Short-term debt and financial crises: What we can learn from U.S. Treasury supply

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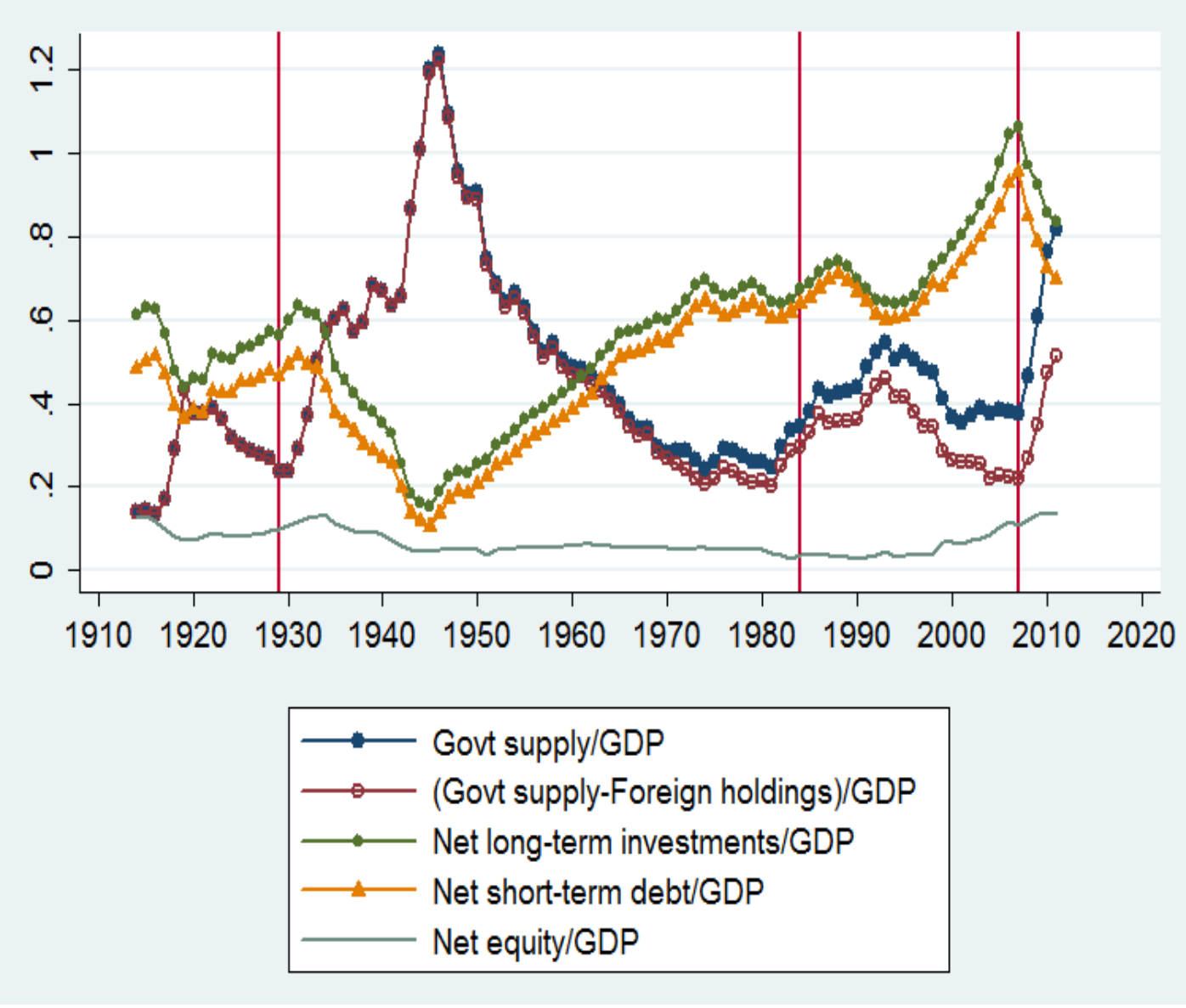
Motivation

- Why so much short-term financing of the financial sector?
  1) Demand from some agents for safe, liquid assets (properties disproportionately possessed by short-term bank debt)

  Diamond and Dybvig (1983), Gorton and Pennacchi (1990), Dang, Gorton and Holmstrom (2010)

  2) Govt. deposit insurance/central bank lender of last resort
  3) Tax advantages to debt
  4) Agency theory (Calomiris and Kahn, 1990, Diamond and Rajan 1998).

  We provide a new test of 1) based on variation in the supply of government securities (mainly Treasuries).



Private and Public Supply of Liquidity are Substitutes (Holmstrom-Tirole, 1998, 2011)

Outline

(1) Evidence from Prices
    (1) Liquidity premium on Treasury debt, bank debt
(2) Model: How to do the accounting
(3) Include business cycle controls. Drop most problematic years.
(4) Exploit a demand shock for safe/liquid assets.
(5) Explore the impact of government supply on the composition of consumption expenditures (``Rajan-Zingales identification").

