Supplemental Appendix:
The Financial Crisis, Fiscal Federalism, and the Creditworthiness of U.S. State Governments

Appendix A- Granger Causality Tests for GSP and Federal Dollars

Our theoretical framework and empirical models suggest that the influence of economic growth on a state's credit rating is conditional on the financial support that state receives from the U.S. federal government. Our empirical analyses include measures of both of these concepts at time t, which implies that there is not a clear causal path between gross state products and federal financial support. That is, our analysis asserts that a more complex system of equations is unnecessary. It is possible, however, that federal financial support is actually caused by changes in gross state product. This would create a more complex set of causal relationships that the models in our main body would fail to capture.

In this appendix we demonstrate that the causal path between GSP and federal financial support to states is not clearly one sided, and thus, that our inclusion of these covariates both measured at time t is a reasonable approach. Were it the case that state GSP clearly caused federal financial dollars, or that federal financial dollars clearly caused state GSP, the our model would be potentially misspecified. To demonstrate that this is not the case, Table 1 provides F-statistics from a Granger causality test using state GSP and federal dollars to states at lags of three, five, and ten years. As the results indicate, there is strong evidence of bi-directional causality in the Granger tests. This indicates that it is unclear which of the two variables is causing the other (i.e. an endogenous relationship), and that a more complex path model or system of equations is unnecessary to test the conditional hypotheses from the main body of our paper. This is true at all three sets of lags. Thus, even when we lag our covariates by more than half of the observed series (ten of the sixteen years included in our data), causal paths between gross state product and federal dollars to state governments remain unclear.

Table 1: Granger Causality Test Considering the Relationship Between State GSP and Federal Financial Support

Relationship Direction	Three-Year Lags	Five-Year Lags	Ten-Year Lags
GSP $\rightarrow$ *Federal Dollars*	11.103*	6.343*	3.960*
	(0.000)	(0.000)	(0.000)
Federal Dollars $\rightarrow$ *GSP*	17.848*	11.853*	9.842 *
	(0.000)	(0.000)	(0.000)

Note: Cell entries report F-statistics for the joint explanatory power of potentially exogenous variable at k lags, where $k = 3$, 5, or 10. P-values on the F-statistics are reported in parentheses.

Appendix B- Incorporating Government Control

Our analysis in the main body of our paper incorporate several economic control variables into our model including unemployment, levels of state debt, and state population size. Several scholars have suggested the state debts, bond ratings, and other state economic outcomes are fundamentally related to the power of political parties in states and in particular, changes in credit ratings and state debts may be driven by divided government or partisan preferences (Alt and Lowry 1994; Lowry, Alt and Ferree 1998; Alt and Lowry 2000; Lowry and Alt 2001). In order to account for these potential alternative explanations, the models reported in Table 2 report the results from error correction models of state credit ratings similar to our initial results in the main body of the paper. However, these models incorporates additional political control variables. The first model includes covariates for both split party control of a state legislature and divided government.[1] The divided government dummy variable is coded zero if the legislature and governor's office are controlled by the same party and one otherwise. The second model includes a variable that indicates the ideology of the state government. [2] This variable is scaled from 0 to 1, with higher values indicating more liberal ideology.

As the results from the models indicate, incorporating additional political covariates does little to alter our primary inferences. The coefficient on Δ gross state product remains negative and significant, while the interaction term remains positive. Again, in order to make our conditional results more easily interpretable, we plot the marginal short-term and long-term effects of gross state product in Figure 1. As in the main body of our paper, economic growth has a negative and significant effect on state credit ratings when a state receive little new federal support (indicated by a small Δ federal intake). The long-term effects of gross state product are never statistically significant regardless of the level of federal dollars received. Thus, even after incorporating economic and political controls into our models, our key inferences stand. Economic growth can have serious negative consequences for state credit ratings, particularly when states receive little in the

[1]These two variables are drawn from Klarner, Phillips and Muckler (2012).

