Cash Reserves and Short-Term Borrowing Under Liquidity Constraints

Luis Navarro[1]

[1]Indiana University, Bloomington

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Introduction

- **Research Question:** What is the effect of cash reserves on short-term borrowing?
- **Theory:** Economic theory and public finance literature show liquidity constraints play a crucial role in determining the relationship between cash reserves and short-term borrowing (Kling, 2018).
- **Empirical Analysis:** Mexico's fiscal system provides a setting with cash-constrained state governments facing liquidity shocks from timing errors (exogenous variation!) on federal transfers.
- **Findings Preview:** Consistent with a theory of short-term borrowing under liquidity constraints, I document a positive effect of cash reserves on short-term debt.

Theoretical Motivation

Figure: Causal Effect of Cash Reserves on Short-Term Borrowing

Cash Reserves $\longrightarrow$ Short-term Borrowing

Without liquidity constraints

- Cash and debt behave like substitutes.
- Pecking order theory: Organizations prefer internal over external financing. Debt carries interest and opens the door to the scrutiny of third parties (Jensen, 1986; Myers, 1984).
- Implication: finance liquidity gaps with cash reserves.

With liquidity constraints

- Relationship is ambiguous (Empirical question!).
- Cash reserves have an operational and precautionary role (Kling, 2018).
- Governments maintain cash reserves to preserve creditworthiness (Marlowe, 2011) and signal solvency to access financial markets.
- Implication: finance liquidity gaps with short-term debt.

Thought Experiment

1. Your employer gives the schedule of the monthly disbursements of your paycheck.
2. However, your monthly payment depends on the level of sales observed each month.
3. Hence, each month you might observe deviations from your budgeted disbursement.
4. **The catch:** observed sales (and the deviations) neither depend on your decisions nor performance.
5. These deviations are hard to anticipate. For you: arguably, as good as random.
6. Would you finance these gaps with your savings (cash reserves) or with your credit card (short-term debt)?

Quasi-Experimental Setting

Mexican state governments experience a similar setting.

Unconditional Revenues: General Participations Fund

General Participation Fund (FGP) provides 36% of fiscal revenues. The main source of discretionary (not earmarked) revenues.

- FGP = VAT + PIT + Use Taxes + Oil Revenues.
- Distribution across states determined (mainly) by population.
- Within fiscal year schedule/distribution: **Determined by the Federal Government** with no clear rules.
- **States have no influence on the determination of the calendar**.

