Hidden Debt Revelations

Sebastian Horn (World Bank) David Mihalyi (World Bank, Kiel)

Philipp Nickol (UDE, Kiel) César Sosa-Padilla (Notre Dame, NBER)

How reliable are public debt statistics?

- Public debt is a cornerstone of macro analysis
- Growing recognition that debt statistics are plagued by major limitations ("hidden debt"), but little academic work

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Can we quantify the underreporting problem?

- **Key idea:** When previously unreported debt gets disclosed, past debt statistics need to be revised.
- We track data revisions across all past editions of the World Bank's debt statistics to quantify the extent, characteristics and timing of hidden debt and its revelation.

Our paper

Empirics: Novel dataset of the full history of World Bank debt reports

- Debt statistics are systematically underreported
- Hidden debt builds up in good times and is revealed in bad times
- Hidden debt is associated with high creditor losses ("haircuts") during defaults

Theory: Model of sovereign debt & default with hidden debt revelations

- Higher default incentives and lower debt-carrying capacity,
- higher borrowing costs,
- significant welfare losses

Mozambique's Hidden Debt Scandal

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MARKETS

IMF Calls for Audit of Mozambique's Undisclosed Debt

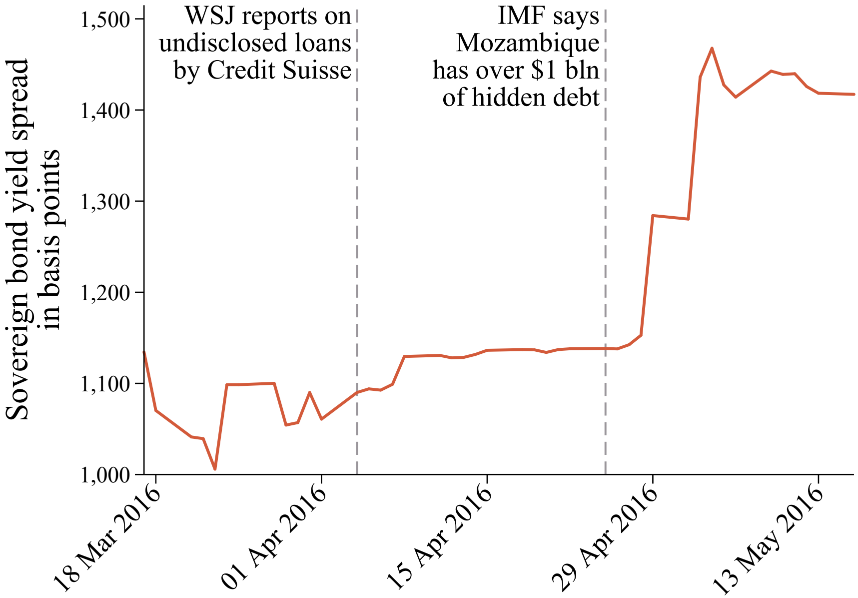
Global Economy ✓ Added

Hidden loans leave once-promising Mozambique with heavy costs

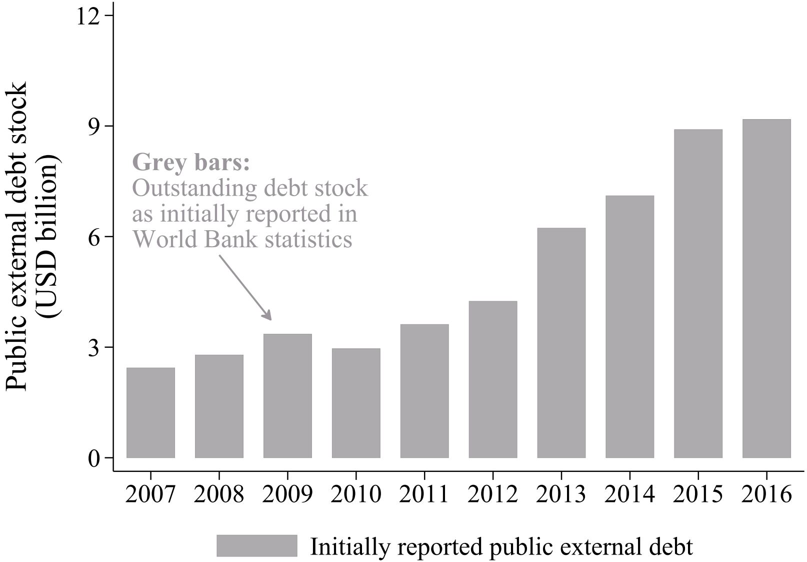
IMF suspends financial aid as analysts see worst national crisis since civil war 20 years ago

Source: Wall Street Journal and FT (2016)

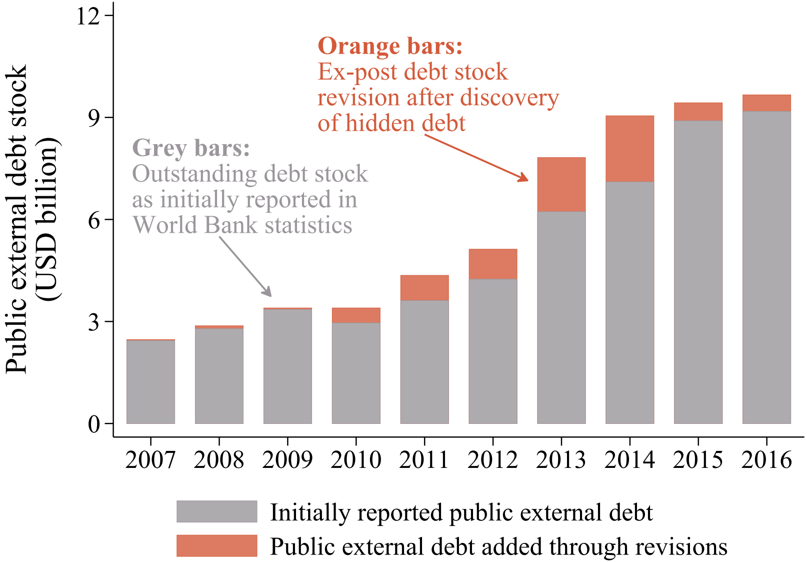
Motivation: Mozambique's hidden debt scandal



Mozambique's initially reported debt stocks, 07-16



Mozambique’s initially reported debt stocks, 07-16, revised



Quantifying hidden debt

Quantifying hidden debt and its revelation

We measure **hidden debt** in country i and year t as the difference in debt between the initial publication (vintage v_0) and the latest publication (vintage V):

$$HiddenDebt_{i,t} = Debt_{i,t}^{V} - Debt_{i,t}^{v_0}$$

We measure **hidden debt revelations** as the amount of debt added retroactively to a country i's debt statistics by vintage v:

$$HiddenDebtRevelations_i^v = \sum_{t=t_0}^{T} \left(Debt_{i,t}^{v} - Debt_{i,t}^{v-1} \right)$$

A new and comprehensive database of debt data revisions

We digitize all past vintages of the World Bank's International Debt Statistics and its predecessors, 1973–2023, and systematically track ex-post revisions to debt and loan statistics across the entire reporting history of 140 developing and emerging market countries.

