BACK TO THE FUTURE: BACKTESTING SYSTEMIC RISK MEASURES DURING HISTORICAL BANK RUNS AND THE GREAT DEPRESSION*

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* The views expressed are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of Chicago or the Federal Reserve System.

Backtesting Systemic Risk Measures

- Since the 2008 financial crisis considerable research has been devoted to measuring and identifying systemically risky institutions
- The number of proposed measures is already quite sizable. However, the literature on this topic is still young and no consensus best practice/unifying approach has emerged
- We assess how useful some of the more popular proposed measures are when applied to historical financial panics

Historical Perspective

In 1907, no one had ever heard of an asset-backed security, and a single private individual could command the resources needed to bailout the banking system; and yet, fundamentally, the Panic of 1907 and the Panic of 2008 were instances of the same phenomenon, as I have discussed today. The challenge for policymakers is to identify and isolate the common factors of crises, thereby allowing us to prevent crises when possible and to respond effectively when not.

Chairman Ben S. Bernanke - Speech November 8, 2013
The Crisis as a Classic Financial Panic

- Between the founding of the national banking system (1863) and the establishment of FDIC insurance, the United States witnessed many financial panics similar in anatomy and magnitude to the 2008 crisis.

- The pre-FDIC era appears to be an ideal laboratory for an evaluation of systemic risk measures.

Historical Perspective

- One of the main challenges of constructing a robust measure of systemic risk is the evolving nature of the financial system

- Regulatory measures of firm-level risk has traditionally measured risky behaviors associated with leverage, liquidity, or the collateral backing liquid liabilities
  - Pre-1863: note collateral
  - National banking era: liquid reserves
  - FDIC era: Capital Requirements
  - Dodd-Frank: Capital and Liquidity

Historical Perspective

- With each panic new regulations alter the importance of each measure
- New regulations passed in the wake of panics make the previous risky behavior less profitable and banks adapt to the new methods of funding
- The challenge for regulators is to develop systemic risk monitoring tools that will remain relevant in the face of these changes

Historical Perspective

- Despite very different banking environments there are fundamental similarities across historical financial crises
- All US financial crises occur when liquid liability holders liquidate their claims and bank assets prove too illiquid to satisfy all claimants
- Since the Civil War all major banks have been publically traded and stock holders were acutely aware of their first loss status.
- These stock holders have incentives to monitor risks and “vote with their feet” by selling their shares whenever they think risk is not accurately reflected in their stock price

Measuring Systemic Risk

- We therefore concentrate on two of the most popular stock market based measures of systemic risk: CoVaR and Srisk

- CoVaR [Adrian and Brunnermeier (2016, AER)]
  - Measures tail codependence with the financial system
  - The CoVaR of a financial institution is equal to the difference between the financial system's Value at Risk when the institution's stock return is in its extreme tail versus the financial system's Value at Risk when the institution's stock return is at its median
  - CoVaR therefore measures how much the entire system's VaR increases when the institution is in financial distress.