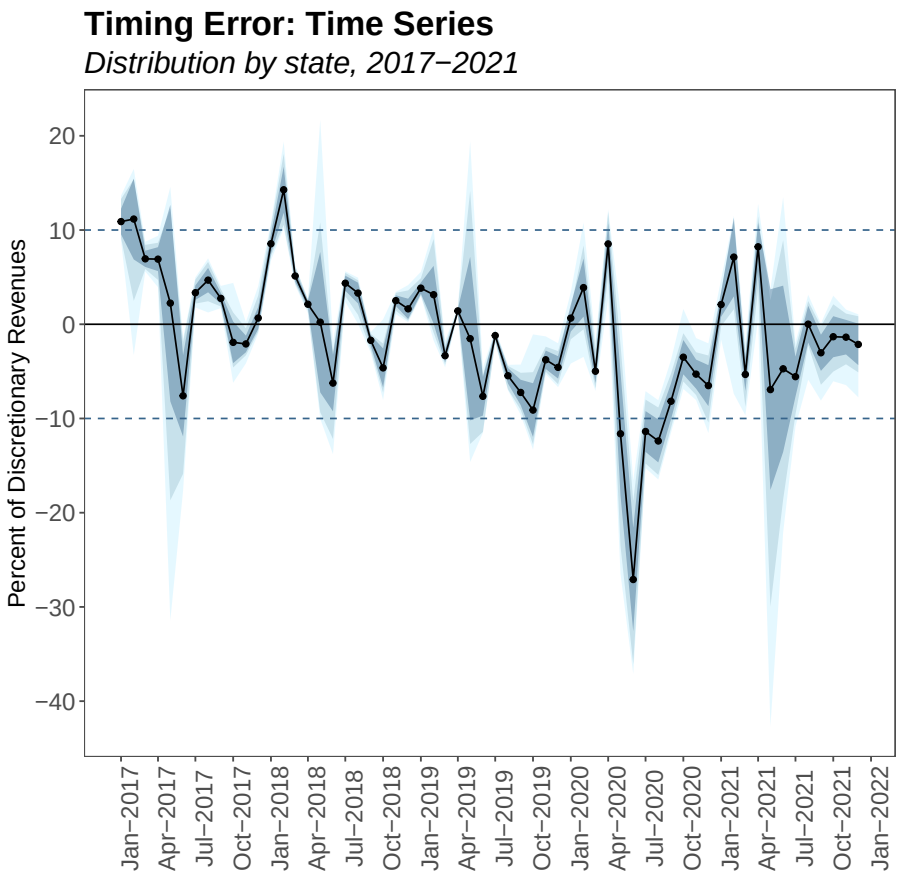
Timing Error: Definition

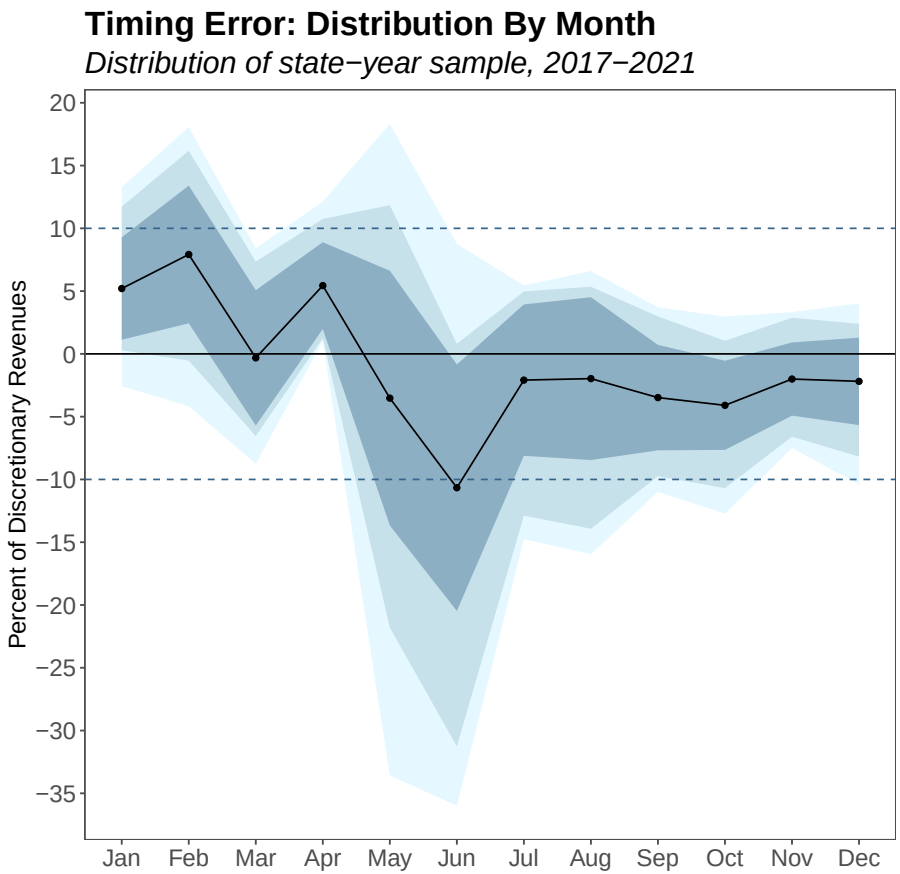
Timing Error

Difference between the budgeted amount and observed transfer. i = state. t = month, within the same fiscal year.

$$TimingError_{it} = FGPPaid_{it} - FGPBudget_{it} \tag{1}$$

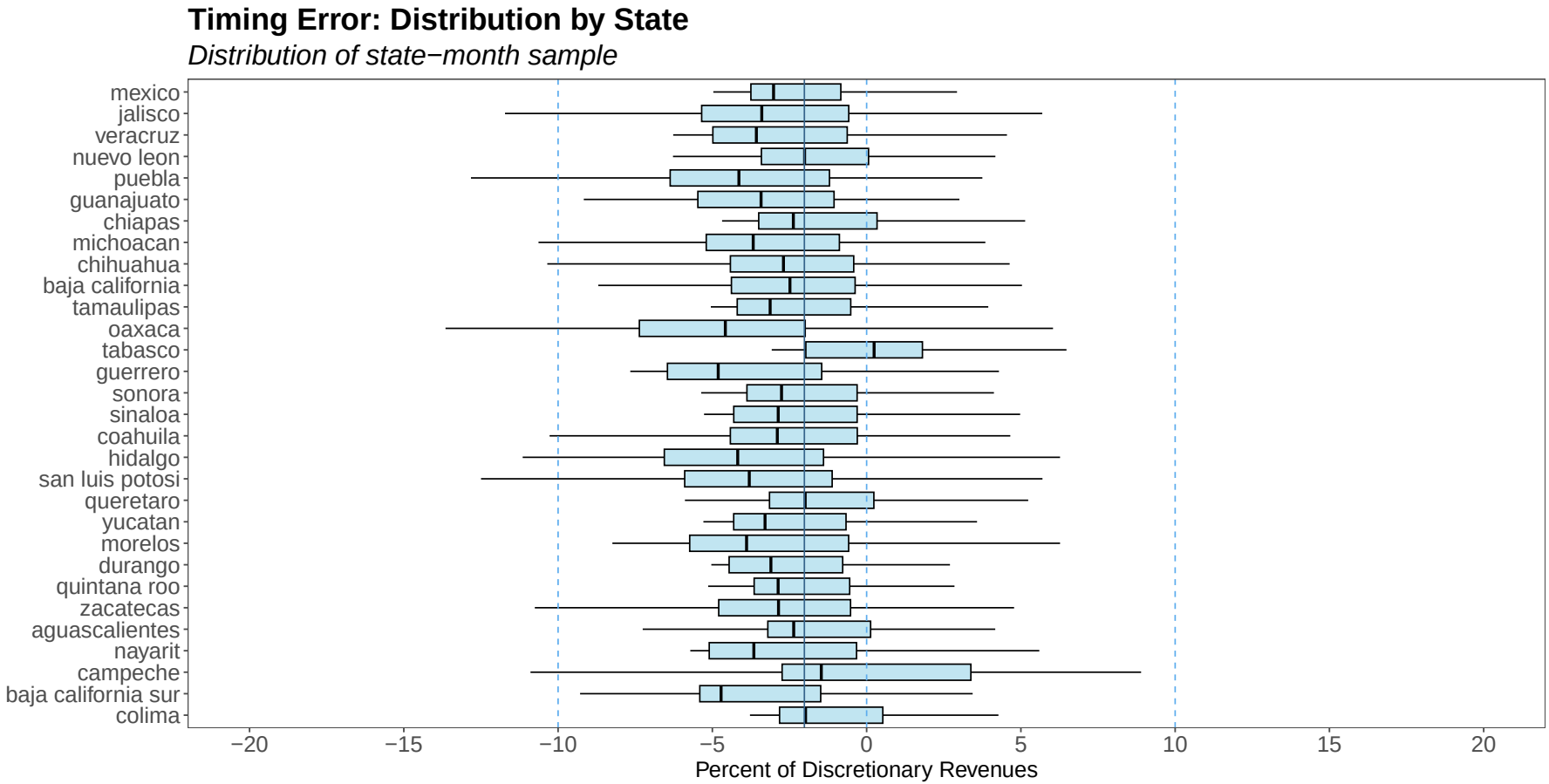
FGP Timing Error: Temporal Variation





Notes: The left panel shows the time series of the timing error, expressed as a percentage of the state's discretionary revenues. The right panel collapses this time series and shows its variation across months. The shaded areas show quantiles of the distribution. Darker blue: mean +/− sd. Medium blue: quantiles 5% and 95%. Light-blue: quantiles 1% to 99% (excluding outliers).

FGP Timing Error: Geographic Variation



Notes: This panel shows the distribution of the timing error by state government, at the state-month sample covering 2018-2022.

Research Design: Instrumental Variable

Econometric Specification

1. First Stage:

$$CashReserves_{it} = \beta TimingError_{it} + X_{it}\alpha + a_i + b_t + \epsilon_{it} \quad (2)$$

2. Reduced Form:

$$ShortTermDebt_{it} = \delta \hat{CashReserves}_{it} + X_{it}\gamma + a_i + b_t + \upsilon_{it} \quad (3)$$

Variables are expressed as a percentage of unconditional revenues (fixed and calculated outside the analysis window).