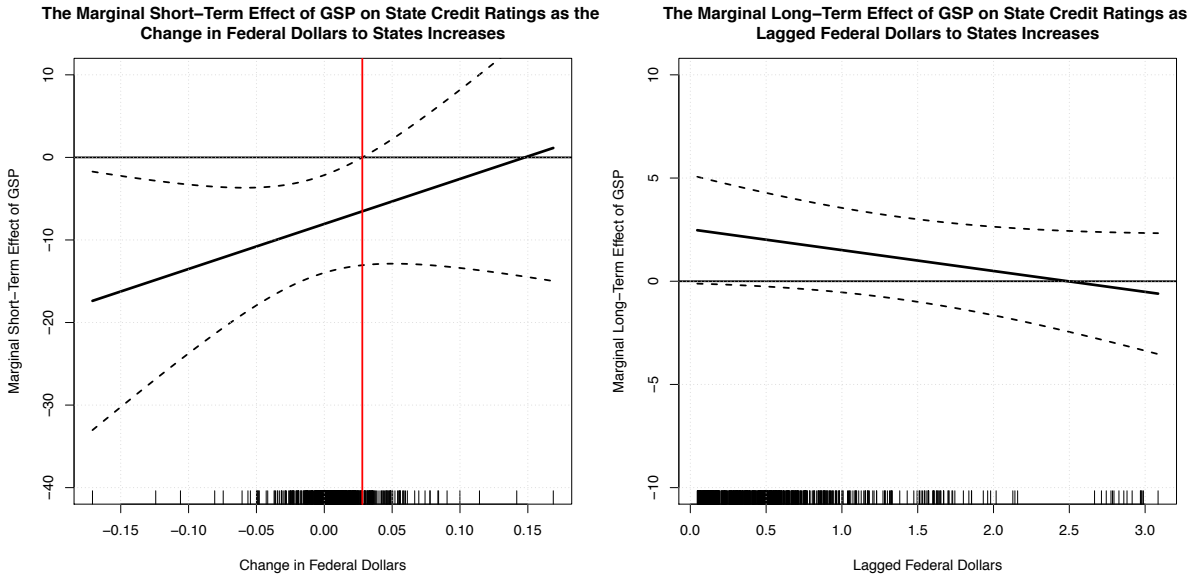
[2]Data drawn from Kelly and Witko (2012).

Table 2: Error Correction Model of State Credit Ratings Incorporating Controls for Government Control (1990-2006)