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Interpretation:

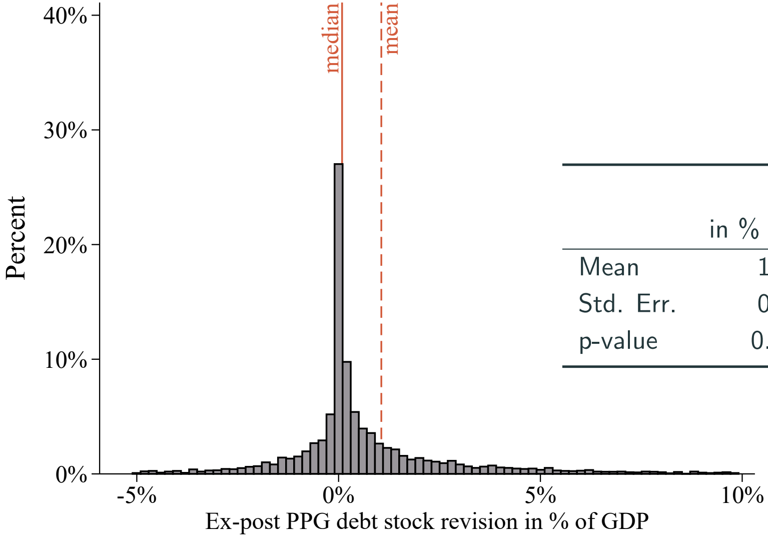
- All data points are reported by debtors and at nominal values (no estimates, no valuation effects)
- Reporting rules have been stable across 50 years
- Our measure is a lower bound for true hidden debt

▸ Caveats ▸ FX revisions ▸ CLR ▸ PNG data revisions ▸ CDF ▸ Excl. latest ▸ IMF reporting violations ▸ Composition

Key empirical findings

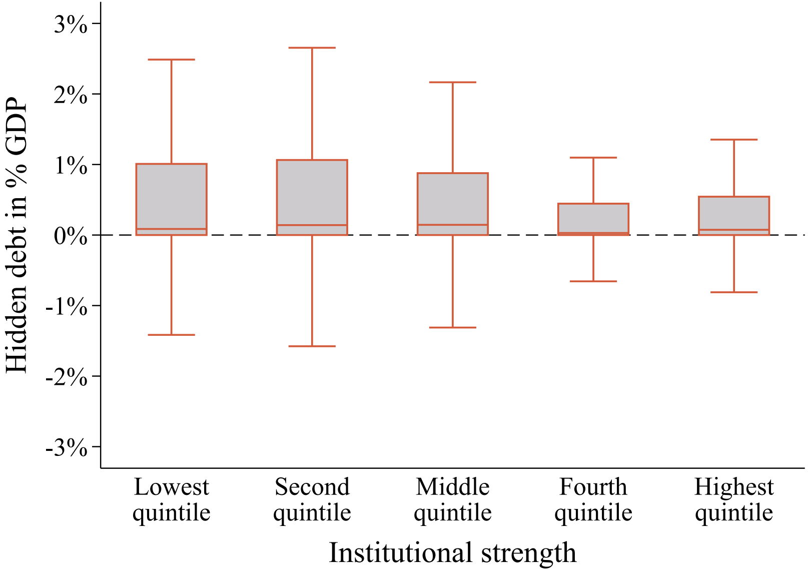
1. **Debt statistics are systematically underreported**
   - Revisions are noisy, but show statistically significant upward bias
   - Right-skewed distribution with fat tail
2. Hidden debt builds up in good times and gets revealed during bad times
   - Mechanism: Outside monitoring (IMF programs, debt restructurings)
3. Underreporting is associated with larger creditor losses ("haircuts") and particularly lengthy debt restructuring episodes

1. Debt stocks are systematically underreported



	Debt stock	
	in % of GDP	in USD mln.
Mean	1.06	159.22
Std. Err.	0.13	42.02
p-value	0.000	0.000

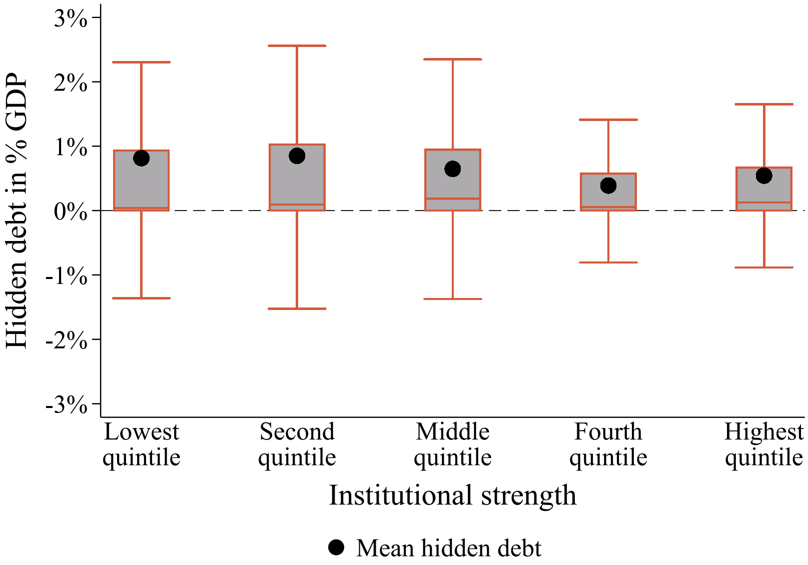
Hidden debt is most severe in countries with weak institutions...



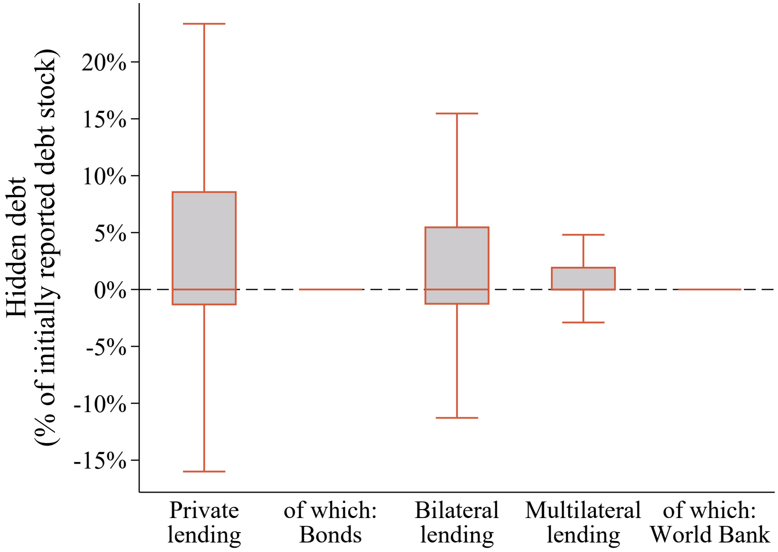
Hidden debt is most severe in countries with weak institutions...

Debt management under weak institutional strength
(Source: World Bank, MENA)

Hidden debt is most severe in countries with weak institutions...



… and for non-bond private & bilateral creditors



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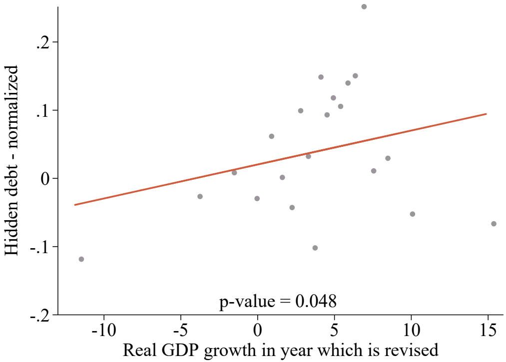
A) Which years are being revised?



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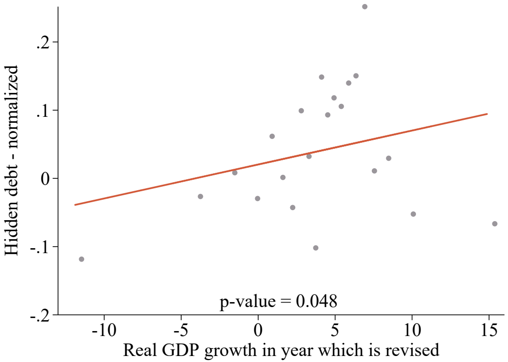
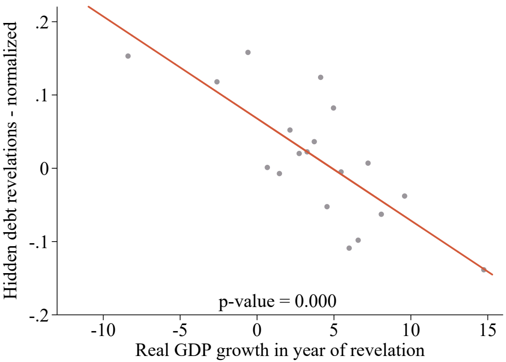


B) When do revelations happen?