Identification Assumptions

Assumption (Exclusion Restriction)

1. *Timing errors (liquidity shocks) only influence the decision to issue short-term debt through state's cash reserves.*
2. *Timing errors are uncorrelated with the state's long-term fiscal outlook and current economic conditions.*

Validity

1. Distribution across states is static over time.
2. Temporal differences in observed FGP payments are determined by national tax collection.
3. State governments have no direct influence on the distribution calendar during the fiscal year.
4. **For states, within-fiscal year deviations from budgeted amounts are as good as random.**

Descriptive Statistics

Sample: 30 state governments $\times$ 20 quarter-years (2018-2022)

Table: Descriptive Statistics

	Mean	SD	P25	P50	P75	N
Short-Term Debt (% DR)	0.0690	0.0844	0.0000	0.0330	0.1251	596
Cash Reserves (% DR)	0.3080	0.2119	0.1553	0.2536	0.4157	596
FGP Budget Error (% DR)	-.0057	0.0316	-.0251	-.0051	0.0101	596
End of Year Fiscal Surplus (% DR)	-.1241	0.2463	-.1685	-.0660	0.0011	596
FGP Surplus Lagged (% DR)	-.0235	0.0859	-.0881	-.0109	0.0528	596
Local Revenues (% Total Revenues)	0.1014	0.0455	0.0624	0.0965	0.1219	596
Current Expenditure (% Total Expenditure)	0.7374	0.0600	0.7121	0.7518	0.7775	596
Credit Rating	2.0906	0.6922	2.0000	2.0000	3.0000	596

Notes: This panel shows the descriptive statistics of the main variables used for the analysis. The first two columns show the sample mean and standard deviation. P25, P50 and P75 show the 25, 50 and 75 percentiles, respectively. Credit rating is coded such that a higher number is associated with a higher credit rating. Considering the distribution of ratings I grouped them in 3 categories AAA,AA = 1, A = 2, and BBB,BB,NR = 3. Short-Term borrowing, cash reserves, FGP budget error, and fiscal balance measures are expressed as a percentage of the average discretionary revenues (DR) observed between 2009 and 2016. That is, outside the analysis period to avoid endogeneity concerns. All these fiscal variables correspond to one-year lagged measures.

Main Results

Table: Effect of Cash Reserves on Short Term Debt Issuance

	(1)	(2)	(3)	(4)
Panel A: OLS Estimates				
Cash Reserves (% DR) $\hat{\delta}$	–0.1464***	–0.0766*	0.0657*	0.0757*
	(0.0285)	(0.0386)	(0.0361)	(0.0374)
Panel B: 2SLS IV Estimates				
Cash Reserves (% DR) $\hat{\delta}$	0.1904	0.0936	0.2047*	0.2074**
	(0.1502)	(0.0941)	(0.1052)	(0.0982)
First Stage: Budget Error $\hat{\beta}$	1.5273**	2.0203***	1.6578***	1.6357***
	(0.5613)	(0.5678)	(0.4193)	(0.4221)
Cragg-Donald F statistic	7.4055	12.6596	15.6315	15.0154
Mean of Dep Var	0.0690	0.0690	0.0690	0.0690
Observations	596	596	596	596
Controls	No	Yes	No	Yes
State FE	No	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes

Notes: Panel A shows the results of the linear regression model across several specifications. Panel B displays the results of the 2SLS regression where the budget error instruments cash reserves. All the dependent, independent, and instrumental variables are expressed as a percentage of each state's average discretionary revenues (DR) from 2009-2016. Time FE = Quarter-Year FE. Standard errors clustered by state. Significance level: *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Empirical Model: Summary

I found a positive relationship between cash reserves and short-term borrowing.

Main Results

- Increasing cash holdings by the equivalent of one percent of discretionary revenues leads to an increase in short-term borrowing equivalent to 0.20 percentage points of discretionary revenues.
- For the average government in the sample, short-term borrowing is equivalent to 6.90% of discretionary revenues, hence implying the effect will place this ratio in 7.10%

- Endogeneity bias attenuates results from OLS.

- OLS is sensitive to econometric specification. IV estimates are robust to this.

Robustness Checks

- **Econometric Specification:** results are robust to exclude inactive governments and different sets of covariates.
- **Checks:** i) heterogeneity by credit rating; ii) short-term borrowing costs as the dependent variable.
- **Preview:** i) Results are larger for lower-rated governments.; ii) Cash reserves induce lower borrowing costs for short-term debt.

Conclusions

- This paper examines the role of cash reserves on short-term borrowing.
- Theory suggests that liquidity constraints shape the complementarity between cash reserves and short-term borrowing.
- Contrasting previous results on American governments, I found evidence of a positive effect of cash reserves on short-term debt liabilities.
- Altogether, these results suggest additional cash holdings make states more attractive to lenders. Increases in short-term borrowing are larger for states with lower credit quality.

Contact

Thanks for your attention!

Contact: Luis Navarro lunavarr@iu.edu

Appendix: Theoretical Model

Theoretical Model: Two Period Model

Variables

1. **Agent:** subnational government.
2. **Decisions:** provision of public goods G and short-term debt D.
3. **Exogenous:** Tax revenues T, and cash reserves (endowment) S.

Dynamics and Budget Constraints

1. Gov chooses G_1 and short-term debt D, given T_1 and S.

$$T_1 + S + D = G_1 \tag{4}$$

2. Gov chooses G_2, given T_2. Pays back $R(D)$ (i.e. gross debt liability function, strictly convex: $R_d > 0, R_{dd} > 0$)

$$T_2 = G_2 + R(D) \tag{5}$$

Welfare Function

$$W(G, T) = G - \gamma C(T) \tag{6}$$

$C()$ is a strictly convex excess burden (DWL) function. $(C'(T) > 0, C''(T) > 0)$ γ is the marginal cost of public funds (Belsey, 2007)

Theoretical Model: Baseline Equilibrium

Social Planner Problem: max $W_1 + \beta W_2$

$$\max_{G_1, G_2, D} \quad G_1 - \gamma C(G_1 - D - S) + \beta \Big[G_2 - \gamma C(G_2 + R(D)) \Big] \tag{7}$$

Optimality (Euler) Condition

$$\frac{\partial W}{\partial D} = C_1' - \beta C_2' R_d = 0 \tag{8}$$

Relationship of Interest

Assuming smooth provision of G (i.e. $dG_1 = dG_2 = 0$), total differentiation of Equation 8 yields:

$$\frac{dD}{dS} = -\frac{C_1''}{C_1'' + \beta(C_2' R_{dd} + C_2'' R_d))} < 0 \tag{9}$$

Intuition: Convexity of C implies cash reserves and short-term debt act like substitutes.