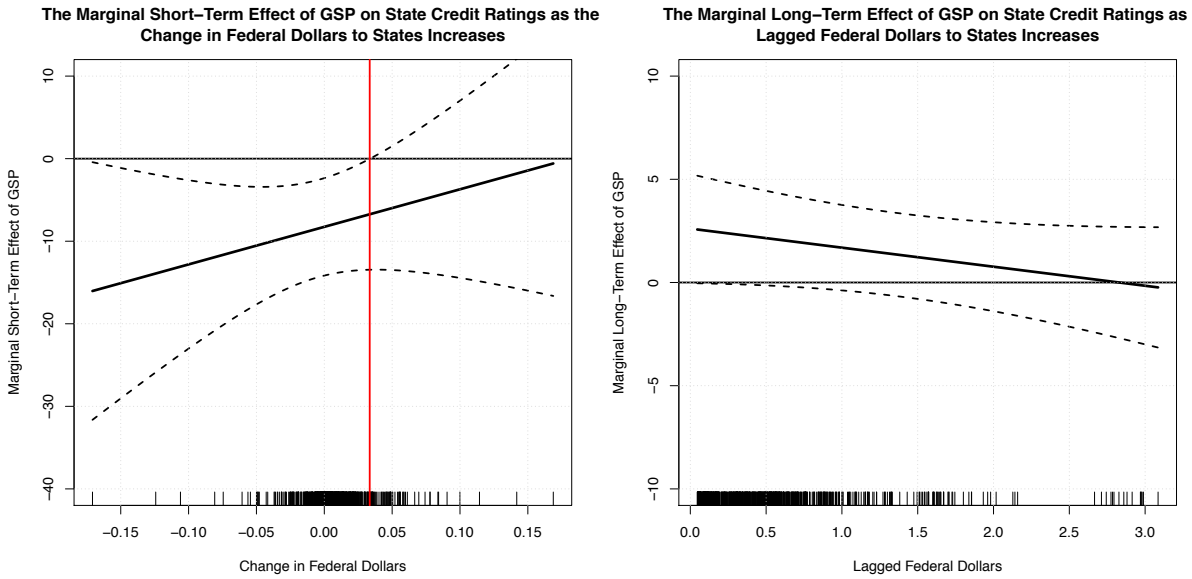
Variable Name	Divided Government	Left Government
State Credit Rating$_{t-1}$	-0.437 *	-0.440 *
	(0.035)	(0.036)
Short-Run Effects		
Δ *Gross State Product*	-8.060 *	-8.260 *
	(3.019)	(3.011)
Δ *Federal Intake*	-3.495	-3.120
	(1.855)	(1.840)
Δ *GSP X* Δ *Federal Intake*	54.538	45.490
	(44.318)	(44.130)
Δ*State Population*	1.338	1.690
	(1.157)	(1.163)
Δ*Unemployment*	-9.123	-8.241
	(4.697)	(4.722)
Δ*Total Debt as % of GSP*	-0.054	-0.050
	(0.045)	(0.045)
Δ *Split Legislature*	-0.130	
	(0.115)	
Δ *Divided Government*	-0.051	
	(0.101)	
Δ *Left Government*		-0.144
		(0.236)
Long-Run Effects		
Gross State Product$_{t-1}$	2.518	2.610
	(1.339)	(1.348)
Federal Intake$_{t-1}$	1.948 *	1.823 *
	(0.812)	(0.811)
GSP$_{t-1}$ *X Federal Intake*$_{t-1}$	-1.011	-0.922
	(0.637)	(0.630)
State Population$_{t-1}$	-0.210	-0.227
	(0.186)	(0.187)
Unemployment$_{t-1}$	-3.526	-2.833
	(3.448)	(3.446)
Total Debt as % of GSP$_{t-1}$	0.016	0.028
	(0.029)	(0.029)
Split Legislature$_{t-1}$	0.065	
	(0.115)	
Divided Government$_{t-1}$	-0.161	
	(0.097)	
Left Government$_{t-1}$		-0.192
		(0.213)
Intercept	3.160 *	2.920 *
	(0.478)	(0.473)
N	568	568
Adj. R^2	0.236	0.231
$F-$test Unit Dummies	2.082 *	2.084 *
$F-$test Time Dummies	0.763	0.744
χ^2 statistic for Unit Dummies	93.514 *	137.190 *

Note: Cell entries report coefficient values from OLS models predicting state credit ratings from S&P's Credit Rating Agency from 1990-2006. Standard errors are reported in parentheses. We include dummy variables (i.e. "fixed effects") for states in the model. The reported $F-$statistics for unit dummies indicate the superiority of the model including dummy variables to a fully pooled model. The reported F-statistic for the inclusion of time dummies indicates that these dummies are unnecessary in the model. Thus, they are excluded. The reported χ^2 statistic indicates the superiority of the dummy variables model to an error decomposition approach ("random effects"). $*$ indicates a p-value < 0.05.

way of new support from the federal government.



(a) Divided Government



(b) Left Government

Figure 1: The Short-Term and Long-Term Marginal Effects of State Economic Growth on a State's Credit Rating as Growth in Federal Financial Support to that State Changes. Dotted Lines are 95% Confidence Intervals.