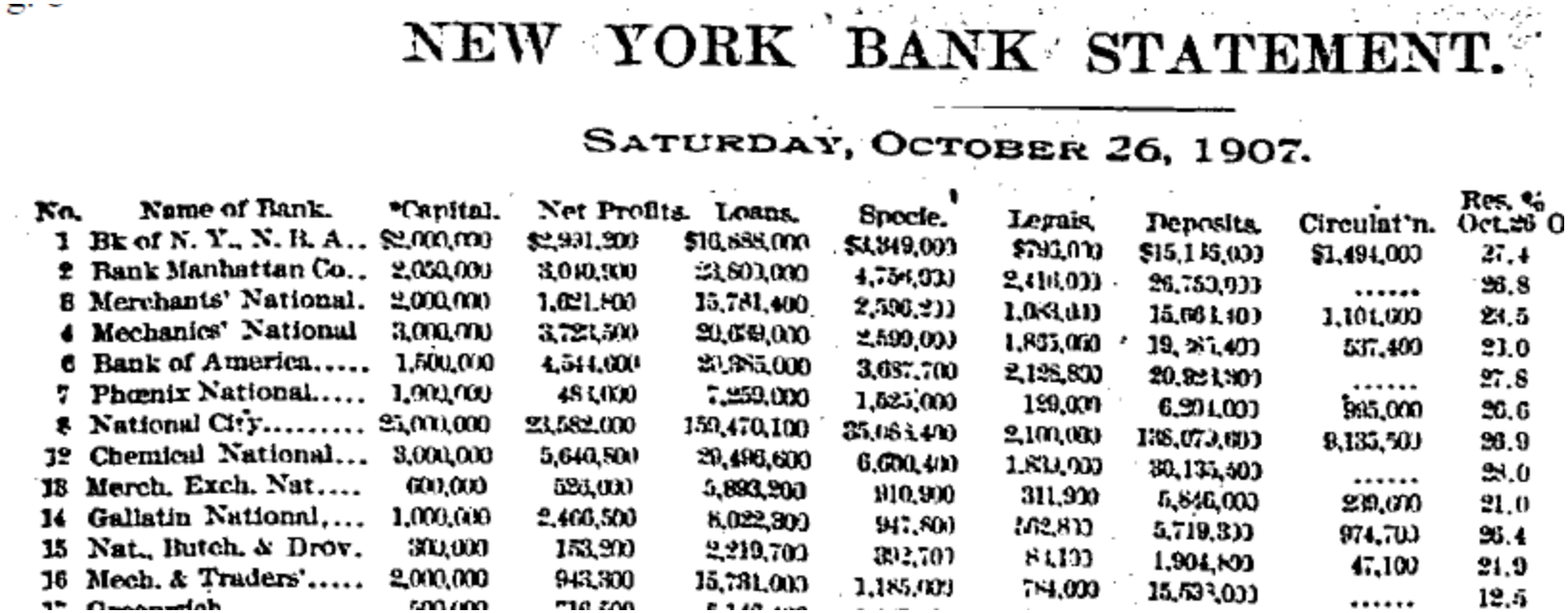
- SRISK [Brownlees and Engle (2016, RFS)]
  - Measures the capital shortfall of a given firm in times of systemic distress
  - The SRISK of a financial institution is the expected capital shortfall of the institution conditional on the return of the financial system being in its extreme tail

Data

- We collect a new dataset of New York bank balance sheets observed every 28-days between 1866 and 1934.
- We combine these new balance sheet data with a pre-existing dataset containing the price and holding period returns of all banks trading over-the-counter in New York City.
- Our combined stock and balance sheet panel spans several financial panics comparable to the 2008 crisis such as the panics of 1873, 1884, 1890, 1893, 1907, 1914, 1921 and 1931.

Data

- Our balance sheet data comes from the weekly reports of the New York Clearing House.



NEW YORK BANK STATEMENT.

SATURDAY, OCTOBER 26, 1907.

No.	Name of Bank.	*Capital.	Net Profits.	Loans.	Specie.	Legals.	Deposits.	Circulat'n.	Res. % Oct.26 O
1	Bk of N. Y., N. B. A..	$2,000,000	$2,931,200	$16,888,000	$3,349,000	$793,000	$15,185,000	$1,494,000	27.4
2	Bank Manhattan Co..	2,050,000	3,040,300	23,803,000	4,756,000	2,418,000	26,753,000	.....	26.8
3	Merchants' National.	2,000,000	1,621,800	15,781,400	2,590,200	1,063,000	15,661,400	1,101,000	24.5
4	Mechanics' National	3,000,000	3,723,500	20,659,000	2,599,000	1,865,000	19,287,400	537,400	21.0
6	Bank of America.....	1,500,000	4,544,000	20,985,000	3,687,700	2,128,800	20,823,900	.....	27.8
7	Phœnix National.....	1,000,000	481,000	7,259,000	1,525,000	199,000	6,204,000	995,000	26.6
8	National City.....	25,000,000	23,582,000	159,470,100	35,063,400	2,100,000	138,079,000	9,135,500	26.9
12	Chemical National...	3,000,000	5,640,500	29,496,600	6,600,400	1,853,000	30,135,400	.....	28.0
13	Merch. Exch. Nat.....	600,000	526,000	5,893,200	910,900	311,900	5,846,000	239,000	21.0
14	Gallatin National,...	1,000,000	2,466,500	8,022,300	947,800	462,800	5,719,300	974,700	25.4
15	Nat., Butch. & Drov.	300,000	153,200	2,219,700	392,700	84,100	1,904,800	47,100	21.9
16	Mech. & Traders'.....	2,000,000	943,300	15,731,000	1,185,000	784,000	15,533,000	.....	12.5
17	Greenwich	500,000	716,500	5,142,400					

Data

- Our stock data comes from over-the-counter quotations published in the financial press

NEW YORK BANKS.