1. Background: Liquidity Premium on Treasuries

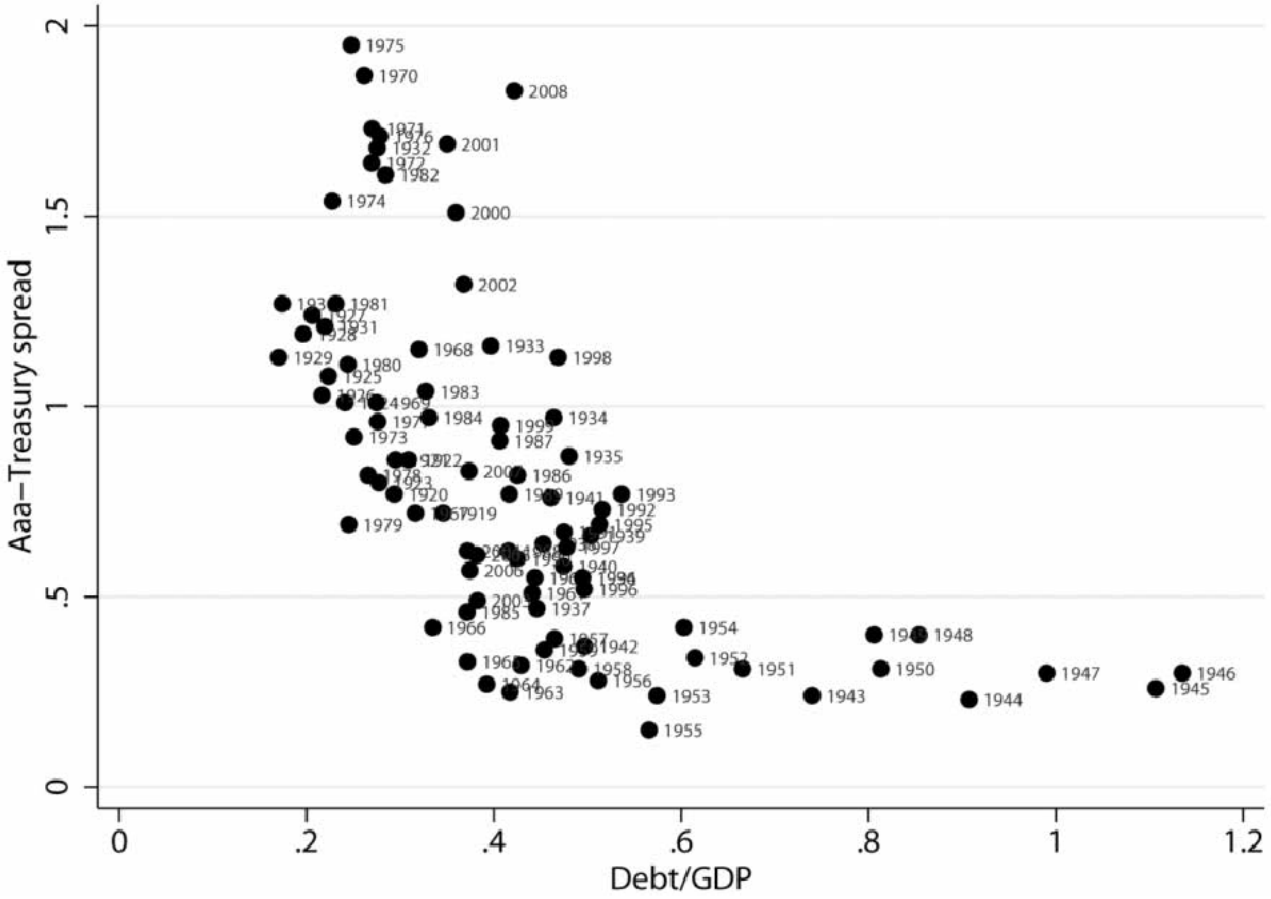


FIG. 1.—Corporate bond spread and government debt. The figure plots the Aaa-Treasury corporate bond spread (y axis) against the debt-to-GDP ratio (x axis) on the basis of annual observations from 1919 to 2008. The corporate bond spread is the difference between the percentage yield on Moody's Aaa long-maturity bond index and the percentage yield on long-maturity Treasury bonds.