Key Mechanism: Outside monitoring

	Dep. variable: Hidden debt revelations, 1975-2022			
	(1)	(2)	(3)	(4)
Real GDP growth	-0.04**			-0.04**
	(0.02)			(0.02)
External sov. default		0.15***		0.12**
		(0.05)		(0.06)
IMF program			0.13***	0.12**
			(0.04)	(0.05)
Observations	3796	3924	3924	3796
Country FE	✓	✓	✓	✓
Vintage FE	✓	✓	✓	✓

- The average IMF program discovers USD 200 million in previously unreported debt.
- No evidence for strategic disclosure by government. ▸ Politics

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Hidden debt associated with large creditor losses during crises

	Haircut		Duration of spell	
	(1)	(2)	(3)	(4)
Hidden debt	0.24**	0.25***	0.62***	0.69***
	(0.11)	(0.10)	(0.21)	(0.19)
Controls		✓		✓
Observations	153	140	153	140
R-squared	0.031	0.308	0.057	0.183

A one standard deviation increase in hidden debt is associated with

- an increase in the haircut of 5 percentage points
- an increase in the duration of the default spell of 13.8 months

A Sovereign Default Model with Hidden Debt Revelations

Main model elements

1. Sovereign default model with long-term debt and positive recovery

2. Hidden debt accumulation process

3. Risk-averse lenders that face simple information acquisition problem (monitoring decision) $\rightarrow$ revelation

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Will start w/ 2, 3 and timing (...may skip full exposition of 1)

Model: Adding hidden debt

Hidden debt accumulation:

- $h' = (1 - \delta)h + \varepsilon$, where ε are random draws from a distribution $G(\varepsilon)$
- Lenders know $G(\varepsilon)$, but do not observe realizations of ε or h
- Use novel data to calibrate $G(\varepsilon)$

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Endogenous recovery rate:

- If the gov. defaults, it pays nothing while excluded.
- Upon reentry, its debt becomes:

$$b_D = \min\{\alpha(y), b + \tilde{h}\} \qquad \text{w/ } \tilde{h} = \max\{0, h\}$$

- Recovery rate defined as:

$$\omega^b(b, h, y) = \frac{b_D(b, h, y) - \chi \tilde{h}}{b}$$

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- $\uparrow$ hidden debt $\downarrow$ recovery rate $\rightarrow$ **hidden debt dilutes recovery**

Model: Adding hidden debt revelations

Lenders face a simple information acquisition problem:

- Lenders arrive in overlapping generations, each with wealth W
- Do not observe h, but know number of periods since last revelation τ
    - They use that info to form expectations about h
- Before buying bonds, lenders decide whether to monitor the sovereign at cost f

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Hidden debt revelations:

- Monitoring triggers a hidden debt revelation. Hidden debt gets added to market debt and $h' = 0$
- Revelations also triggered by default (as in data)

Model: Timing

bad standing

For a country starting t in good standing:

1. $\{b, h\}$ are known to the government. Lenders know b and τ.
2. y and ε are realized. All agents observe y, only the government observes ε.
3. Government decides whether to default or repay: $d \in \{0, 1\}$

$d = 1$ **Default.** No coupons are paid, all hidden debt gets revealed. Income losses and exclusion.

$d = 0$ **Repayment.** Gov evaluates different levels of b', for each the lender decides whether to monitor $m \in \{0, 1\}$

$m = 1$ Monitoring: $h' = 0$ and the discovered debt gets added to b.
$m = 0$ No Monitoring: $h' = h(1 - \delta) + \varepsilon$ (but random variable for lenders).

4. Consumption and coupon payments take place.

Model: Lender's problem

The lender's problem

$$V^{\ell}(b', y, \tau) = \max_{m \in \{0,1\}} \left\{ m\, V^{\ell}_{M}(b', y) + (1-m)\, V^{\ell}_{NM}(b', y, \tau) \right\} . \tag{1}$$

with the value of monitoring

$$V^{\ell}_{M}(b', y) = \max_{B'} \; E^{\ell}\left[u_{\ell}\left(C'_{\ell} \right) \right] \tag{2}$$

subject to

$$C'_{\ell}\left(B', h', y', \varepsilon', \tau'\right) = (W - f - q_{\mathrm{M}} B')(1+r) + B'\mathcal{R}' \tag{3}$$

$$\text{and} \quad \mathcal{R}'(b', h', y', \varepsilon', \tau') \equiv \; d'\, q_{D}(b', h', y') + \tag{4}$$

$$(1-d') \times \Big[\kappa + (1-\delta)\Big(m^{*}(b'', y', \tau') q_{\mathrm{M}}(b'', y') +$$

$$(1 - m^{*}(b'', y', \tau')) q_{\mathrm{NM}}(b'', y', \tau') \Big) \Big]$$

w/ $\tau' = 1$ and $h' = 0$.

Model: Lender's problem (contd)

Value of no monitoring

$$V^{\ell}_{NM}(b', y, \tau) = \max_{B'} \; E^{\ell}_{\tau}\left[u_{\ell}\left(C'_{\ell}\right)\right] \tag{5}$$

subject to

$$C'_{\ell}\left(B', h', y', \varepsilon', \tau'\right) = (W - q_{\mathrm{NM}} B')(1 + r) + B' \mathcal{R}'(b', h', y', \varepsilon', \tau') \tag{6}$$

where $\mathcal{R}'(b', h', y', \varepsilon', \tau')$ is given by (4) evaluated at $\tau' = \tau + 1$, and with h' being a random variable (from the viewpoint of lenders)

Model: Lender's problem (contd)

default

Demand schedule under monitoring

$$q_{\mathrm{M}}(b', y) = \frac{E^{\ell}\left\{u'_{\ell}\left(C'_{\ell}\left(B', 0, y', \varepsilon', 1\right)\right) \times \mathcal{R}'(b', 0, y', \varepsilon', 1)\right\}}{(1+r)\, E^{\ell}\left[u'_{\ell}\left(C'_{\ell}\left(B', 0, y', \varepsilon', 1\right)\right)\right]} \tag{7}$$

Demand schedule under no monitoring

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Naturally, the C'_{ℓ} is different in each case.

Model: Lender's problem (contd)

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Naturally, the C'_{ℓ} is different in each case.

Gov Problem | Equilibrium definition | Functional forms | Calibration

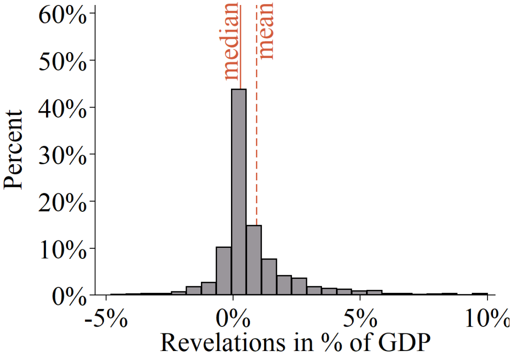
Model fit

	Data	Model
Targeted moments		
Mean Debt-to-GDP	26	24
Mean spread (r_s)	3.0	3.0
Mean recovery rate	55	56
Freq. of revelations	7.1	7.2
Non-Targeted moments		
Mean Revelation$/y$	0.94	0.87
ρ(Revelation$/y$, b/y)	0.10	0.03
ρ(Revelation$/y$, y)	-0.07	-0.19
ρ(Hidden debt, HC)	0.24	0.13