Manhattan and Bronx.

	Bid.	Ask.
America	230	234
Amer Union	195	210
Bk of U S un.	177	179
Bk Yorktown.	224	236
B'way Nat.	186	196
Bryant Pk, n.	74	80
Do rights	32	..
Central Nat.	195	202
Chase	255	258
Chat Phenix.	173	177
Chelsea Exch.	108	111
City	490	494
Columbus	230	260
Commercial.	870	885
Continental.	55½	56½
Fifth Av.	3900	*4050
First Nat.	8150	8300
Grace	900	..
Guild State.	110	130
Harbor State.	80	85
Harriman	1925	2050
Industrial	245	255
Inter Union.	80	85
Lebanon	139	145
Lefcourt N, n	65	70
Liberty	218	225
Manhat Co.	1145	1165
Melrose	260	290
Merchants ex rights	180	190
Midtown	200	215
Penn Exch.	120	130
Pt Morris.	85	..
Prisco State.	600	..
Public	264	268
Seward	160	165
Sixth Av.	220	235
Sterling Nat.	108	116
Straus Nat.	350	360
Textile	63	68
Trade	300	312
Union (Br'x).	130	140
Wash Sq N.	160	170
World Exch.	230	260
Yorkville	..	230

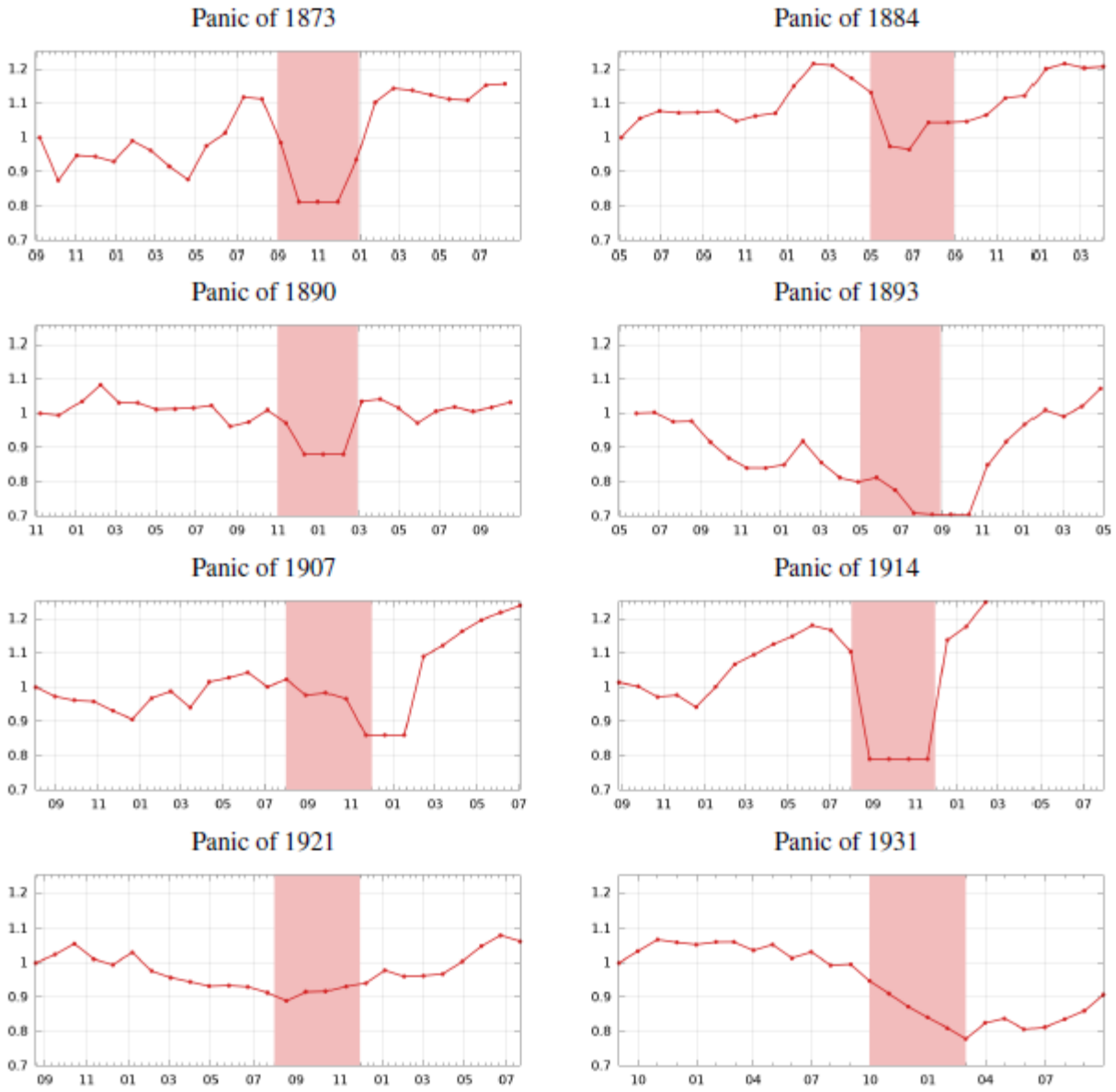
*Ex dividend.