1. Liquidity Premium on Bank Debt

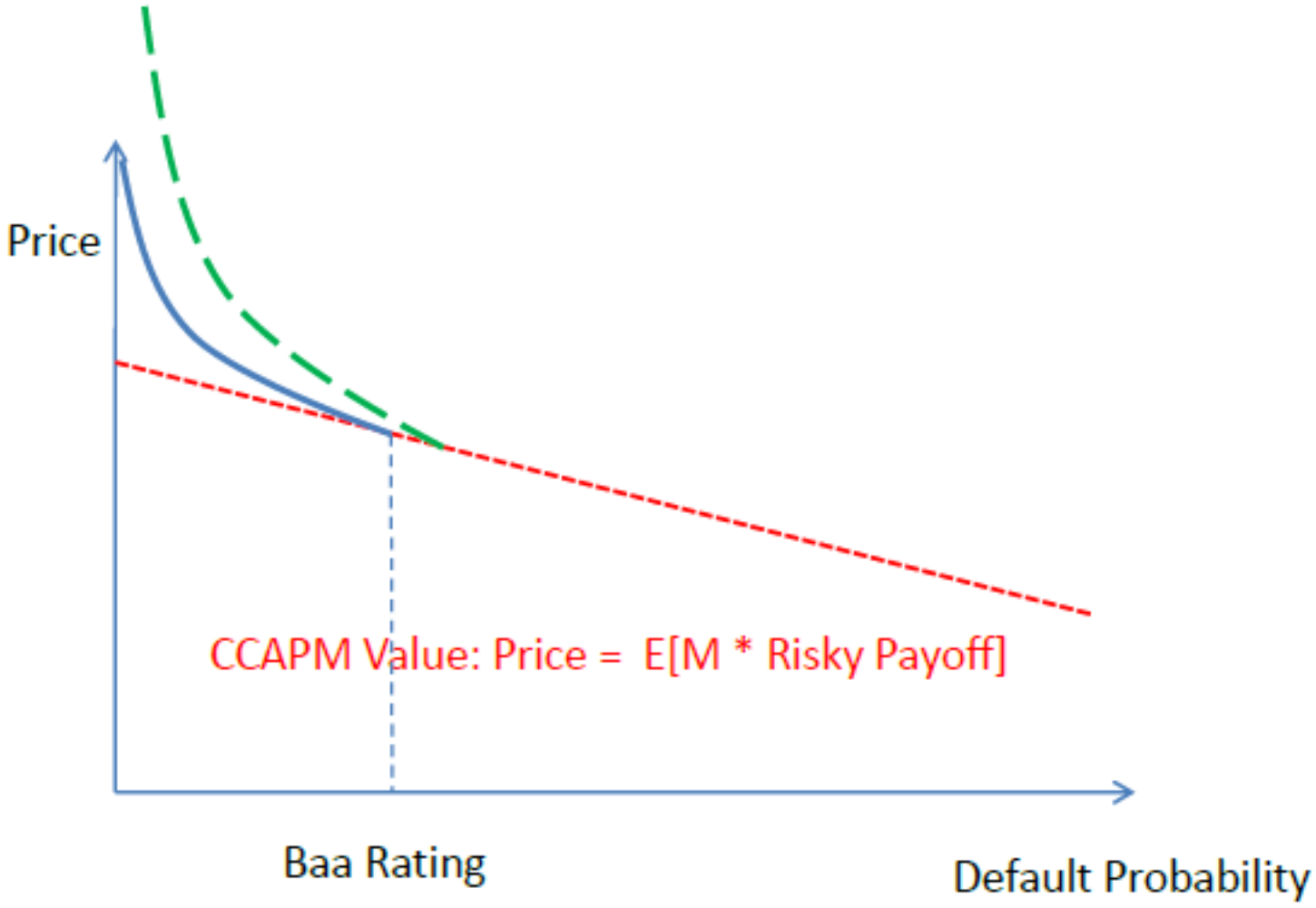
	Baa-(Time&Savings)	CPP2-(Time&Savings)
ln(Debt/GDP)	-1.41	-2.63
	(-2.32)	(-3.11)
EDF	0.93	-0.88
	(1.38)	(-0.96)
Slope of yield curve		
(10-year minus 3-month)	0.64	-0.77
	(5.03)	(-4.67)
Constant	1.02	0.69
	(1.66)	(0.75)
R2	0.524	0.532
N	74	35
Time period	1935-2008	1974-2008

Note: t-statistics in parenthesis. OLS estimations with standard error calculated assuming AR(1) error terms. For EDF, we use fitted values from a regression of EDF on stock market volatility prior to 1963, based on a regression run using data from 1963-2008.

1. Liquidity Premium on High Grade CP

	$S^{\text{Baa-Aaa}}$		$S^{\text{P2-P1}}$		$S^{\text{FDIC-insured CDs–Bills}}$	$S^{\text{Time/Savings Accounts–Bills}}$
	1926–2008 (1)	1926–2008 (2)	1974–2007 (3)	1974–2007 (4)	1984–2008 (5)	1935–65 (6)
Log(debt/GDP)	−.510 [−3.45]		−.888 [−4.34]		−1.884 [−1.71]	−.690 [−2.57]
Log(debt > 10-year maturity/GDP)*		−.304 [−2.44]				
Log(debt ≤ 1-year maturity/GDP)*				−1.462 [−2.84]		
Volatility	5.031 [6.47]	6.232 [6.65]				
EDF			.074 [.35]	.019 [.07]		
Slope	.232 [4.20]	.211 [3.29]	.014 [.42]	.055 [1.13]	.101 [.88]	1.181 [10.04]
Constant	.660 [4.54]	.264 [.74]	−.508 [−2.39]	−2.679 [−2.47]	−1.486 [−1.52]	−.170 [−.95]
Observations	83	83	34	34	25	31
R^2	.600		.497		.233	.898
Estimation method	OLS	IV	OLS	IV	OLS	OLS
Error term	AR(1)	AR(1)	AR(1)	AR(1)	AR(1)	AR(1)

What is "safety"? Not C-CAPM



2. Motivating model

F (financial sector)		N (non-financial sector)
K (Capital)	D^F Deposits →	D^N
θ_T^F (Treasury Bonds)	W_0^F (Equity)	θ_T^N

