyclical co-variation is addressed through the inclusion of current and lagged state unemployment rates and current federal intergovernmental transfers. These controls help address any residual simultaneity issues not addressed by the use of lagged dependent variables and, along with state fixed effects, also help to limit significant autocorrelation in the residual errors.

4. Results

Table 2 reports our primary estimates for the growth equation (1). The linear coefficients for deficit and debt are both significantly positive, while the quadratic terms are both significantly negative. The interaction between debt and the deficit is also negative and significant. The estimates imply that a small deficit has a positive effect on growth, but that increments to the deficit produce smaller changes in growth, the larger the deficit – the estimates support 'diminishing returns' to deficit-financed stimulus spending. In addition, the effect of a deficit on growth decreases as the stock of debt becomes larger. Sufficiently high levels of state debt can render state fiscal policy ineffective or even counter-productive (growth-impeding).

These results for U.S. states are broadly consistent with the cross-national results reported in Adam and Bevan (2005). The estimates in Table 2 also suggest that at sufficiently high levels, a state's indebtedness may reduce its growth, regardless of the stance of state fiscal policy, parallel to the country-level findings of Reinhart and Rogoff (2010).

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Table 2 - Effects of Fiscal Policy on Growth (49 States, 1957-2007)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-32.77	10.57	-3.10	0.00
Fiscal Variables				
DEFICIT(-1)	5.75	1.36	4.22	0.00
DEFICIT(-1)SQ	-0.28	0.07	-3.85	0.00
DEBT(-1)	0.83	0.33	2.54	0.01
DEBT(-1)SQ	-0.01	0.00	-2.02	0.04
DEFICIT(-1)*DEBT(-1)	-0.06	0.03	-1.89	0.06
TAXES(-1)	2.98	1.43	2.09	0.04
TAXES(-1)SQ	-0.10	0.07	-1.60	0.11
FED(-1)	4.51	1.08	4.19	0.00
FED(-1)SQ	-0.29	0.12	-2.46	0.01
Cyclical Controls				
FED	-2.65	0.44	-6.03	0.00
UR	-1.71	0.16	-10.96	0.00
UR(-1)	0.57	0.15	3.83	0.00
Effects Specification				
Cross-section fixed (dummy variables)				
Period fixed (dummy variables)				
Periods included	9			
Cross-sections included	49			
R-squared	0.67			
Adjusted R-squared	0.60			
F-statistic	10.86			
Durbin-Watson stat	2.28			
Robust standard errors				

Consistent with Barro (1989) and results in Bania et al. (2007), the tax coefficients reported in the table exhibit positive linear and negative quadratic effects, as do the coefficients on federal intergovernmental transfers (FED). The cyclical control variables are highly significant and of the expected sign.

The signs and general magnitudes of the estimates reported for the deficit and debt terms in Table 2 are not sensitive to omitting either the fixed effects or the cyclical controls, although in general the standard errors are larger. In addition, estimates are not sensitive to inclusion of an interaction between an index measure of the restrictiveness of constitutional budget limitations (ACIR, 2006) and our deficit measure of fiscal stimulus. Hence, the results are not an artifact of state-level constitutional budget rules.

5. Conclusions and policy implications

Our evidence of nonlinear effects of fiscal policy for sub-national states contributes to a converging pool of evidence for such effects from various theoretical and empirical studies. Collectively, these studies provide substantial support for the following conclusions at both the national and subnational levels: 1) The effect of deficit spending on growth depends on the initial stock of government debt. 2) While a given fiscal stimulus can have expansionary Keynesian effects at low levels of debt, the effects will be smaller at higher debt levels, and can become negative. Thus, at high debt levels 'stimulus' spending may be anti-Keynesian (growth impeding). 3) While an increase in deficit spending may be growth enhancing at a sufficiently low level of debt, the effects diminish as the initial level of the *deficit* increases; there are diminishing returns to stimulus at a given level of debt. 4) The level of debt itself has non-linear effects on growth. At sufficiently high levels, debt may be growth-impeding, independent of the size of the deficit.

Policy implications are all too clear. A nation or a subnational state that relies on deficit spending to bolster its economy more than transitorily will typically see its debt grow over time. Higher debt levels diminish the effectiveness of traditional Keynesian stimulus policies, weakening or rendering useless an important tool of stabilization policy. Furthermore, compensating for a weaker tool by deploying it more vigorously may be counterproductive, given evidence of diminishing returns in the size of fiscal stimulus. Finally, diminished power for fiscal expansion is particularly problematic for economies caught in a 'liquidity trap;' since monetary policy also tends to be weak in a liquidity trap.

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