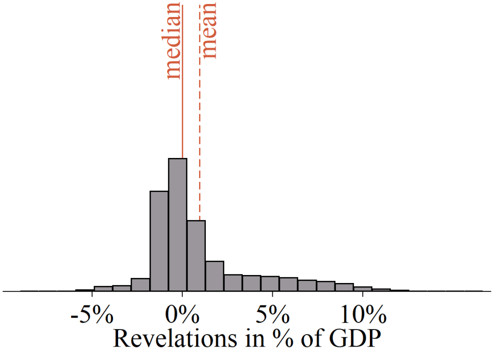
Business cycle moments

Hidden debt revelations in data and model

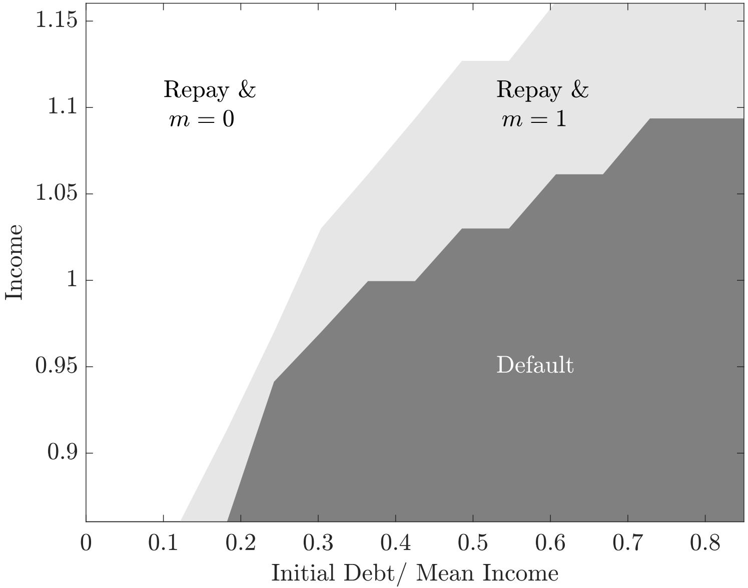
Panel A: Data



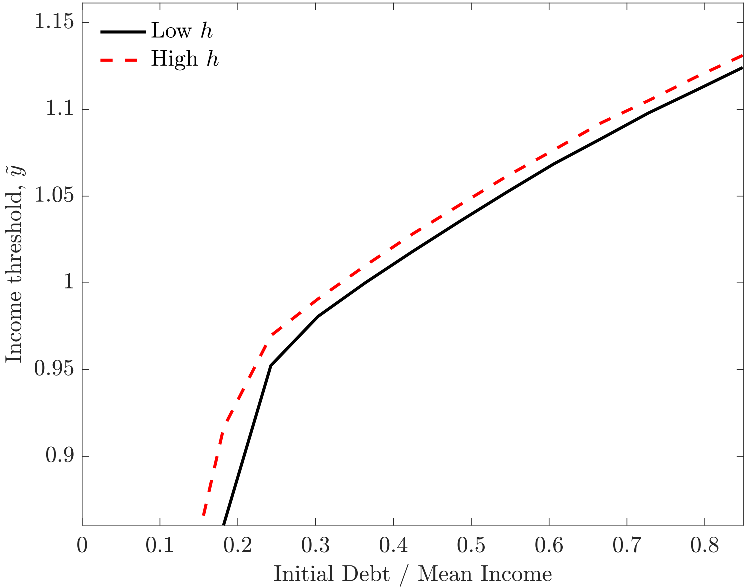
Panel B: Simulated model



Default and monitoring in equilibrium

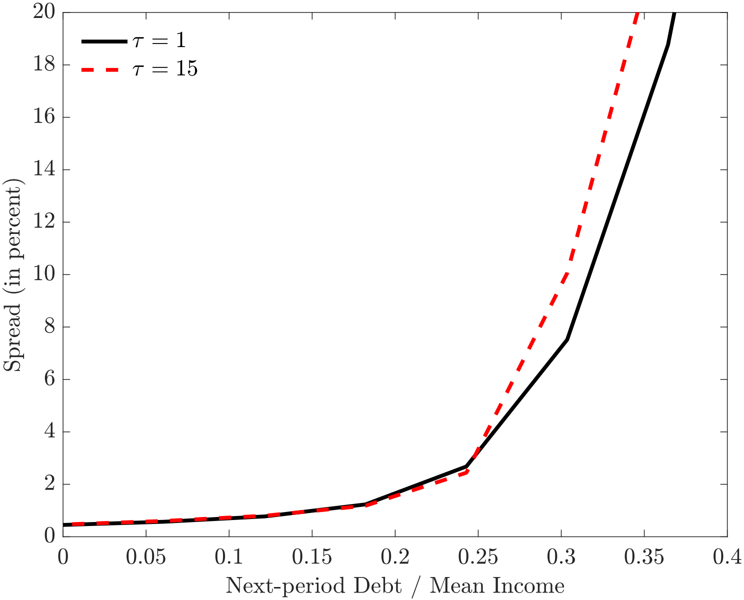


Default incentives: the effect of larger h



The effect of uncertainty on spreads ($\tau \uparrow$)

▸ menu M, NM



Spread response to hidden debt revelations

	Model	Database
Revelation size	1.37***	0.22***
	(0.05)	(0.08)
Growth	-1.21***	-1.45***
	(0.02)	(0.34)
Debt/GDP	1.82***	0.73*
	(0.02)	(0.42)
Disclosed borrowing	4.36***	-0.26
	(0.05)	(0.24)
Constant	4.49***	4.71***
	(0.02)	(0.11)
Observations	201,430	595
R-squared	0.09	0.49
Fixed Effects	✓	✓
Clustered SE	✓	✓

The costs of hidden debt

▸ FI

We run two distinct exercises to analyze the welfare costs of hidden debt.

1. **Full information economy:**
    - We make ε and h public knowledge
    - What are the welfare gains of eliminating hidden debt?

    $\rightarrow$ Average gain equivalent to 5.5 % permanent consumption increase

2. **Greater oversight:**
    - We take the existence of hidden debt as given
    - What are the welfare gains (and losses) of inducing greater oversight by lowering the costs of monitoring?
    - Countries with strong fundamentals gain, countries with weak fundamentals lose

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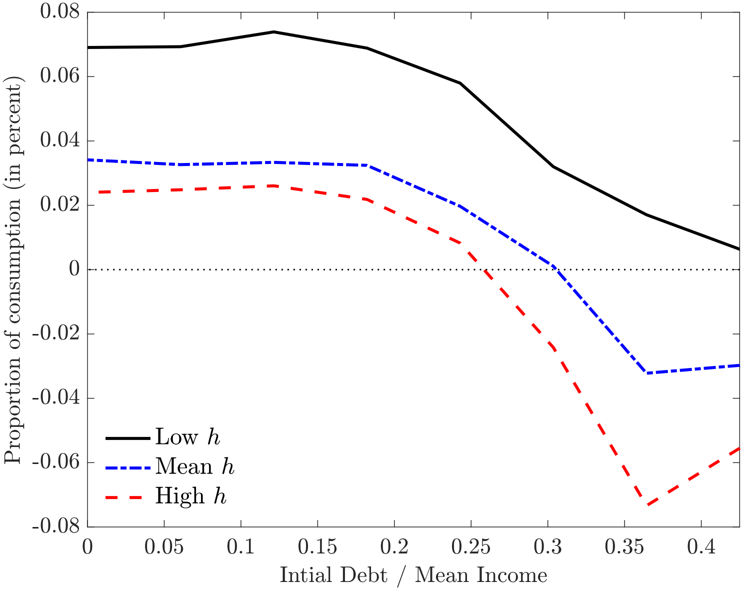
Welfare gains from greater oversight ($f \downarrow$)



Conclusion

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Novel data: First to quantify size, timing and characteristics of hidden debt

1. Debt statistics are systematically underreported, important implications for debt sustainability assessments
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Theory: Sovereign debt model with hidden debt and revelations

- $\uparrow$ default incentives, $\downarrow$ debt-carrying capacity ("debt intolerance")
- Uncertainty about debt leads to higher spreads
- Transparency can be costly if countries already have high hidden debt

Appendix

Measuring Hidden Debt: Caveats

back

- Any loan initially missing from IDS *may* have been reported in some other database
  - still violation of WB req. but implies less secrecy
- A revelation in IDS may have followed a revelation from elsewhere w/ a lag
  - So: caution in interpreting our measure as "news shocks"
- By construction, our measure is a lower bound for the true level of unreported or hidden debt.