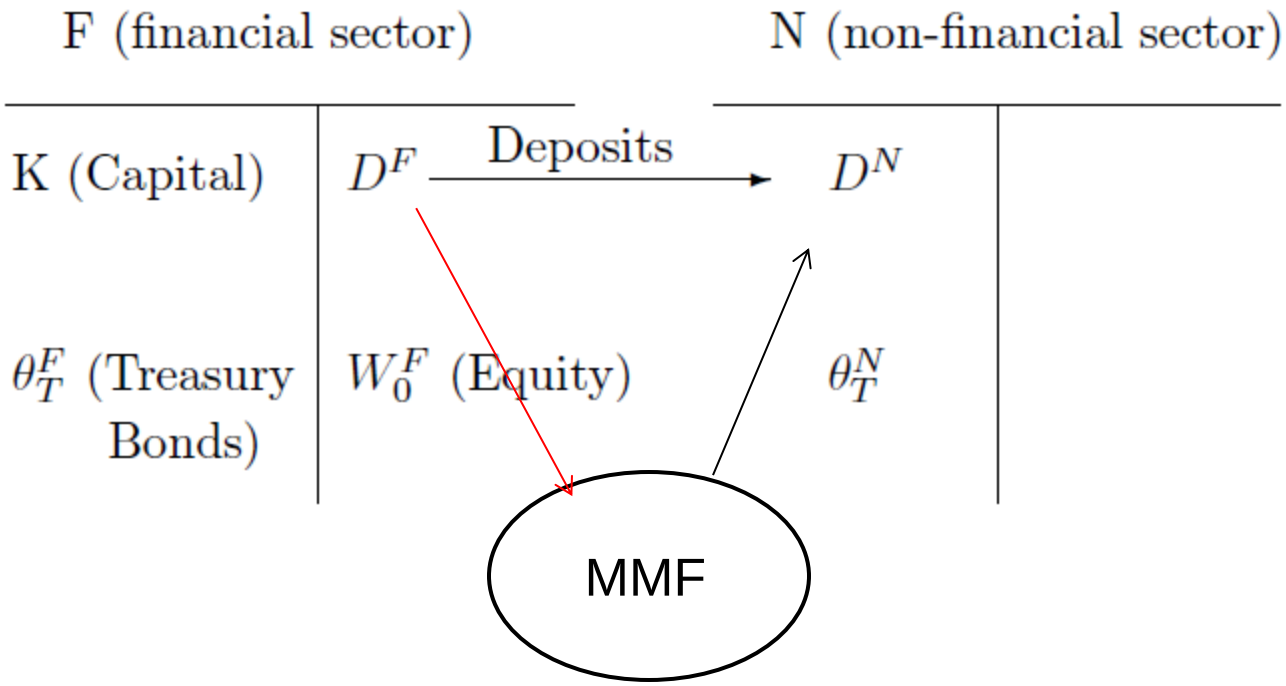
- D (short-term debt) and θ (Treasury bonds) offer convenience (liquidity/safety) services to non-financial sector
- We want to understand how changing $\theta_T^F + \theta_T^N = \Theta$, affects D

2. Motivating model

	F (financial sector)		N (non-financial sector)
r_K	K (Capital)	D^F	D^N
		Deposits $\xrightarrow[r_D]{}$	
r_T	θ_T^F (Treasury Bonds)	W_0^F (Equity)	θ_T^N

- How does changing $\theta_T^F + \theta_T^N = \Theta$ affect D?
- Less $\Theta \Longrightarrow r_D, r_T \downarrow \Longrightarrow$ More K, funded by D

2. Accounting: Inter-financial sector debt



- Need to net inter-financial-sector debt holdings
- MMF holds bank CDs

2. Accounting: Government Purchases

F (financial sector)		N (non-financial sector)
K (Capital)	D^F Deposits →	D^N
	+1	
+1 θ_T^F (Treasury Bonds)	W_0^F (Equity)	θ_T^N

- Government issues +1 bond, buys +1 worth of tank
  - Bank buys +1 bond; issues +1 deposit to government
  - Government +1 deposit then pays for tank, and N gets +1 deposit
- We net F's holdings of Treasury bonds from D

3. Defining government supply in the data (Θ)

- We are interested in the government's supply of safe and liquid assets, θ.
- Main component is Treasury securities, but one could also consider the role of the Fed.

Government sector net supply of safe and liquid instruments

= Treasuries at market value

+ [Reserves

+ Currency, except for part held by Treasury

+ Net security repo agreements issued by Fed

− Treasury securities held by Fed]

- Avg. govt. net supply/GDP=0.47 of which Federal reserve component averages 0.055.

4. Constructing an overall balance sheet for the entire U.S. financial sector

Include all net suppliers of safe/liquid assets, not just com. banks.

- From 1952 we use the Flow of Funds sectors below.

  Prior to 1952 we use data for "All Banks" (i.e. commercial banks and mutual savings banks) from All Bank Statistics.

Net out interbank claims:

- For each financial instrument, e.g. commercial paper, use financial sector's assets minus liabilities.

Then sort instruments into those that are net assets and those that are net liabilities for the financial sector, based on averages from 1914-2011 of the ratio (Assets-Liabilities)/GDP.

- 33 different types of instruments show up as an asset and/or liability of one or more of the 14 parts of the financial sector

L.110 U.S.-Chartered Commercial Banks

L.111 Foreign Banking Offices in U.S.

L.112 Bank Holding Companies

L.113 Banks in U.S.-Affiliated Areas

L.114 Savings Institutions

L.115 Credit Unions

L.121 Money Market Mutual Funds

L.127 Finance Companies

L.129 Security Brokers and Dealers

L.130 Funding Corporations

L.124 Government-Sponsored Enterprises (GSEs)

L.125 Agency- and GSE-Backed Mortgage Pools

L.126 Issuers of Asset-Backed Securities (ABS)

L.128 Real Estate Investment Trusts (REITs)