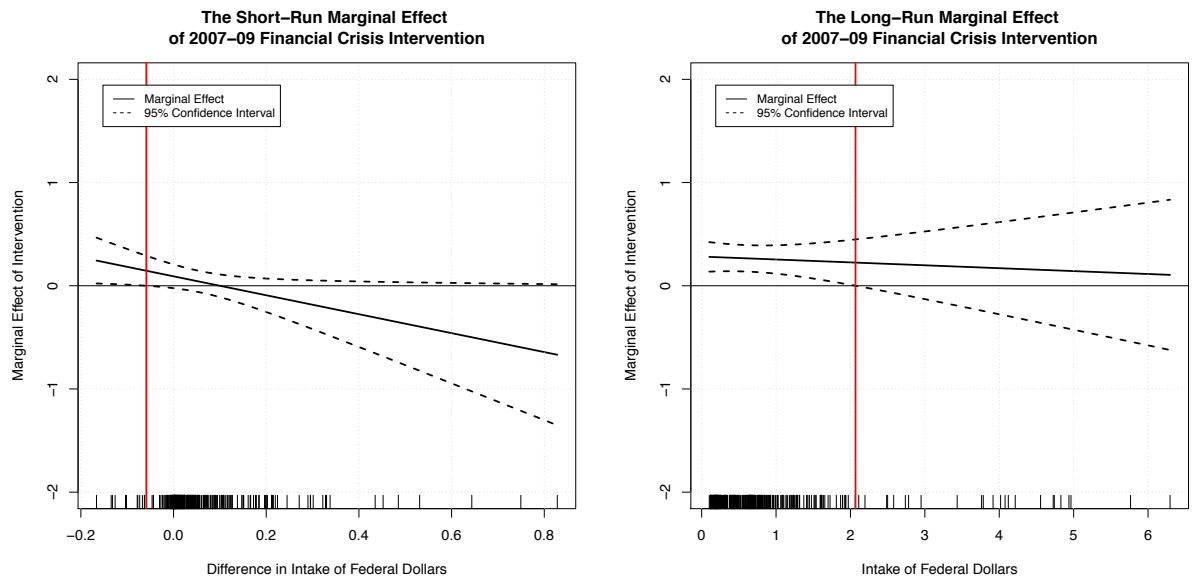


Figure 2: The Short-Term and Long-Term Marginal Effect of the 2007-2009 Financial Crisis on State Credit Ratings (2004 - 2012). Dotted Lines are 95% Confidence Intervals.

Appendix C - Intervention Analysis Robustness

Our intervention analysis assumes that the exogenous shock on states' creditworthiness is captured in the years of 2008 and 2009. However, the financial crisis began to unravel in 2007.[3] Theoretically, we expect that although the crisis may have began towards the end of 2007, the effects would mostly be observed in state GSP in 2008 and 2009. To ensure that our results are robust to our coding decisions, we reanalyze the intervention analysis with the financial crisis coded as 2007, 2008, and 2009. As shown in Table 3 and Figure 2, the robustness results are consistent with the intervention analysis in the main manuscript. While the positive short-term effects of the crisis cover a narrower range of federal financial support, the long-term positive effects of the crisis occur across a wider range of the intake of federal dollars. Thus, we again find support for the notion that the crisis increased the credit ratings of states receiving the lowest levels of support from the federal government.

[3]Federal Reserve Bank of St. Louis, "Financial Crisis Timeline," http://timeline.stlouisfed.org/index.cfm?p=timeline.

Table 3: Error Correction Model of 2007-2009 Financial Crisis Affect on State Credit Ratings (2004 - 2012)

Variable Name	Intervention
State Credit Rating$_{t-1}$	-0.707*
	(0.055)
Short-Run Effects	
Δ *Financial Crisis*	0.091
	(0.058)
Δ *Federal Intake*	-1.511*
	(0.333)
Δ *Financial Crisis X* Δ *Federal Intake*	-0.917*
	(0.447)
Long-Run Effects	
Financial Crisis$_{t-1}$	0.282*
	(0.076)
Federal Intake$_{t-1}$	0.399
	(0.335)
Financial Crisis$_{t-1}$ *X Federal Intake*$_{t-1}$	-0.028
	(0.064)
Intercept	4.855*
	(0.965)
N	398
Adj. R^2	0.379
$F-$test Unit Dummies	3.691 *

Note: Cell entries report coefficient values from an error correction model predicting state credit ratings from S&P's Credit Rating Agency from 2004 - 2012. Standard errors are reported in parentheses. We include dummy variables (i.e. "fixed effects") for states in the model. The reported $F-$statistics for unit dummies indicate the superiority of the model including dummy variables to a fully pooled model. $*$ indicates a p-value < 0.05.

Appendix D - Intervention Effects Across the States

In the main body of our manuscript, we leverage the 2008 global financial crisis as an exogenous intervention on gross state products. Because our theory suggests that growth in gross state products produces decreases in credit ratings, and the crisis created an unanticipated depression in state economic growth, our theory suggests that many state credit ratings should have actually improved in the wake of the crisis. As our theory suggests, this is precisely what we find, with many states experiencing growth in their credit ratings in 2008 and 2009 in spite of the dramatic decreases in the economic health of their economies.