Theoretical Model: Liquidity Constraints

Assumption (Risk Averse Investors)

Let the gross liability function $R(D, S)$ be a continuous and twice differentiable function that is:

1. *increasing function on short-term debt D; $R_d > 0$,*
2. *decreasing in cash reserves S; $R_s < 0$*
3. *convex on both S and D; $R_{dd} > 0$, $R_{ss} > 0$; $R_{ds} \leq 0$*

Relationship of Interest

$$\frac{dD}{dS} = -\frac{C_1'' + \beta\left(C_2' R_{ds} + C_2'' R_d R_s\right)}{C_1'' + \beta\left(C_2' R_{dd} + C_2'' R_d\right)} \tag{10}$$

Given Assumption 2, the sign is now ambiguous. It suffices to note that $\left(C_2'' R_d R_s\right) < 0$ while $C_1'' > 0$.

Theoretical Model: Main Takeaway

Main Result: Cash Reserves under Liquidity Constraints

Cash reserves hold a dual role for short-borrowing (Kling, 2018):

$$\underbrace{C_1''}_{\text{Change in Excess Burden}} + \underbrace{\beta C_2' R_{DS}}_{\substack{\text{Precautionary Role of Cash} \\ \text{(Substitution Effect)}}} + \underbrace{\beta C_2'' R_D R_S}_{\substack{\text{Operational Role of Cash} \\ \text{(Income Effect)}}}$$

1. **Precautionary Role:** Holding more cash reduces borrowing costs.
2. **Operational Role:** Higher borrowing reduces resources for provision of G_2.

Example

Debt Service Gross Liability Function: $R(D, S) = (1 + r(S))D$

- $R_D = (1 + r(S))$; $R_S = r'(S)D$; $R_{DS} = r'(S)$.
- By Assumption 2 $r'(S) < 0$

$$\underbrace{C_1''}_{\text{Change in Excess Burden}} + \underbrace{\beta C_2' r'(S)}_{\substack{\text{Precautionary Role of Cash} \\ \text{(Substitution Effect)}}} + \underbrace{\beta C_2''(1 + r(S))Dr'(S)}_{\substack{\text{Operational Role of Cash} \\ \text{(Income Effect)}}}$$

Literature Review

- **Pecking Order Theory:** Organizations choose between external (debt) and internal (cash reserves) financing.
  - Organizations prefer internal over external financing. Debt carries interest and opens the door to scrutiny of third parties.

- **Rationales to Accumulate Cash:** precautionary reasons (e.g. rainy day funds); preserve and improve creditworthiness (Marlowe, 2011).

- **Evidence towards cash hoarding:** Governments facing tax limitations, high dependence on IG transfers, few and volatile fiscal revenues, and high levels of current expenditure have less fiscal flexibility to cope with shocks (Hendrick, 2006; Joyce, 2001).
  - No one-size-fits-all policy. Optimal slack depends on the fiscal structure and current expenditures pressures (Marlowe, 2011; Navin and Navin, 1997).
  - Cash reserves hedge against forecasting mistakes (Vasche and Williams, 1987).

Empirical Evidence

Negative relationship between cash reserves and short-term debt (Cash and debt behave like substitutes).

- Su and Hildreth (2018): California cities between 2003 and 2011. Heckman selection model.
- Lofton and Kioko (2021): General-purpose governments in New York State between 1995 and 2016. Linear hurdle model.

Limitations

- With liquidity constraints, effects are downward biased due to endogeneity between cash reserves and short-term debt.
- **Past Literature Limitations:** Two-step research designs (e.g. Heckman-type models) address sampling bias of short-term debt. Yet, they do not solve the potential endogeneity bias.

Appendix: Descriptive Statistics

Setting: Mexican state governments

Empirical Setting

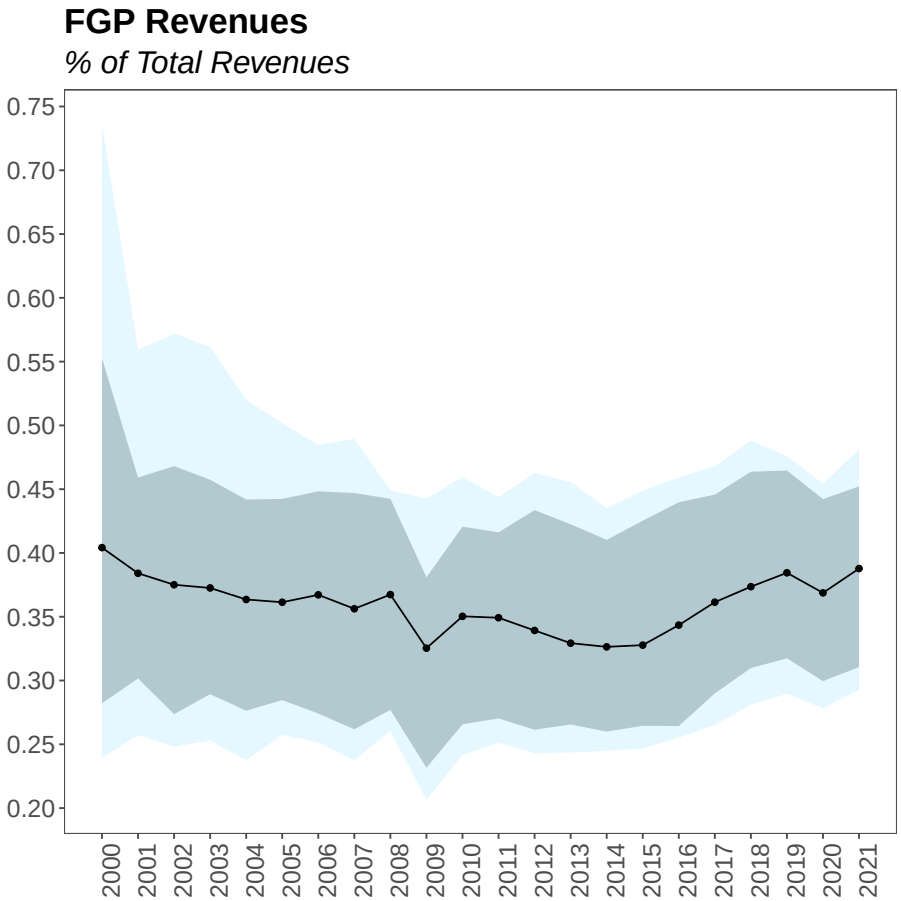
Mexican state governments observe low fiscal flexibility (i.e. government's ability to adjust spending and revenue decisions based on their current financial conditions and available resources) and stringent liquidity constraints.