Debt stock revisions in % of GDP by regions

back

	N	Mean	Median	Std. Err.	p-value
Europe	315	-0.23	0.01	0.19	0.232
Asia	1246	0.65	0.00	0.20	0.001
Middle-East and North Africa	689	0.01	0.04	0.26	0.962
Sub-Saharan Africa	1874	1.63	0.10	0.32	0.000
Latin America	1358	1.69	0.48	0.22	0.000

Debt stock revisions in % of GDP by income groups

back

	N	Mean	Median	Std. Err.	p-value
Low income	1471	1.43	0.01	0.39	0.000
Lower middle income	1519	0.59	0.11	0.13	0.000
Upper middle income	957	0.55	0.03	0.11	0.000
High income	17	0.41	0.00	0.31	0.203

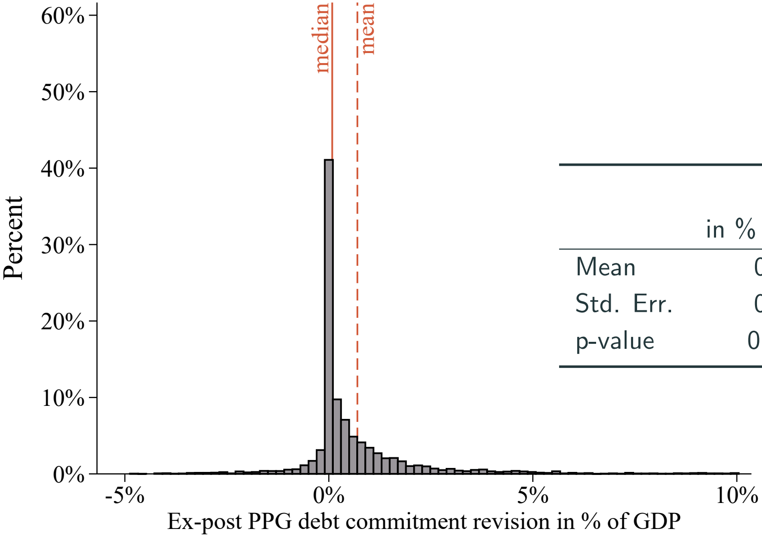
Debt stock revisions in % of GDP by decade

back

	N	Mean	Median	Std. Err.	p-value
1970s	892	1.51	0.59	0.25	0.000
1980s	1030	1.88	0.15	0.44	0.000
1990s	1216	1.40	0.13	0.36	0.000
2000s	1279	0.24	0.01	0.13	0.061
2010s	1172	0.56	0.05	0.11	0.000

Debt flows are systematically underreported

▸ back



	Debt flows	
	in % of GDP	in USD mln.
Mean	0.70	148.60
Std. Err.	0.06	18.68
p-value	0.000	0.000

FX data revisions are too small to explain debt data revisions

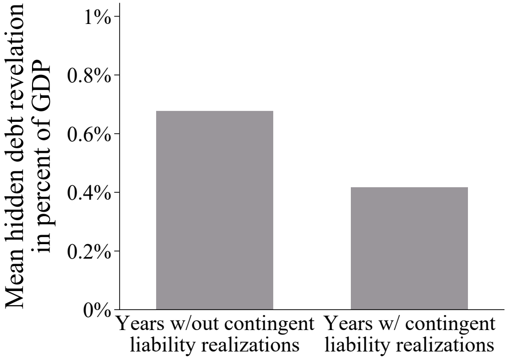
back

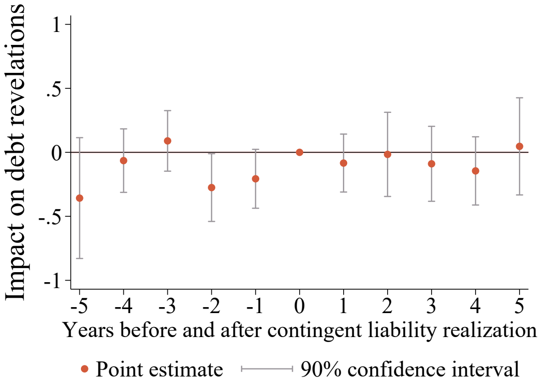
- Ex-post revisions to the USD exchange rate could lead to large ex-post revisions to the outstanding debt stock for debtor countries with large amounts of non-USD debt
- Using the IMF's IFS we quantify revisions to exchange rate data
  - Using year-on-year revisions to the yearly average and end of period exchange rate data between 2019 and 2021, we find
  - The average ex-post revision of the period average exchange rate ranges between -0.00044 percent and 0.00158 percent.
  - The average ex-post revision of the end of period exchange rate ranges between -0.00396 percent and 0.00130 percent.

→ Revisions to exchange rates are far too low to explain the sizeable magnitude of debt stock revisions we document.

Years after contingent liability realizations are not associated with higher hidden debt revelations