The value of the crisis as an instrument lies in the fact that the crisis was unexpected, and directly influenced gross state products without influencing federal support to states. This makes the crisis a useful instrument for gross state products and a valuable tool in guarding against endogeneity in our models. However, even though our results suggest that the crisis caused decreases in state economic growth in the aggregate, it remains possible that the crisis had heterogeneous effects on state economies and that this heterogeneity is correlated with credit ratings. In other words, credit ratings may have increased in the states least effected by the crisis. If this were true, it would indicate that credit ratings increased in states where GSPs did not go down in substantial ways, which would be contrary to our theoretical expectations and the inferences that we draw.

To ensure that this is not the case, we begin by subsetting our intervention dataset (2004-2012) by state. We then regress the crisis on gross state product for each state individually, producing 50 different regression coefficients. These coefficients represent the effect of the 2008 crisis in each state. We present the distribution of these coefficients in Figure 3. In the figure, the states whose coefficients are highlighted squares are states whose credit ratings increased in either 2008 or 2009. The effect of the crisis on the gross state product of these states is not noticeably different than the remaining states. In fact, the average effect of the crisis on the gross state product of states whose credit scores increased was -0.0639, while the average effect of the crisis on the gross state product of states whose credit ratings did not increase was -0.0465. This suggests that the crisis had slightly larger economically negative consequences for the states whose credit ratings increased. This of

course matches our expectations that economic depression will result in increased credit ratings perfectly.