Panel B. Instruments that are net liabilities on average across years

Instrument	(Liabs.-Assets) /GDP			Assets ($B)	Liabs. ($B)	Liabs.-Assets ($B)
	Avg for 1914-2011	End of 2007	End of Q3 2011	End of 2007		
Short-term debt						
17. Checkable deposits and currency	20.5	3.6	6.7	209	708	499
18. Savings and time deposits	36.6	50.4	54.0	388	7,463	7,074
19. Money market mutual fund shares	3.2	14.8	12.8	702	2,780	2,078
20. Federal funds and security RPs	1.9	11.6	2.3	702	2,324	1,623
21. Securities loaned (for funding corporations)	1.1	10.1	4.8	0	1,415	1,415
22. Commercial paper	1.1	2.4	0.1	961	1,300	338
23. Interbank liabilities to foreign banks	0.3	0.2	1.2	0	28	28
24. Interbank liabilities to domestic banks	0.3	0.1	0.7	0	18	18
25. Security credit	0.3	4.6	4.6	432	1,078	646
26. Acceptance liabilities	0.1	0.0	0.0	0	0	0
27. Taxes payable	0.1	0.3	-0.2	0	38	38
Sum	65.6	98.1	87.0	3,393	17,150	13,757
Long-term debt						
28. Agency- and GSE- backed securities	6.1	30.2	30.0	2,846	7,077	4,231
29. Corporate and foreign bonds	0.9	22.9	14.3	2,828	6,037	3,209
Issued by ABS issuers	3.0	27.4	13.3	0	3,841	3,841
Issued by other fin. inst's	-2.1	-4.5	1.0	2,828	2,196	-632
30. U.S. govt. loans to GSEs	0.02	0.0	0	0	0	0
Sum	7.0	53.0	44.4	5,674	13,114	7,440

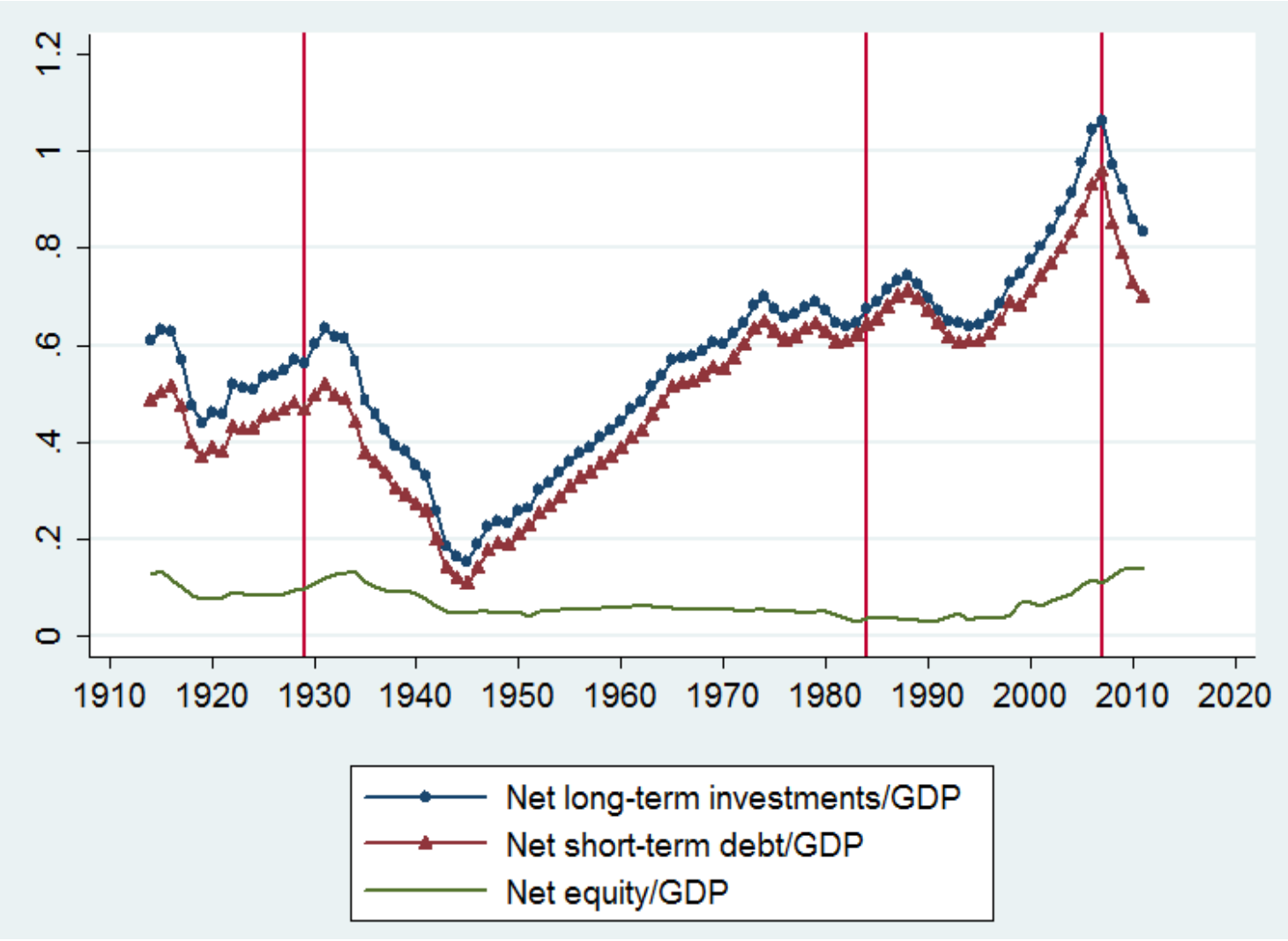
Instrument	(Liabs.-Assets) /GDP			Assets ($B)	Liabs. ($B)	Assets-Liabs. ($B)
	Avg for 1914-2011	End of 2007	End of Q3 2011	End of 2007		
Equity						
31. Financial sector equity	6.9	10.5	12.6	0	1,475	1,475
32. Investment by bank holding companies (in bank subsidiaries), or by parent (in savings inst. and finance comp.'s), or by affiliates (for security brokers and dealers) or by funding corp.'s in security brokers and dealers	1.1	4.7	6.5	1,623	2,280	656
33. Foreign direct inv. U.S.	0.2	2.0	2.1	0	280	280
Sum	8.2	17.2	21.2	1,623	4,034	2,411
Overall sum	80.9	168.3	152.6			