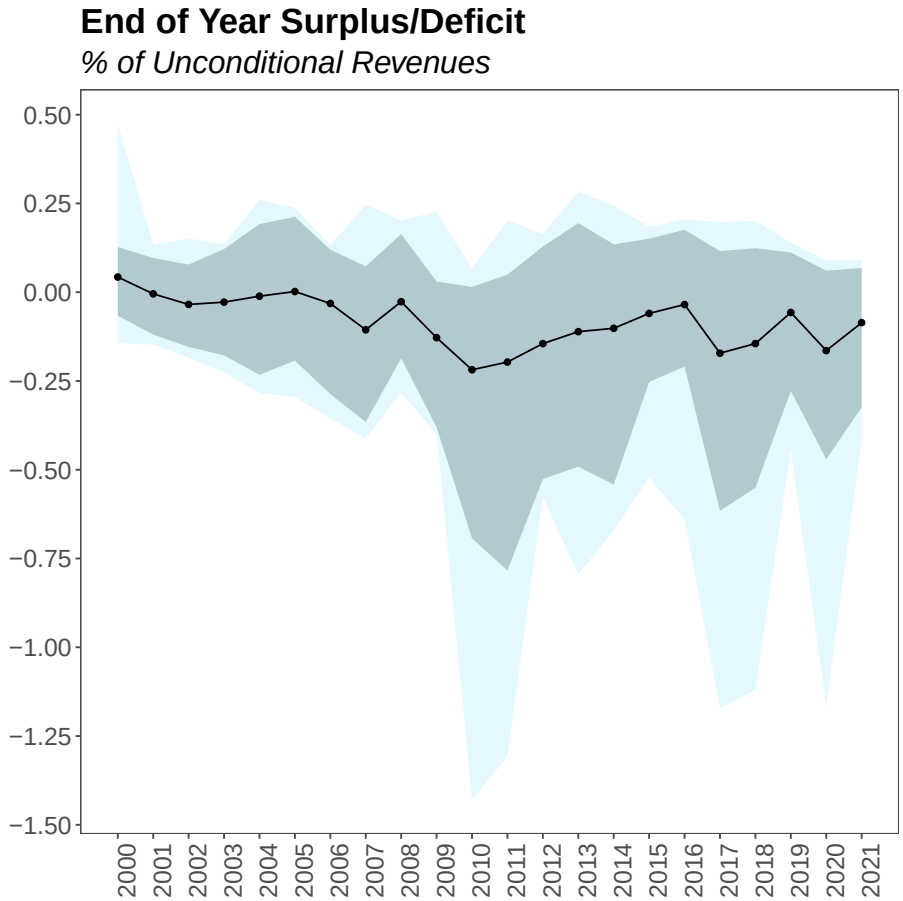
- High reliance on federal transfers (91% of total revenues: 55% earmarked, 36% discretionary)
- Large current expenditures (74% of total expenditures)
- Persistent fiscal deficits.
- Few policy tools to improve local tax collection. No formal rainy day funds.

Data Collection

- **Ministry of Finance (SHCP):** Quarterly financial data on government's cash reserves, debt structure, and outstanding debt. (scraped from Ministry of Finance website.)
  - Data only available after 2017. Comparisons using data before 2016 might be biased due to major fiscal reform.
- **Public Finance Census Data:** historical data of revenues and expenditures.
- **Credit Ratings:** Fitch Ratings issuer rating (web scraped from Fitch's website).
- **Excluded states:** Tlaxcala (no public debt policy) and Mexico City (like DC, subject to different fiscal rules)
- **Final Sample:** strongly balanced panel of 30 states across quarters between 2018 and 2022.

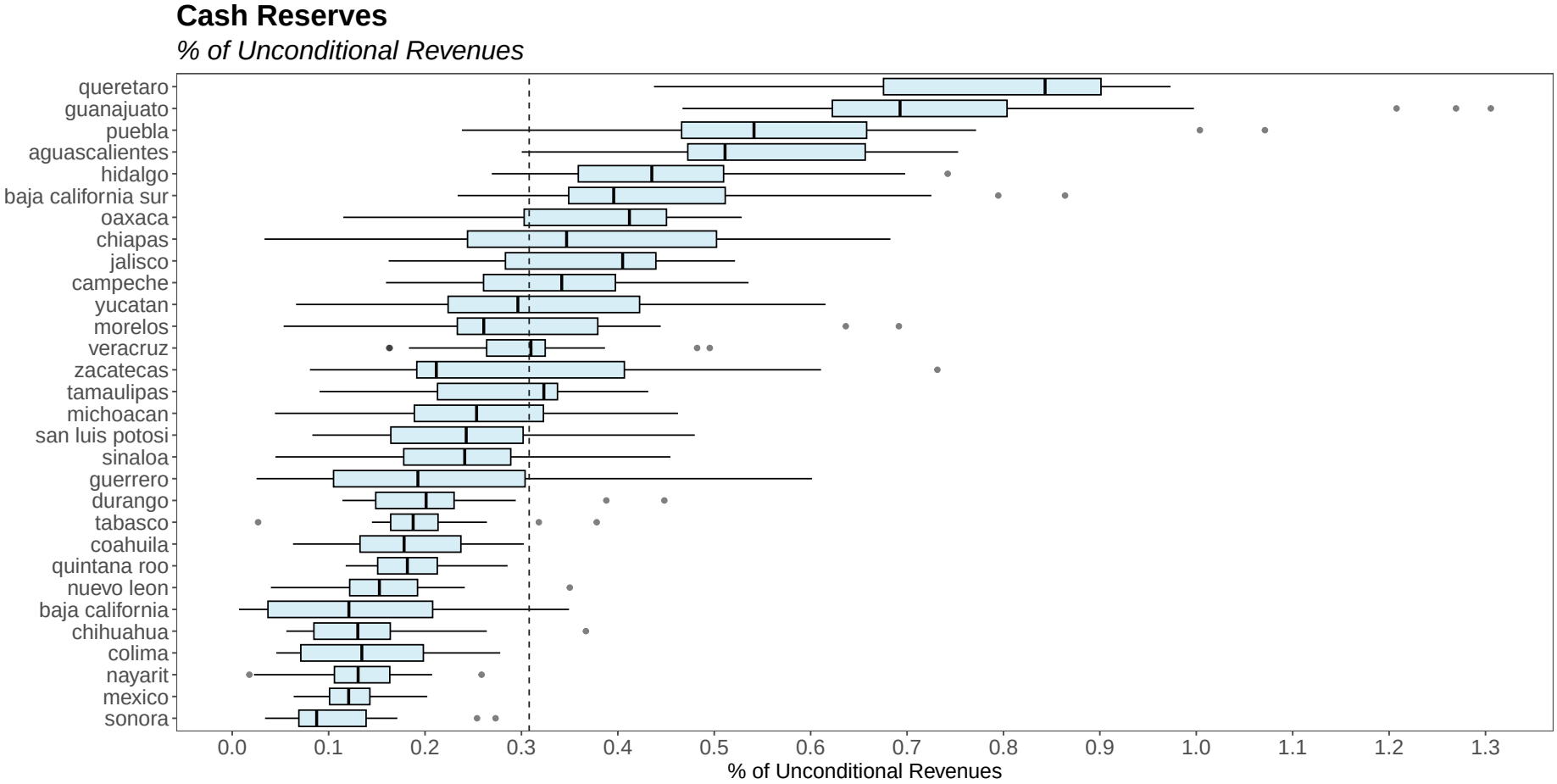
State Governments Exposure to FGP Liquidity Shocks