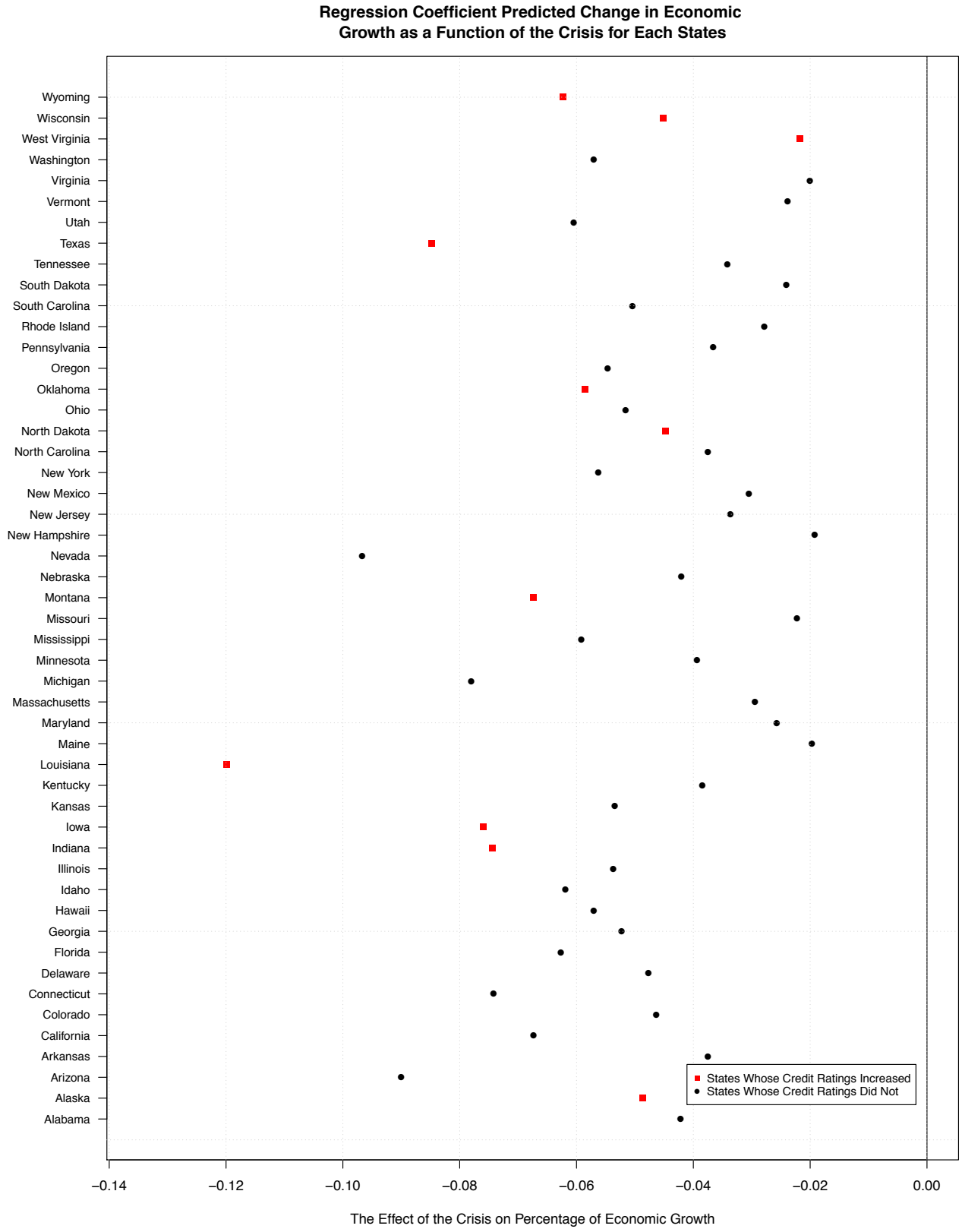


Figure 3: The Distribution of the Effect of the 2008-2009 Financial Crisis on Gross State Products (2004 - 2012).

Appendix E - Traditional Lagged Dependent Variable Models

The models we present throughout our manuscript utilize an error correction specification. We use this technique so that we might estimate the effect of differences in our key covariates controlling for their prior levels. Indeed, throughout our models we find that it is the differences in gross state product, not the levels of gross state product that are related to credit ratings. The error correction specification was developed primarily as a means for dealing with cointegrated series, and while some have suggested that the model is appropriate for stationary series (De Boef and Keele 2008), our time series are not uniformly cointegrated. Thus, it is possible that our models evidence support for our hypothesis because of the structure of the model rather than because of some true relationship (i.e. model dependence).

To demonstrate that this is not true Tables 4 and 5 re-estimate our primary models in a more traditional distributed lag framework. Table 4 predicts U.S. state credit ratings as a function of differenced gross state product, differenced federal intake, and the interaction of these two variables. We estimate two versions of this model: one with a lagged dependent variable and one without. Lagged levels of covariates are not included, and the dependent variable is the level of credit rating rather than differenced credit ratings. In other words, the model follows standard approaches to panel time series (Beck 2001). Table 5 again predicts U.S. credit ratings as a function of the financial crisis intervention (our instrument for economic shrinkage), differenced federal intake, and their interaction terms.

As the tables clearly show, the effects that we find in the main body of our paper hold up under these simpler modeling choices. The effects of economic growth are negative and significant and the interaction term is positive, mirroring our error correction model results. Additionally, the effects of the financial crisis intervention are positive and significant and the interaction of the crisis and federal dollars is negative, again mirroring our main results. Thus, our key inferences are not dependent on our use of error correction models and are robust across a wide array of model specifications.

Table 4: OLS Model of State Credit Ratings (1990-2006)

Variable Name	Without LDV	With LDV
State Credit Rating$_{t-1}$	—	0.591*
	(—)	(0.034)
Δ *Gross State Product*	-8.416*	-7.223 *
	(3.326)	(2.581)
Δ *Federal Intake*	-3.452	-3.344
	(2.242)	(2.582)
Δ *Gross State Product X* Δ *Federal Intake*	43.052	51.585
	(55.562)	(42.237)
Intercept	7.337*	3.051*
	(1.007)	(0.438)
N	605	568
Adj. R^2	0.012	0.344
$F-$test Unit Dummies	16.056*	2.236*

Note: Cell entries report coefficient values from an OLS model predicting state credit ratings from S&P's Credit Rating Agency from 1990 - 2006. Standard errors are reported in parentheses. We include dummy variables (i.e. "fixed effects") for states in the model. The reported $F-$statistics for unit dummies indicate the superiority of the model including dummy variables to a fully pooled model. $*$ indicates a p-value < 0.05.