Table 2. Financial sector balance sheet, 1914-2011

Panel A. Instruments that are net assets on average across years

	Instrument	(Assets-Liabs.) /GDP			Assets ($B)	Liabs. ($B)	Assets-Liabs. ($B)
		Avg for 1914-2011	End of 2007	End of Q3 2011	End of 2007		
Assets supplied by govt (Treasury/ Federal Reserve)							
1.	Treasury securities	11.2	1.8	5.6	245	0	245
2.	Vault cash and reserves at Federal Reserve (assets), Federal Reserve float+Borrowing from Fed Res banks (liabilities)	4.0	0.5	10.9	64	-1	65
	Sum	15.1	2.2	16.5	310	-1	310
Short-term assets							
3.	Customers' liability on acceptances	0.3	0.0	0.0	0	0	0
4.	Foreign deposits	0.2	0.7	0.6	102	0	102
5.	Trade credit	0.1	0.3	0.2	105	62	42
	Sum	0.6	1.0	0.8	207	62	145
Long-term assets							
6.	Mortgages	31.5	96.2	83.0	13,520	154	13,365
7.	Bank loans	15.2	11.9	11.7	1,915	261	1,654
8.	Consumer credit	7.9	18.2	14.1	2,531	0	2,531
9.	Municipal securities	3.9	3.9	1.4	713	167	546
10.	Miscellaneous	3.3	21.7	11.6	3,432	413	3,019
11.	Other loans and advances (loans made by GSEs or finance companies, syndicated loans, other)	2.6	7.9	5.9	1,898	796	1,101
	Sum	64.3	159.9	127.8	24,009	1,792	22,217

Figure 1. Financial sector balance sheet, 1914-2011
Panel D. Short, long, and equity categories netted



- Fluctuations in net LT investments are driven almost entirely by fluctuations in net ST debt.

5. Empirical tests – main results

- An increase in government supply:

  P1. Decreases net short-term debt (ST liabs-ST assets-fin. sector's holdings of govt. supplied assets)

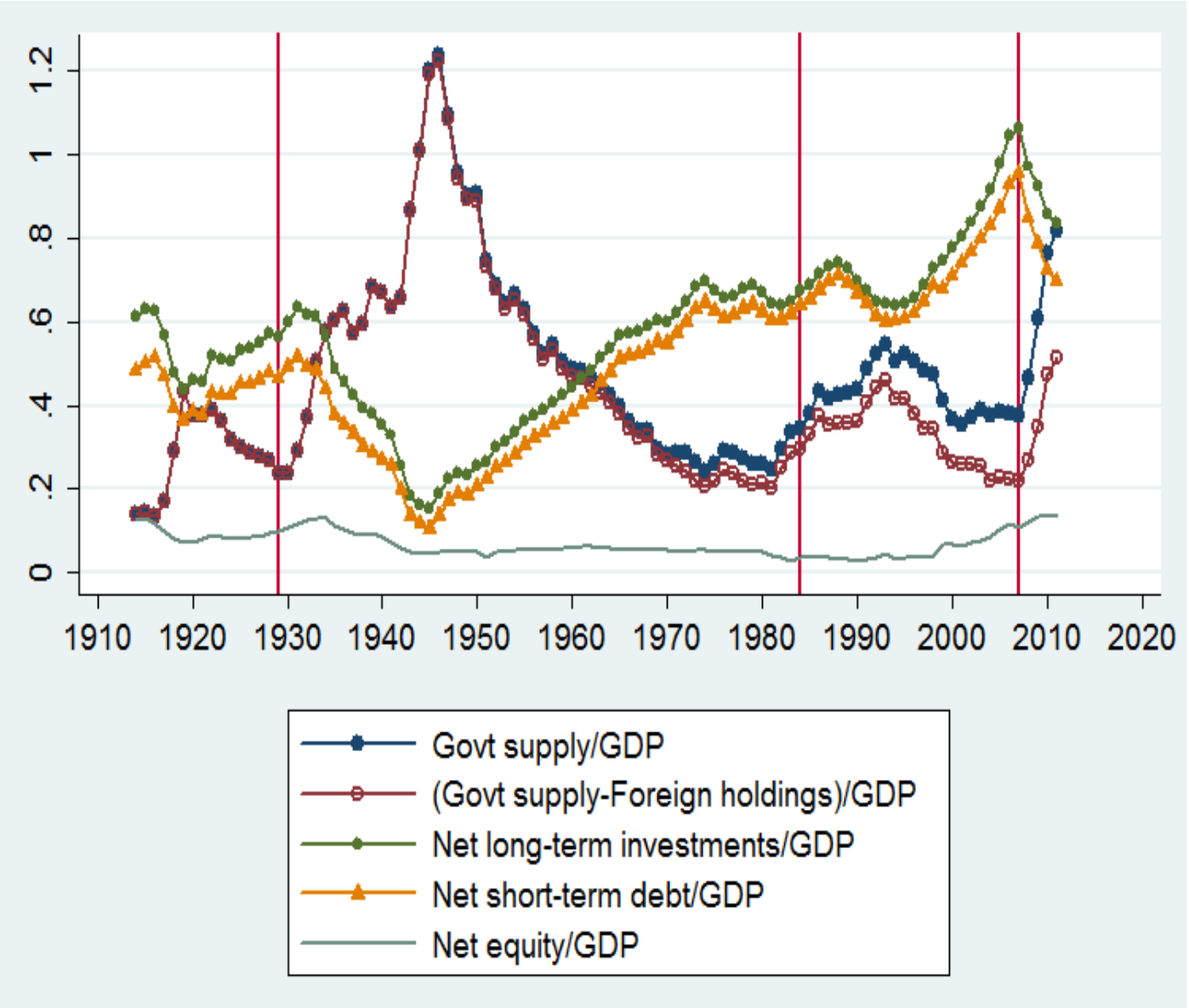
  P2. Decreases net long-term investments (LT asset-LT liabs)