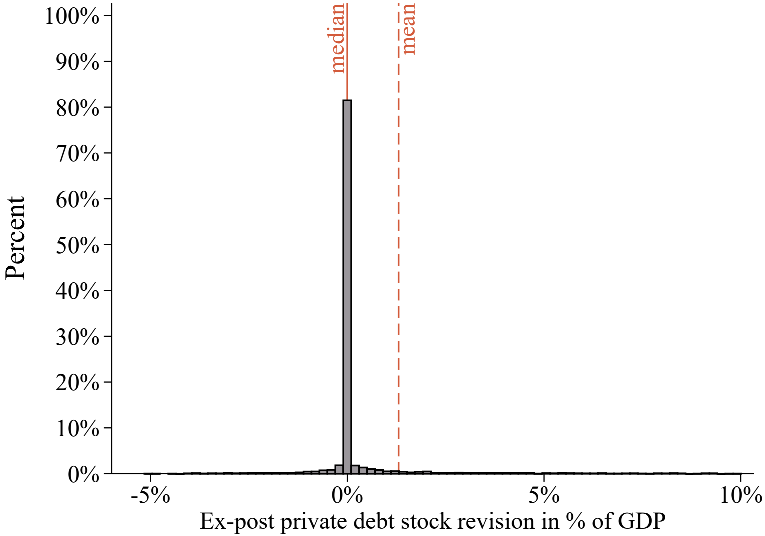
back





Private non-guaranteed debt is underreported

back



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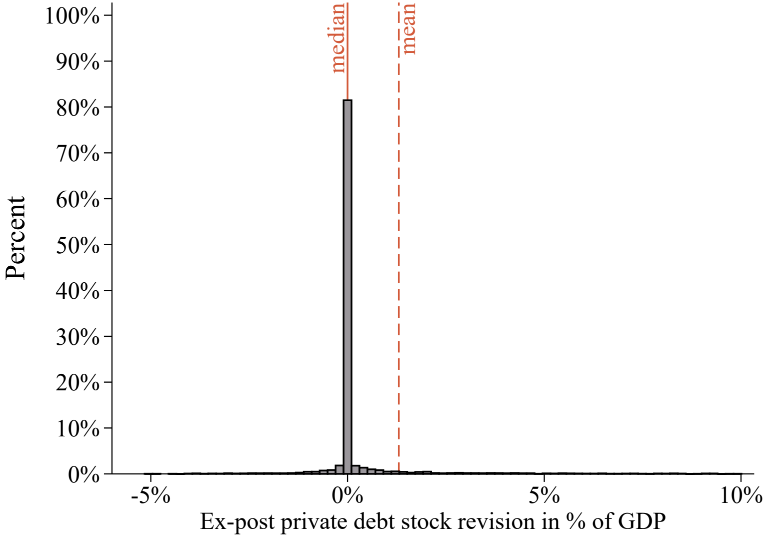
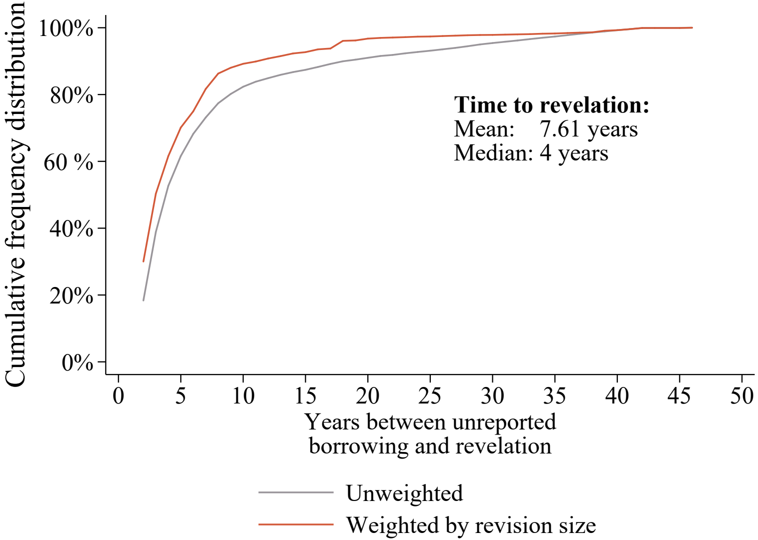


Time between accumulation and revelation of hidden debt



Revision patterns are robust to excluding two subsequent vintages

▸ back

	N	Mean	Median	Std. Err.	p-value
Panel A: Debt stocks					
In % of GDP	5702	1.06	0.09	5.77	0.000
excl. first year	5550	0.88	0.05	5.32	0.000
excl. first two years	5515	0.76	0.02	5.52	0.000
In mln USD	5702	159.22	5.00	1,909.90	0.000
excl. first year	5550	121.82	3.00	1,635.39	0.001
excl. first two years	5515	97.61	1.00	1,434.19	0.001
Panel B: Commitments					
In % of GDP	5695	0.70	0.08	4.17	0.000
excl. first year	5542	0.48	0.01	5.45	0.000
excl. first two years	5508	0.40	0.00	2.93	0.000
In mln USD	5695	148.60	6.00	1,169.82	0.000
excl. first year	5542	91.54	1.00	965.71	0.000
excl. first two years	5508	64.81	0.00	838.86	0.000

IMF reporting violations are followed by hidden debt revel.

back

Country	Date discussed	Revelation *(mln. USD)*	Vintage
Argentina	September 17, 2004	57	GDF 2006
Burkina Faso	February 2, 2005	12	GDF 2006
Chad	June 23, 2003	4	GDF 2005
Djibouti	December 20, 2002	0	GDF 2004
Dominica	April 8, 2004	0	GDF 2006
Dominica	July 3, 2005	12	GDF 2007
Ghana	June 28, 2001	115	GDF 2003
Hungary	February 21, 1990	1,226	WDT 1991–92
Nepal	January 18, 2006	127	GDF 2007
Tajikistan	February 7, 1999	0	GDF 2000
Tajikistan	February 13, 2002	23	GDF 2003
Tajikistan	November 12, 2002	78	GDF 2004
Turkey	April 26, 2005	1,270	GDF 2007
Uganda	July 30, 2004	0	GDF 2006
Ukraine	December 13, 1995	49	GDF 1997

Debt stock revisions are driven by revisions to underlying flows

back

- To investigate what drives debt stock revisions we can use the law of motion for the debt stock:

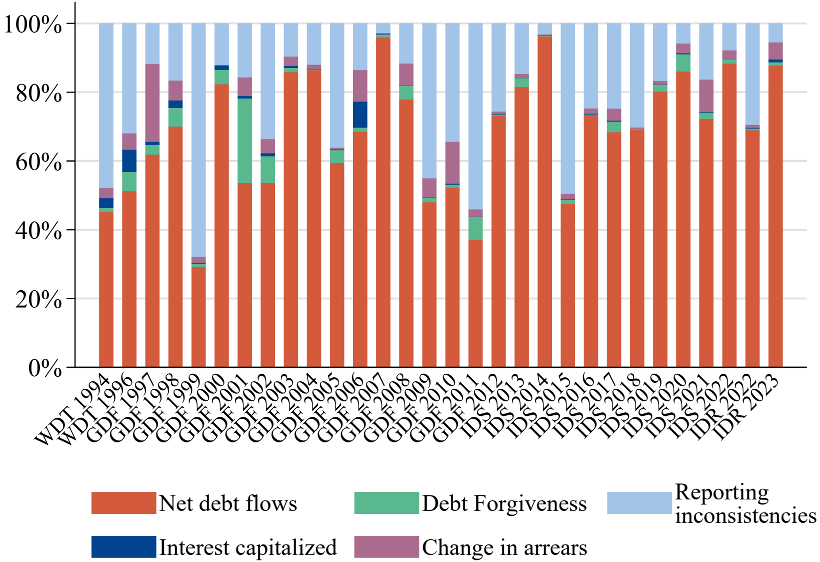
$$\Delta DOD_{i,t} = NFL_{i,t} + \Delta IXA_{i,t} + IXR_{i,t} + DFR_{i,t} + \Delta XCV_{i,t}$$

- If revisions to the debt stock are not driven by revisions to one of its components, revisions are an indication of reporting inconsistencies
- Calculating contributing shares to the debt stock revisions

$$share_x^y = \frac{\sum_{i=1}^{I} \sum_{t=1970}^{T} |x_{i,t}^y|}{\sum_{i=1}^{I} \sum_{t=1970}^{T} \left(|RNFL_{i,t}^y| + |R\Delta IXA_{i,t}^y| + |RIXR_{i,t}^y| + |RDFR_{i,t}^y| + |\epsilon_{i,t}^y|\right)}$$

- The majority of debt stock revisions is accompanied by revisions to underlying debt flows, confirming that most upward revisions in the debt stock are caused by the ex-post addition of previously unreported borrowing.

Debt stock revisions are accompanied by revisions to underlying debt flows



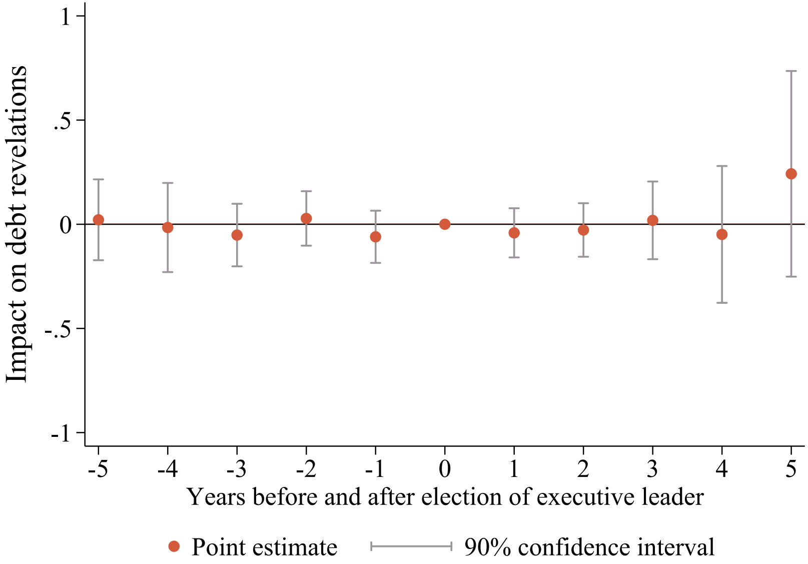
Hidden debt revelations and the political cycle