Table 5: OLS Model of 2008-2009 Financial Crisis Affect on State Credit Ratings (2004 - 2012)

Variable Name	Without LDV	With LDV
State Credit Rating$_{t-1}$	—	0.527*
	(—)	(0.044)
Financial Crisis	0.282*	0.177*
	(0.062)	(0.054)
Δ *Federal Intake*	-0.197	0.072
	(0.303)	(0.175)
Financial Crisis X Δ *Federal Intake*	-1.551*	-2.080*
	(0.481)	(0.412)
Intercept	7.345*	4.817*
	(1.121)	(0.401)
N	398	398
Adj. R^2	0.086	0.276
$F-$test Unit Dummies	37.153*	40.249*

Note: Cell entries report coefficient values from an error correction model predicting state credit ratings from S&P's Credit Rating Agency from 2004 - 2012. Standard errors are reported in parentheses. We include dummy variables (i.e. "fixed effects") for states in the model. The reported $F-$statistics for unit dummies indicate the superiority of the model including dummy variables to a fully pooled model. $*$ indicates a p-value < 0.05.

Appendix F - Are States Procyclic Spenders?

In our theoretical development, we emphasize the role of credit raters' expectations of state government behavior. Because credit raters expect state governments to increase debts during times of economic growth, those same raters view economic growth as potentially harmful for a states ability to repay its debts. This in turn creates a negative relationship between economic growth and credit ratings for many states. Importantly, as we point out in the main body, this action does not necessarily need states to change policies for credit raters to alter their behavior. Because credit raters are anticipating state government activity, they can and do alter ratings in response to economic growth, rather than actual fiscal policy. This particular argument begs the question of whether credit raters are right to expect that states will behave in a procyclic fashion. In our theory development, we point out that an expectation of procyclic behavior by state governments is well supported by extant research. We now offer a simple analysis to demonstrate the rationality of these expectations.

Table 6 reports OLS regression coefficients from a model predicting (1) the ratio of expenditures to gross state product and (2) the ratio of outstanding debts to gross state products for all the states in our sample from 1990-2006. The model contains two independent variables: lagged gross state product and lagged state revenues as a function of GSP. Both models include unit fixed effects. Before discussing the results themselves, note an important measurement based relationship that ought to exist. As a state's gross state product becomes larger, the denominator of the dependent variable in both models is also increasing, thus making the dependent variable smaller. Just based on the construction of the measurement alone, we should observe a negative relationship between lagged GSP and any ratio with GSP as its denominator. However, in both of the models in Table 6, we see that the relationship between lagged GSP and the ratio of debts to GSP and expenditures to GSP are positive, even after controlling for state revenues. That is, state governments increase both their outstanding debts and expenditures by such quantities during times of economic growth that the natural negative relationship that ought to exist in this regression setup flips signs entirely. In other words, during times of economic growth in states, state governments increase both their

Table 6: OLS Model of State Debts and Expenditures (1990-2006)

Variable Name	Outstanding Debt/GSP	Expenditures/GSP
Lagged Gross State Product	1.964*	2.544*
	(0.591)	(0.457)
Lagged Total Revenue/GSP	-0.032	0.111*
	(0.028)	(0.022)
Intercept	7.160	10.851*
	(4.143)	(2.786)
N	800	800
Adj. R^2	0.014	0.072

Note: Cell entries report coefficient values from an OLS model predicting state governments' outstanding debts as a percentage of GSP and expenditures as a percentage of GSP from 1990 - 2006. Standard errors are reported in parentheses. We include dummy variables (i.e. "fixed effects") for states in the model. $*$ indicates a p-value < 0.05.

debts and expenditures significantly more quickly than their economies are actually growing. We take this as rather strong evidence that credit raters are correct to assume that on average stares are procyclic spenders, and thus, raters are right to alter credit ratings as a response to economic growth itself, rather than waiting for fiscal changes to actually occur before changing ratings.