Table 4. Impact of Treasury supply on financial sector balance sheet, 1914-2011
Panel A. Short, long, and equity categories netted

	Govt. supply/GDP	Year	R2	Partial R2 of Govt.
Net long-term investments	-0.506	0.005	0.765	0.332
=(Long-term assets)-(Long-term debt)	(t=-3.84)	(2.62)		
Net short-term debt	-0.486	0.005	0.853	0.325
=(Short-term debt)-(Short-term assets)	(-5.02)	(4.49)		
-(Assets supplied by US govt./Federal reserve)				
Net equity	-0.020	-0.0003	0.118	0.022
=(Equity on liability side-(Equity on asset side)	(-0.47)	(-0.45)		

- Scale all quantity variables by GDP. OLS regressions with std. errors assuming AR(1) error terms. Constant included (not reported).
- Strong support for govt. supply crowding out net short-term debt (P1) and net long-term investments (P2)

Figure 2. Impact of government supply on financial sector balance sheet, 1914-2011
Panel A. Impact on short, long, and equity net categories



Endogeneity?

- Business cycle boom drives up bank lending, bank financing, at the same time that government runs surplus and Debt/GDP falls.
  - We need to control for standard business cycle drivers of bank lending
- Higher deficits indicate future taxation which directly reduces loan demand
  - Control for recent deficits
- Financial crisis leads to disintermediation (less bank debt) and increase in government debt
  - Drop years after crisis

Table 6. Three additional approaches to address endogeneity concerns

Panel A. Controls for loan demand. Dropping most problematic years.

	Dependent variable: Net short-term debt(t)/GDP(t)					
	(1)	(2)	(3)	(4)	(5)	(6)
Govt. supply(t)/GDP(t)	-0.486	-0.309	-0.320	-0.556	-0.487	-0.516
	(t=-5.02)	(-4.81)	(-5.48)	(-5.03)	(-5.67)	(-4.84)
Real GDP(t)/Real GDP(t-5)		-0.094				
		(-2.20)				
Primary deficit/GDP, year t-4 to t				0.119		
				(1.36)		
Primary deficit/GDP, year t+1 to t+5				-0.053		
				(-0.83)		
Year	0.005	0.007	0.007	0.004	0.004	0.004
	(4.49)	(9.24)	(10.82)	(4.85)	(4.59)	(2.90)
R^2	0.853	0.928	0.923	0.900	0.886	0.878
Sample	1914-2011	1934-2011	As (2)	1918-2004	As (4)	Drop year t to t+9 after financial crisis

2) Include controls for recent GDP growth and current budget deficit. Results hold up.

Why? Because government supply has little cyclicality on average. It increases during recessions but also during wars which (in US history) are expansionary.

We also drop the most problematic years with respect to reverse causality, namely those following financial crisis (crisis drives ST debt down and government supply up).

3) Test whether positive demand shock for safe/liquid assets has opposite impact on fin. sector's net supply of short-term debt: Increase in foreign holdings of Treasuries since the early 1970s.

- US trade deficits that underlie this build-up are unlikely to directly cause an increase in US short-term debt (if anything corporate loan demand in the US would decline as more is produced abroad).

- Effect may be larger (in absolute value) than that of government supply since foreign Treasury purchases:
  - Crowd in ST debt in by ``removing'' govt. supply.
  - May correlate with foreign purchase of ST debt, thus increasing ST debt demand.

	Dependent variable:	
	Net short-term debt/GDP	Net long-term investments/GDP
	(1)	(2)
Govt. supply/GDP	-0.508	-0.537
	(-8.41)	(-7.77)
Foreign Treasury holdings/GDP	1.375	1.993
	(4.04)	(5.12)
Year	0.002	0.001
	(2.67)	(0.83)
R^2	0.923	0.903
Sample	1914-2011	1914-2011

4) Examine composition of household expenditures.

- Consider expenditures on ``credit goods'' (products often bought on credit): NIPA categories "Durable goods"+"Housing and utilities
- Treasuries should crowd out such purchases by crowding out funding from banks.
- Because we have agreed upon models of budget shares (Deaton and Muellbauer (1980)), this can be tested without omitted variables concerns:

$$BudgetShare_t^C = \beta_X \ln(Expend_t) + \beta_P \ln\left(\frac{P_t^C}{P_t}\right)$$

If Treasuries matter for budget share controlling for total consumption and relative prices it must be via its impact on funding.