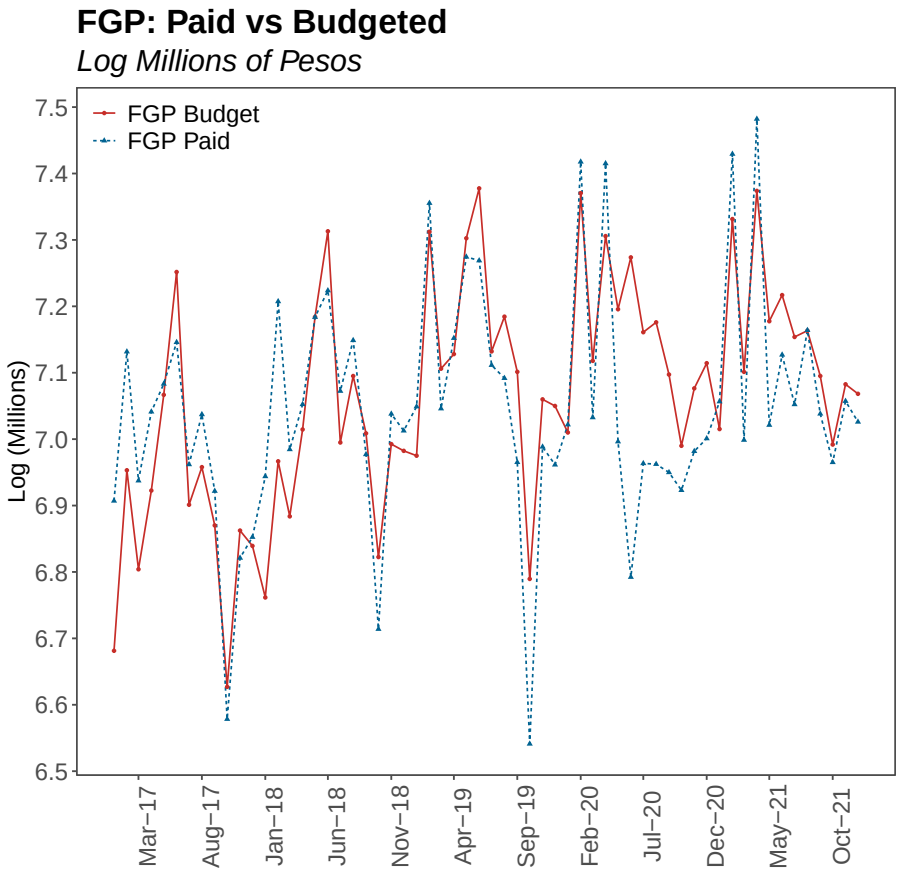
Notes: The graph on the left shows the percentage of FGP revenues with respect to total fiscal revenues for all states across time. The solid black line represents the average in the sample. Dark-shaded area covers show quantiles between 5% and 95%, while light-shaded area quantiles 1% to 99% (excluding outliers). End-of-year balance defined as the difference between total revenues (earmarked transfers + unconditional transfers + own source revenues) and total expenditures (payroll + operating expenses + IG transfers + capital outlays + debt service). In average, 36% of fiscal revenues come from the General Participation Fund. At the same time, the average government experiences a deficit equivalent to 8% of their unconditional revenues in a given fiscal year.

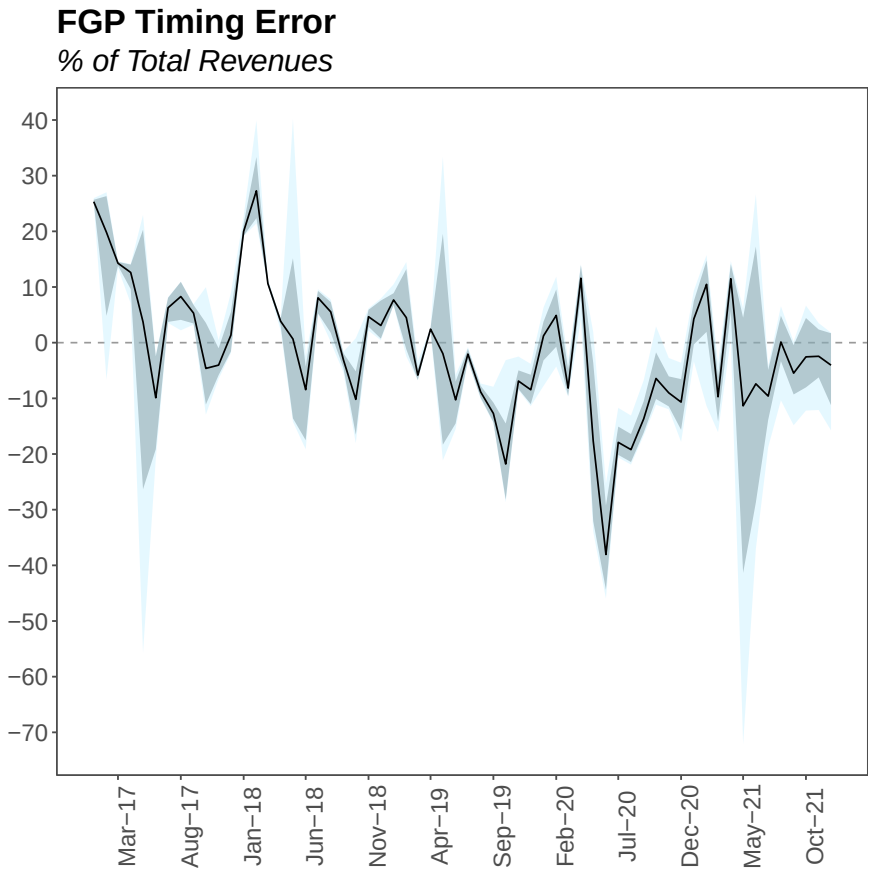
Figure: Budget Error and Cash Reserves by State Government (2018-2022)



Notes: This panel shows the distribution of cash reserves by state governments. The Gray dashed line depicts the average reserves observed in the sample.