Appendix G - States and Credit Rating Data Coverage

Table 7: States and Credit Rating Data Coverage (1990 - 2012)

State	Beginning Year	End Year
Alabama	1992	2012
Alaska	1994	2012
Arizona	2002	2012
Arkansas	1991	2012
California	1990	2012
Colorado	2001	2012
Connecticut	1990	2012
Delaware	1991	2012
Florida	1990	2012
Georgia	1992	2012
Hawaii	1991	2012
Idaho	2001	2012
Illinois	1993	2012
Indiana	2001	2012
Iowa	2001	2012
Kansas	2001	2012
Kentucky	2001	2012
Louisiana	1993	2012
Maine	1991	2012
Maryland	1990	2012
Massachusetts	1991	2012
Michigan	1995	2012
Minnesota	1991	2012
Mississippi	1991	2012
Missouri	1991	2012
Montana	1993	2012
Nebraska	2001	2012
Nevada	1990	2012
New Hampshire	1991	2012
New Jersey	1991	2012
New Mexico	1993	2012
New York	1990	2012
North Carolina	1993	2012
North Dakota	2001	2012
Ohio	1991	2012
Oklahoma	1993	2012
Oregon	1990	2012
Pennsylvania	1992	2012
Rhode Island	1990	2012
South Carolina	1990	2012
South Dakota	2007	2012
Tennessee	1991	2012
Texas	1990	2012
Utah	1991	2012
Vermont	1991	2012
Virginia	1993	2012
Washington	1990	2012
West Virginia	1996	2012
Wisconsin	1990	2012
Wyoming	2001	2012

Appendix H - Credit Rating Coding Robustness

This section examines the robustness of our results to coding decisions on credit ratings. In the manuscript's analysis, a state's credit in a given year is that state's median credit rating. Here we examine credit ratings that are measured as of the last day of a given year (and thus changes would be measured from December 31 to December 31). The results below replicate our analysis in Table 2 in the manuscript using this alternative credit coding. We note that our results are nearly identical.

Table 8: ECM with Alternative Credit Rating Coding(1990-2006)

Variable Name	
State Credit Rating$_{t-1}$	-0.421*
	(0.035)
Long-Run Effects	
Federal Intake$_{t-1}$	1.375*
	(0.652)
Gross State Product$_{t-1}$	1.697
	(1.178)
GSP$_{t-1}$ *X Federal Intake*$_{t-1}$	-1.079*
	(0.548)
Short-Run Effects	
Δ *Federal Intake*	-2.987
	(1.806)
Δ *Gross State Product*	-7.246*
	(2.799)
Δ *GSP X* Δ *Federal Intake*	39.149
	(42.767)
Intercept	2.245*
	(0.443)
Adj. R^2	0.24
N	568

Note: Cell entries report coefficient values from OLS models predicting state credit ratings from S&P's Credit Rating Agency from 1990-2006. Standard errors are reported in parentheses. We include dummy variables (i.e. "fixed effects") for states in the model. $*$ indicates a p-value < 0.05.

Appendix I - Tax and Expenditure Limitations (TELs)

This section examines whether institutional and policy rules related to fiscal budgets and borrowing affect our inferences. We are confident that our unit-effects estimators account for much of the state heterogeneity regarding different policy rules. This is particularly true given that these rules tend from to vary over time. However, to ensure that our inferences are valid we examine whether tax and expenditure limitations (TELs) affect our results, given that these policy rule do have some variance overtime. We implement a binary coding of TELs, drawing our data from White (2015). Controlling for TELs does not change our main inferences and does not reveal a statistically significant relationship between TELs and credit ratings. This does not mean that the TELs do not matter, but we think that our unit fixed effect estimators largely account for variation already.

Table 9: ECM with TELs(1990-2006)

Variable Name	
State Credit Rating$_{t-1}$	0.566*
	(0.036)
Long-Run Effects	
Federal Intake$_{t-1}$	1.255
	(0.662)
Gross State Product$_{t-1}$	1.741
	(1.209)
GSP$_{t-1}$ *X Federal Intake*$_{t-1}$	-1.116*
	(0.559)
Tax/Expenditure Limits$_{t-1}$	0.035
	(0.226)
Short-Run Effects	
Δ *Federal Intake*	-3.239
	(1.827)
Δ *Gross State Product*	-6.617*
	(2.833)
Δ *GSP X* Δ *Federal Intake*	39.853
	(43.198)
Δ *Tax/Expenditure Limits*	-0.255
	(0.298)
Intercept	2.398*
	(0.453)
R-Squared	0.39
N	568

Note: Cell entries report coefficient values from OLS models predicting state credit ratings from S&P's Credit Rating Agency from 1990-2006. Standard errors are reported in parentheses. We include dummy variables (i.e. "fixed effects") for states in the model. $*$ indicates a p-value < 0.05.

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