back

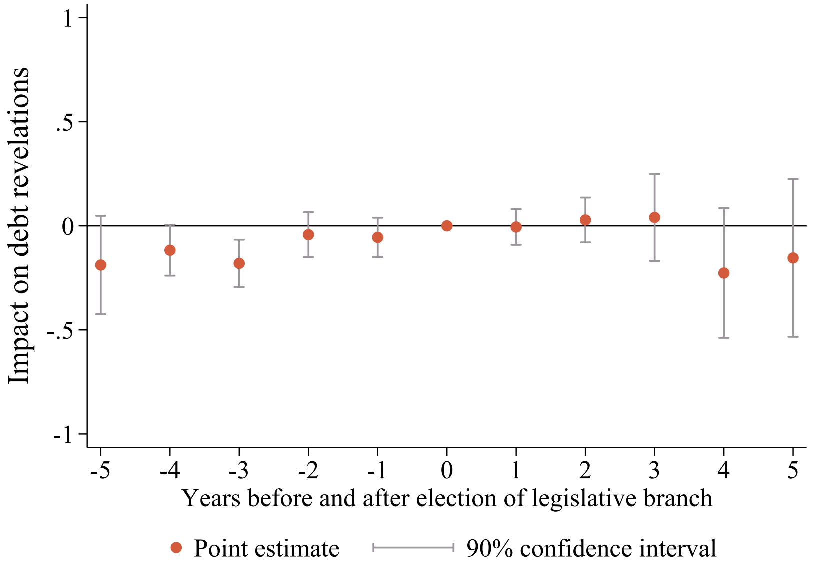
	(2)	(3)	(4)	(5)	(6)
Executive election	0.03				0.04
	(0.06)				(0.06)
Legislative election		0.01			0.00
		(0.05)			(0.05)
Regular change in leadership			-0.01		-0.03
			(0.04)		(0.05)
Irregular change in leadership				-0.05	-0.05
				(0.10)	(0.12)
Real GDP growth					-0.04**
					(0.02)
IMF program					0.11**
					(0.05)
External sov. default					0.10*
					(0.06)
Observations	3511	3510	3924	3924	3411
R-squared	0.054	0.057	0.044	0.044	0.063
Country FE	✓	✓	✓	✓	✓
Vintage FE	✓	✓	✓	✓	✓

Hidden debt revelations and the political cycle

back

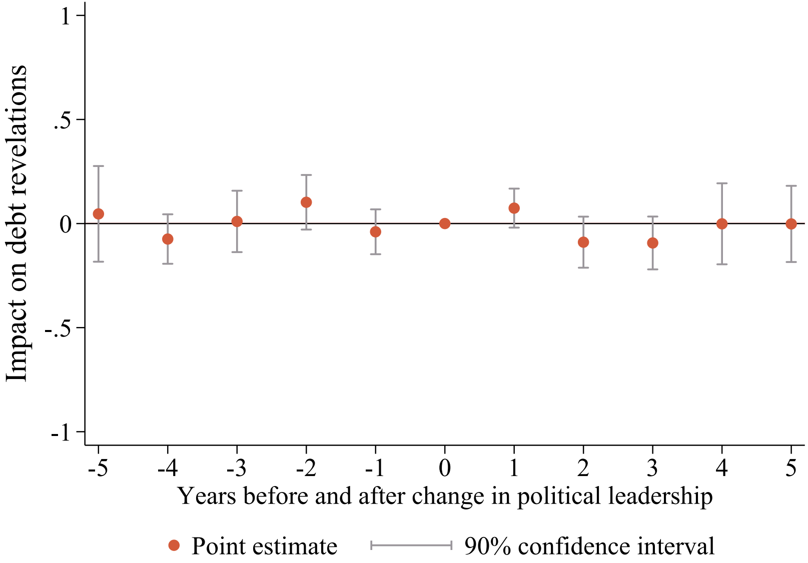


Hidden debt revelations and the political cycle



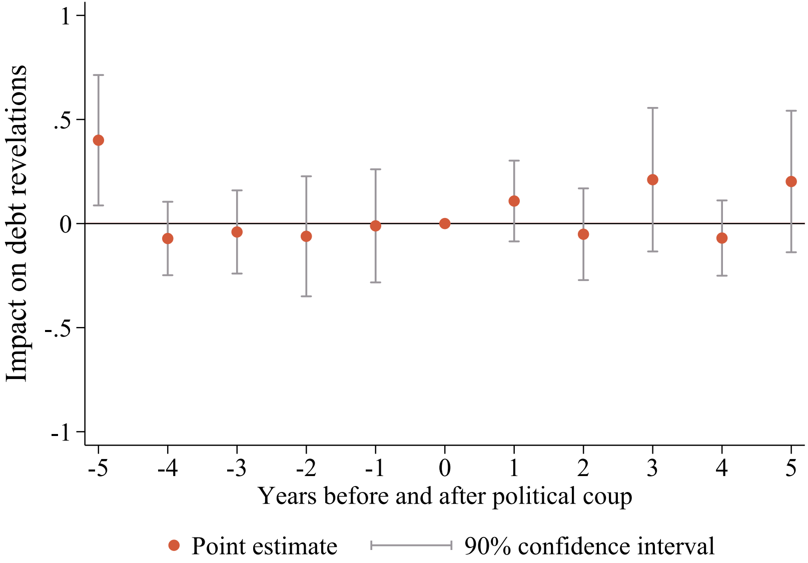
Hidden debt revelations and the political cycle

back



Hidden debt revelations and the political cycle

back



Model: Government problem (I)

back

The Government's Problem

$$V(b,h,y,\varepsilon,\tau) = \max_{d\in\{0,1\}} \left\{ d\, V_1(b,h,y) + (1-d)\, V_0(b,h,y,\varepsilon,\tau) \right\} \tag{9}$$

with value under default:

$$V_1(b,h,y) \quad = \quad u(c_D) + \beta E_{y',\varepsilon'|y}\left[(1-\theta)\, V_1(b,\tilde{h},y') + \theta\, V(b_D,h',y',\varepsilon',\tau') \right] \tag{10}$$

subject to

$$c_D = y - \phi(y) + \left(\tilde{h} - h \right) \tag{11}$$

where $\tilde{h} = \max\{h, 0\}$, $h' = 0$, $\tau' = 1$, and $b_D(b,h,y') = \min\left\{ \alpha(y), b + \tilde{h} \right\}$

Model: Government problem (II)

back

Under no default, the government's value function depends on the lenders monitoring decision

$$V_0 = m^* \, V_0^M + (1 - m^*) \, V_0^{NM}$$

in the case of monitoring

$$V_0^M(b, h, y, \varepsilon) = \max_{b'} \left\{ u(c) + \beta E_{y', \varepsilon' | y} \, V(b', h', y', \varepsilon', \tau') \right\} \tag{12}$$

subject to

$$\begin{aligned}
c &= y - \kappa(b + h) + q_{\mathrm{M}}(b', y)\iota + q_h \varepsilon \\
\iota &= b' - [(1 - \delta)b + (1 - \delta)h + \varepsilon] \\
h' &= 0 \qquad \tau' = 1 \\
\iota &> 0, \quad \text{only if} \quad q_{\mathrm{M}}(b', y) > \underline{q}
\end{aligned}$$

Model: Government problem (III)

back

and in the case of no monitoring

$$V_0^{NM}(b, y, h, \varepsilon; \tau) = \max_{b'} \left\{ u(c) + \beta E_{y', \varepsilon' | y} V(b', y', h', \varepsilon', \tau + 1) \right\} \tag{13}$$

subject to

$$\begin{aligned}
c &= y - \kappa(b + h) + q_{\mathrm{NM}}(b', y, \tau)\iota + q_h \varepsilon \\
\iota &= b' - (1 - \delta)b \\
h' &= (1 - \delta)h + \varepsilon \\
\iota &> 0 \quad \text{only if} \quad q_{\mathrm{NM}}(b', y, \tau) > \underline{q}
\end{aligned}$$