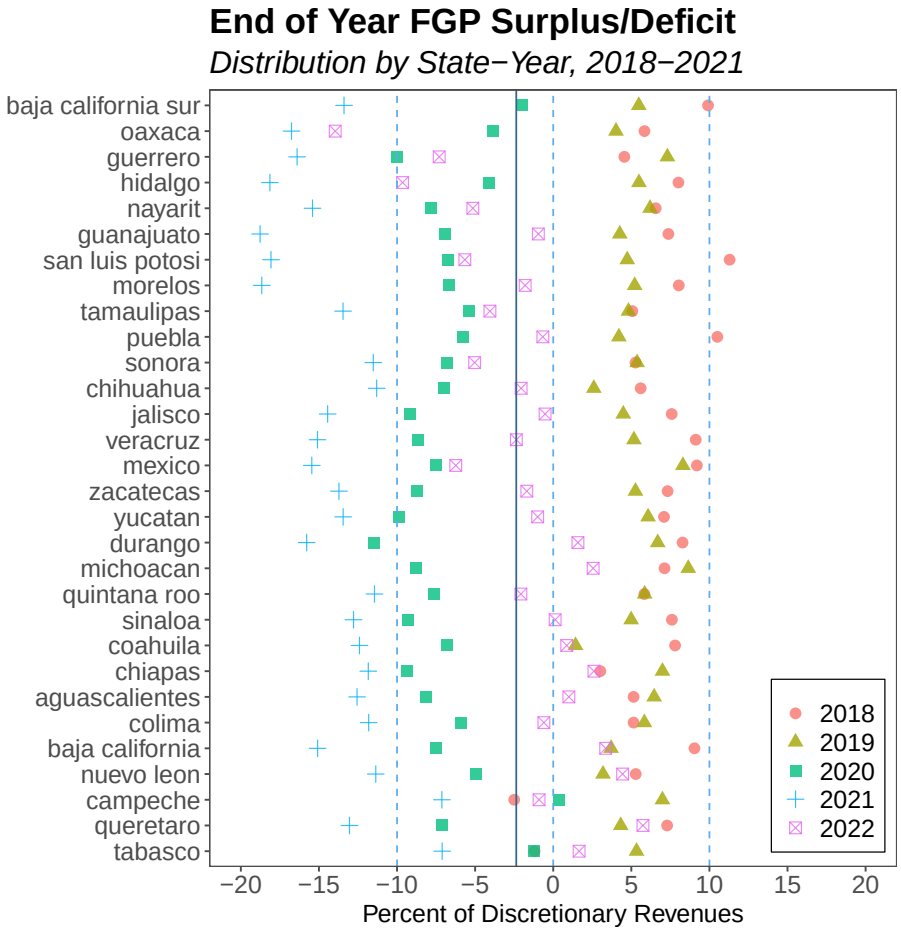
Timing Errors in the General Participations Fund

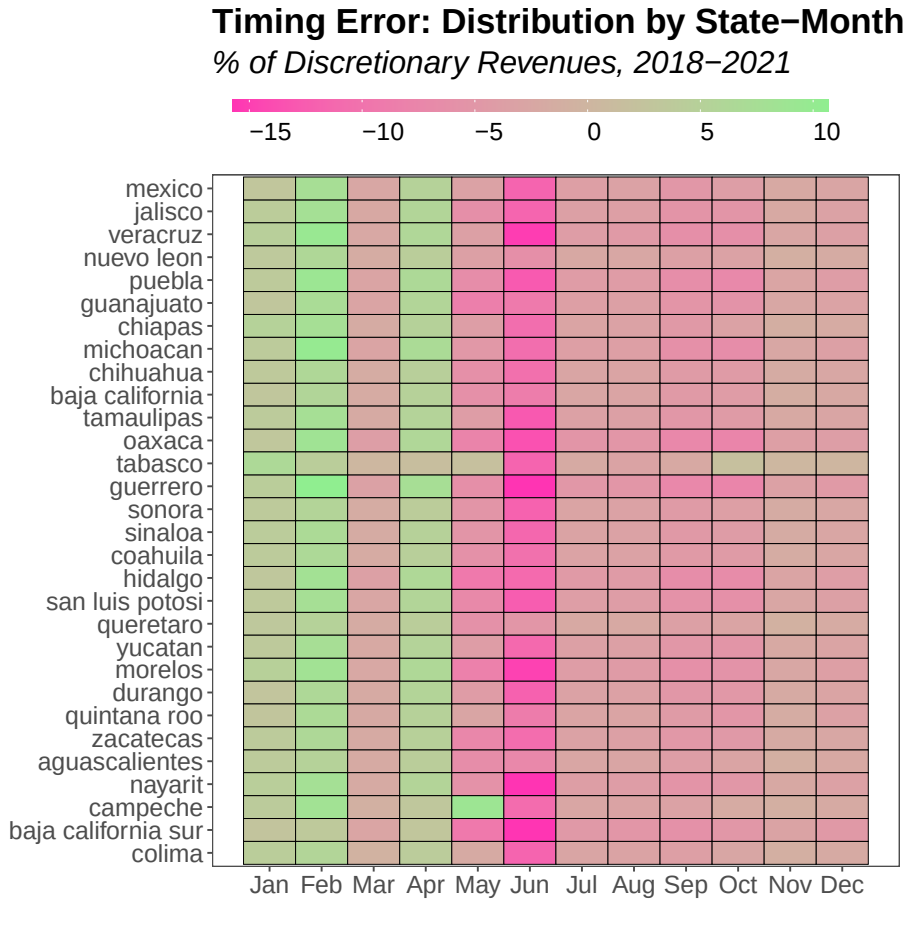




Notes: The Left panel shows the difference between paid and budgeted FGP allocations. The right panel depicts this difference in terms of unconditional revenues. The dark-shaded area shows quantiles between 5% and 95%, while light-shaded area quantiles 1% to 99% (excluding outliers).

General Fund of Participations: Distribution, Dependence and Timing Errors





Notes: The left panel displays the end-of-year cumulative difference between FGP paid and budgeted across states, by different fiscal years. The right panel shows the average monthly timing error for each state and month. Red tones imply a negative deviation (*paid* $<$ *budget*) while green tones are positive ones (*paid* $>$ *budget*). While there is mild seasonality on the error, variation across states seems to be random.