Panel C. ``Rajan-Zingales identification'': Household expenditure shares for ``credit goods''. Are expenditure shares for products often bought with borrowed money higher when government debt supply is smaller?

	Dependent variable: Expenditure share of products often bought with borrowed money	
	(1)	(2)
	Coef.	Coef.
Govt. supply/GDP	-0.064	-0.081
	(t=-4.16)	(-4.41)
Log(real expenditure)	0.051	0.011
	(5.38)	(1.93)
Log(price of products often bought with borrowed money/price of all expenditure)	0.216	
	(5.52)	
R^2	0.814	0.696
Sample	1929-2011	1929-2011

Note: t-statistics in parenthesis. Estimations in all three panels are by OLS with standard errors estimated assuming AR(1) error terms. Regressions include a constant (not reported for brevity). Expenditure on products often bought with borrowed money is defined as the sum of expenditure on durable goods and on housing and utilities. Expenditure data are from NIPA Table 2.3.5 and price data from NIPA Table 2.4.4.

We ask: Are consumption expenditures for products where buyers for technical reasons (usefulness as collateral+size of purchase) often buy them on credit larger in periods with less Treasury supply.

- Good: Controls for the fact that private borrowing and Treasury supply may both be driven by some unobservable (wars/the business cycle).
- At first not so good: Identification doesn't work if the driver of Treasury supply affects expenditures on products usually purchased with borrowed money differently.
- However!!! Theory tells us that there should be very few drivers of budget shares above and beyond funding conditions (total consumption, relative prices). We can control for these.

Two additional results

- Treasury supply and M1
  - Can help stabilize money demand functions ("missing money" puzzle)
- Short-term debt helps predict crises
  - Better than private credit growth

Panel B. Using conventional money measures from Friedman and Schwartz and the Federal Reserve's H6 release

	ln(M1/GDP)						
	1914-1979			1914-2011			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(Nom. yield on	-0.267	-0.233	-0.068	-0.174	-0.115	0.043	-0.079
3-mo com. paper)	(-3.98)	(-4.37)	(-1.52)	(-1.56)	(-2.34)	(1.00)	(-2.30)
ln(Real GDP)		-0.145	-0.207		-0.362	-0.380	-0.203
		(-2.10)	(-4.46)		(-3.63)	(-7.33)	(-4.03)
Government supply/GDP			0.637			0.955	0.641
			(4.53)			(4.72)	(4.90)
Foreign Treasury holdings/GDP							-3.230
							(-4.38)
Constant	-2.183	-1.689	-1.254	-2.093	-0.761	-0.603	-1.283
	(-9.03)	(-5.81)	(-6.27)	(-13.34)	(-2.13)	(-2.92)	(-6.61)
N	66	66	66	98	98	98	98
R^2	0.650	0.783	0.896	0.143	0.792	0.906	0.955

- R2 pretty high pre-80, then tiny. Allowing non-unit elasticity on income helps R2 but coefficients on nom. yield and income are unstable.
- Adding ln(Govt supply/GDP) and ln(Foreign Treasury Holdings/GDP) (not very relevant pre-1980) leads to more stable coefficients.

8. Predicting financial crisis in the US, 1914-2011

- The probability of a financial crisis is:

  P5A: Increasing in net short-term debt

  P5B: Decreasing in government supply.

- Schularick and Taylor (2012): 3 crisis. 1929, 1984, and 2007.

  (Could add 1914, see e.g. Sprague, Oliver M.W., 1915, "The Crisis of 1914 in the United States," American Economic Review)

- We estimate logit models following methodology of Gourinchas and Obstfeld (2012):
  - Use data known in year t to predict crisis in year t+k (k=1 or 3)
  - Drop year t if year t itself is a crisis year or any of year t-1, t-2, t-3, or t-4 were crisis years in order to avoid mechanical biases (cannot be at risk of entering a new crisis until you get out of the current one).
  - Error terms robust to heteroscedasticity.

Table 7. Predicting banking crisis in the US, 1914-2011
Panel A. Using predictors directly

	Dummy=1 if first year of a US banking crisis is in year t+1, t+2, or				Dummy=1 if first year of a US banking crisis is in year t+1			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net short-term debt/GDP		24.277				21.36		
		(t=2.99)				(1.78)		
Private credit/GDP			8.100				7.195	
			(3.25)				(1.75)	
Government supply/GDP				-18.75				-12.674
				(-4.09)				(-3.50)
Foreign Treasury holdings/GDP				21.287				15.627
				(2.10)				(1.01)
Year	0.015	-0.099	-0.07		0.016	-0.094	-0.066	
	(0.79)	(-2.47)	(-2.34)		(0.48)	(-1.43)	(-1.30)	
Area under ROC curve (AUROC)	**0.628**	**0.865**	**0.783**	**0.873**	**0.631**	**0.862**	**0.747**	**0.818**
Std. error for AUROC	0.137	0.065	0.085	0.047	0.265	0.127	0.198	0.092
T	78	78	78	78	78	78	78	78

- Net short-term debt predicts crisis positively (P5A), better than the most popular predictor Private credit/GDP (see AUROCs)
- Govt supply predicts crisis negatively (P5B)

Conclusions

- Important source of variation in financial sector short-term debt:
  - Moneyness of such debt
- We investigate by looking at variation in Treasury supply
- Helps to understand key determinant of financial crises
- Helps to understand missing money puzzle