Model: Lender's problem under default

back

The lender's problem in case of default

$$V_D^\ell(b,h,y) = \max_{B'} \; E^\ell\left[u_\ell(C'_\ell)\right] \tag{14}$$

subject to

$$C'_\ell = (W - q_D(b,h,y)B')(1+r) + B'\mathcal{R}'_{\mathcal{D}}(b,h,y',\varepsilon',\tau')\,, \tag{15}$$

$$\begin{aligned}\mathcal{R}'_{\mathcal{D}}(b,h,y',\varepsilon',\tau') = (1-\theta)q_D(b,\tilde{h},y') + \theta\,\omega(b,h,y')\Bigg[\hat{d}(b_D,0,y',\varepsilon',\tau')\,q_D(b_D,0,y') + \\ (1-\hat{d}(b_D,0,y',\varepsilon',\tau'))\Bigg[\kappa + (1-\delta)\Big(m^*(b'',y',\tau')q_{\mathrm{M}}(b'',y') + \\ (1-m^*(b'',y',\tau'))\,q_{\mathrm{NM}}(b'',y',\tau')\Big)\Bigg]\Bigg]\end{aligned} \tag{16}$$

where $\tilde{h} = \max\{h,0\}$, $\tau' = 1$, and b_D and $\omega(b,h,y')$ as defined above.

Model: Lender's problem under default

back

Demand schedule under default

$$q_D(b, h, y) = \frac{E^\ell \left\{ u'_\ell(C'_\ell)\, \mathcal{R}'_{\mathcal{D}}(b, h, y', \varepsilon', \tau') \right\}}{(1 + r)\, E^\ell \left[u'_\ell(C'_\ell) \right]} \tag{17}$$

Timing (II)

back

For a country ending $t-1$ in financial exclusion:

1. Realization of a re-entry shock,
   - With probability $1-\theta$ the country remains excluded and can only consume its reduced income level.
   - With probability θ, the country re-enters, gets a realization of ε, its initial debt level gets reduced to $b_D = \min\left\{\alpha(y), b + \tilde{h}\right\}$ and its initial hidden debt is set to zero.
2. If re-entry occurs, timinig continues as in the case of good financial standing from the government default decision onwards.

Equilibrium definition

back

A Markov perfect equilibrium is defined by

- value functions $\{V(b, h, y, \varepsilon, \tau), V_0^M(b, h, y, \varepsilon), V_0^{NM}(b, h, y, \varepsilon, \tau), V_1(b, h, y)\}$
- policy functions $\left\{\hat{d}(b, h, y, \varepsilon, \tau), \hat{b}_M(b, h, y, \varepsilon), \hat{b}_{NM}(b, h, y, \varepsilon, \tau)\right\}$
- a monitoring rule $m^*(b', y, \tau)$, and
- bond price schedules $\{q_{\mathrm{M}}(b', y), q_{\mathrm{NM}}(b', y, \tau), q_D(b, h, y)\}$

such that

(i) given bond price schedules and monitoring rules, the government policy and value functions solve the dynamic programming problem defined by equations (9)–(13)

(ii) given bond price schedules and government policies, the monitoring rule solves the problem in (1),

(iii) the price functions satisfy equations (7), (8), and (17), and

(iv) the market for government debt clears.

Functional forms and stochastic processes (I)

back

- Utility function with constant relative risk aversion:

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma}, \text{ with } \gamma \neq 1.$$

  of the representative agent in the small open economy and of the lender with γ_ℓ

- Endowment process following

$$\log(y_t) = (1-\rho)\mu + \rho \log(y_{t-1}) + \nu_t, \tag{18}$$

  with $|\rho| < 1$, and $\nu_t \sim N(0, \sigma_\nu^2)$

Functional forms and stochastic processes (II)

back

- For income during a default episode we assume a quadratic loss function:

$$\phi(y) = \max\left\{y\left[\lambda_0 + \lambda_1[y - \mathbb{E}(y)]\right], 0\right\} \tag{19}$$

- Minimum level of debt upon reentry: $\alpha(y) = \bar{\alpha}$

- Issuance of hidden debt, ϵ, is *iid*, following a Normal distribution with mean μ_ϵ and variance σ_ϵ^2

- Next period hidden debt, h', is distributed as

$$h' \sim N\left(\mu_\varepsilon \frac{1-(1-\delta)^\tau}{\delta}, \sigma_\varepsilon^2 \frac{1-(1-\delta)^\tau}{\delta}\right).$$

  and known by the lenders

Calibration (I)

back

Borrower's risk aversion	γ	2	Standard
Risk-free rate	r	0.04	Standard
Discount factor	β	0.90	Standard
Income autocorrelation coefficient	ρ	0.6	Estimated
Standard deviation of innovations	σ_ν	0.03	Estimated
Probability exclusion ends	θ	0.33	Mean exclusion $=$ 3 years
Debt duration	δ	0.31	Debt duration $=$ 5 years
Bond coupon	κ	$(r+\delta)e^{-r}$	Risk-free bond price $= e^{-r}$
Price floor	$\underline{q}$	$0.7\,e^{-r}$	Never binding

Calibration (II)

back

Lender's risk aversion	γ_ℓ	2	Aguiar et al. (2016)
Lender's wealth	W	2.5	Aguiar et al. (2016)
Hidden debt price	q_h	e^{-r}	Normalization
Hidden debt recovery	χ	1.0	Normalization
Mean of ε	μ_ε	1%	Our dataset
Standard deviation of ε	σ_ε	0.02	Our dataset
Income cost of defaulting	λ_0	0.07	Avg. market debt $=$ 26%
Income cost of defaulting	λ_1	1.75	Avg. spread $=$ 3.0%
Monitoring fee	f	0.03%	Freq. of monitoring $=$ 7.1%
Recovery rate parameter	$\overline{\alpha}$	0.15	Mean recovery rate $=$ 55%

Business Cycle Statistics

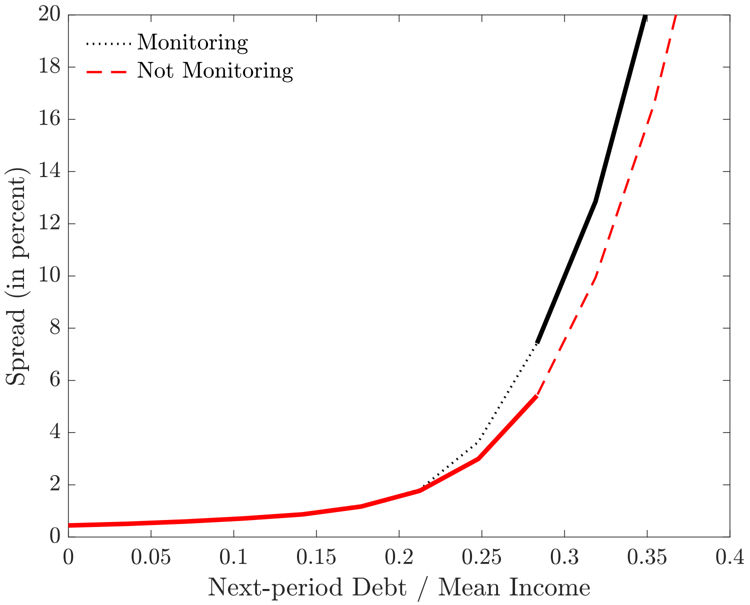
back

Non-Targeted moments: Business cycle statistics

	Data	Model
$\sigma(c)/\sigma(y)$	1.1	1.3
$\rho\,(c, y)$	0.9	0.8
$\rho\,(r_s, y)$	-0.1	-0.4
$\sigma\,(r_s)$	2.8	1.8

Spread menu under M and NM

back



Welfare gains from full information

back