Descriptive Statistics by Credit Rating

Table: Descriptive Statistics by Credit Rating Group

	(1)	(2)	(3)
	AAA,AA	A	BBB,BB,NR
Short-Term Debt (% DR)	0.0112	0.0704	0.1065
Cash Reserves (% DR)	0.4644	0.2677	0.2585
FGP Budget Error (% DR)	-.0105	-.0040	-.0056
Net Operating Balance (% DR)	-.0072	-.0660	-.0853
% FGP Securing LT debt	0.5184	0.5084	0.5918
Long Term Debt (% DR)	0.4492	0.7925	1.3769
Current Expenditure (% Total Expenditure)	0.7579	0.7365	0.7276
Discretionary Revenue (% Total Revenue)	0.5209	0.4519	0.4850
Observations	121	325	180

Notes: This panel show the descriptive statistics of the main variables used for the analysis by credit rating group. The first two columns show the sample mean and standard deviation. P25, P50 and P75 show the 25, 50 and 75 percentiles, respectively. Short-Term borrowing, cash reserves, FGP budget error, and Net Operating Balance are expressed as a percentage of the average discretionary revenues (DR) observed between 2009 and 2016. That is, outside the analysis period to avoid endogeneity concerns. Net operating balance, current expenditures, and discretionary revenues correspond to one year lagged measures.

Appendix: Robustness Checks

Main Results: Borrowing Costs

Table: Effect of Cash Reserves on Borrowing Costs (Only Short-Term)

	(1)	(2)	(3)	(4)
Panel A: OLS Estimates				
Cash Reserves (% DR) $\hat{\delta}$	–0.0261	–0.0299	–0.0899**	–0.0537***
	(0.0174)	(0.0224)	(0.0386)	(0.0156)
Panel B: 2SLS IV Estimates				
Cash Reserves (% DR) $\hat{\delta}$	–0.3138	–0.2164*	–1.7221	–0.4603
	(0.2359)	(0.1235)	(22.4606)	(1.1026)
Cragg-Donald F stat	2.4625	7.2082	0.0054	0.1457
Mean of Dep Var	0.0738	0.0738	0.0739	0.0739
Observations	139	139	138	138
Controls	No	Yes	No	Yes
State FE	No	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
$budget_error$	–0.8891	–1.5158***	–0.0477	–0.2443
	(0.5666)	(0.5646)	(0.6465)	(0.6370)

Notes: Panel A shows the results of the linear regression model across several specifications. Panel B displays the results of the 2SLS regression where the budget error instruments cash reserves. All the dependent, independent, and instrumental variables are expressed as a percentage of each state's average discretionary revenues (DR) from 2009-2016. Time FE = Year FE. Standard errors clustered by state. Significance level: *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Main Results: Heterogeneity by Credit Quality

Table: Effect of Cash Reserves on Short Term Debt Issuance

	(1)	(2)	(3)	(4)
Panel A: OLS Estimates				
AAA,AA	–0.0021	–0.0261	0.0153	0.0101
	(0.0159)	(0.0187)	(0.0190)	(0.0152)
A	–0.1670**	–0.1059	0.0784	0.1080*
	(0.0700)	(0.0742)	(0.0750)	(0.0596)
BBB,BB,NR	–0.1764***	–0.1553***	0.1072*	0.1566**
	(0.0228)	(0.0380)	(0.0534)	(0.0658)
Panel B: IV Estimates				
AAA,AA	0.0108	0.0004	0.2133***	0.2898***
	(0.0232)	(0.0116)	(0.0519)	(0.0828)
A	0.0020	0.0893	0.1073	0.1304
	(0.1879)	(0.1653)	(0.1244)	(0.0826)
BBB,BB,NR	0.3171	0.1836	3.3030	2.3001
	(0.4508)	(0.3322)	(7.9612)	(2.2128)
Cragg-Donald F stat: AAA,AA	3.1225	3.1282	38.2809	25.3695
Cragg-Donald F stat: A	4.3431	4.7550	6.2652	6.0910
Cragg-Donald F stat: BBB,BB,NR	1.9234	2.7849	0.1820	1.0942
Controls	No	Yes	No	Yes
State FE	No	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes

Notes: Panel A shows the results of the linear regression model across several specifications. Panel B displays the results of the 2SLS regression where the budget error instruments cash reserves. All the dependent, independent, and instrumental variables are expressed as a percentage of each state's average discretionary revenues (DR) from 2009-2016. Time FE = Quarter-Year FE. Standard errors clustered by state. Significance level: *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Robustness Checks

- **Only issuing governments:** results hold. Estimates suggest a slightly smaller. Coefficient estimates point towards an increase of 0.17 percentage points. Stronger fist stage.

- **Heckman Selection Model**: using timing error as an instrument, the model yields null result. Results underline the sensitivity of econometric specification.

Robustness Checks - Only Active Governments

Table: Effect of Cash Reserves on Short Term Debt Issuance

	(1)	(2)	(3)	(4)
Panel A: OLS Estimates				
AAA,AA	–0.0021	–0.0261	0.0153	0.0101
	(0.0159)	(0.0187)	(0.0190)	(0.0152)
A	–0.1670**	–0.1059	0.0784	0.1080*
	(0.0700)	(0.0742)	(0.0750)	(0.0596)
BBB,BB,NR	–0.1764***	–0.1553***	0.1072*	0.1566**
	(0.0228)	(0.0380)	(0.0534)	(0.0658)
Panel B: IV Estimates				
AAA,AA	0.0108	0.0004	0.2133***	0.2898***
	(0.0232)	(0.0116)	(0.0519)	(0.0828)
A	0.0020	0.0893	0.1073	0.1304
	(0.1879)	(0.1653)	(0.1244)	(0.0826)
BBB,BB,NR	0.3171	0.1836	3.3030	2.3001
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Controls	No	Yes	No	Yes
State FE	No	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes

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Robustness Check - Heckman Model

Table: Heckman Selection Model: Short Term Borrowing and Cash Reserves

	(1)	(2)	(3)	(4)
Panel A: Second Stage (Outcome Model)				
Cash Reserves (% DR)	–0.1690***	–0.1042*	0.0152	0.0385
	(0.0529)	(0.0570)	(0.0549)	(0.1278)
Panel B: First Stage (Selection Model)				
Budget Error (% DR)	–2.6477	–2.6477	–2.6477	–2.6477
	(2.6885)	(2.6885)	(2.6885)	(2.6885)
Mean of Dep Var	0.0687	0.0687	0.0687	0.0687
Observations	599	599	599	599
Controls	No	Yes	No	Yes
State FE	No	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes

Notes: Panel A shows the results from the second stage regression. Panel B shows displays the results of the instrument used for the selection model. Estimation is done using Heckman's (1979) two-step efficient estimates of parameters and standard errors. Results in Column (2) replicate the econometric specification at (Su and Hildreth, 2018). All the dependent, independent, and instrumental variables are expressed as a percentage of each state's average discretionary revenues (DR) from 2009-2016. Standard errors clustered by state. Significance level: *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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