Empirical Strategy

- We estimate a panel of CoVaR and SRISK measures
  - Systemic risk measure at time *t* is estimated with a 5-year rolling window from *t-65* → *t* (recall we have observations every 28-days so 5 years = 65 obs)

- With systemic risk measures in hand, we evaluate the ability of ex-ante measures of CoVaR and SRISK to predict:
  1. Which firms will suffer the largest deposit withdrawals during banking panics.
  2. Whether aggregate systemic risk measures are good measures of system wide deposit withdrawal (our definition of panic)

Figure 2: AGGREGATE DEPOSITS AROUND PANIC EVENTS



Plots of aggregate deposits in a two year window containing each of the panics. The vertical shaded areas are the panics as listed in Table 1.

Empirical Strategy

- We evaluate the ability of CoVaR and SRISK to identify systemically risky firms by evaluating the ability of each systemic risk measure to predict bank deposit losses during financial panics.

- We control for other measures of systemic risk (Leverage, Size, Stock Price Volatility, Beta with the bank index)

$$\Delta \mathsf{Dep}_{it} = \beta\, \mathsf{SRM}_{i\,t-l} + \sum_{k=1}^{p} \gamma_k\, x_{k\,i\,t-l} + \eta_i + \nu_t + u_{it}$$

Horizon	6									
CoVaR	-0.057^{***}	-0.044^{**}			-0.025^{*}	-0.021			-0.038^{**}	-0.028^{*}
	(0.014)	(0.021)			(0.017)	(0.022)			(0.017)	(0.022)
SRISK			-0.566^{***}	-0.527^{***}			-0.513^{***}	-0.510^{***}		
			(0.064)	(0.066)			(0.072)	(0.075)		
Lev					-0.305^{***}	-0.392^{***}	-0.102	-0.121	-0.245^{**}	-0.314^{**}
					(0.123)	(0.144)	(0.115)	(0.138)	(0.122)	(0.141)
Siz					-0.919^{***}	-1.227^{***}	-0.499^{**}	-0.429	-0.881^{***}	-1.036^{***}
					(0.301)	(0.418)	(0.262)	(0.387)	(0.304)	(0.414)
Vol					0.192^{**}	0.190^{*}	0.217^{**}	0.233^{**}	-0.002	0.010
					(0.116)	(0.126)	(0.106)	(0.114)	(0.086)	(0.101)
Beta					-0.099	-0.101	0.239	0.213	-0.182	-0.213
					(0.220)	(0.228)	(0.206)	(0.214)	(0.220)	(0.225)
VaR					-0.281^{***}	-0.287^{***}	-0.260^{***}	-0.225^{**}		
					(0.114)	(0.122)	(0.100)	(0.112)		
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Panic FE		✓		✓		✓		✓		✓
R^2	5.62	8.26	23.67	25.79	13.21	14.26	27.22	27.70	11.10	12.32

Entries are estimates of panel regression model (8) pooling all panic events and regressing $\Delta \mathsf{Dep}_i$, the maximum deposit loss of institution i from the beginning of the panic until the end of the panic window, onto the value of the systemic risk measure ΔCoVaR or SRISK measured in percentage terms, bank fixed effect, panic fixed effect, and a set of controls – level of volatility, beta, leverage, VaR and size. The regressors are computed using the data available 1, 3, and 6 months-ahead of the beginning of the panic event.

Predicting Panics

- The Systemic risk measures do a good job of predicting which banks are likely to suffer deposit losses during panics.
- Can aggregate systemic risk predict when a panic is more likely to occur?
- Short answer: Not very well.

Predicted Capital Shortfall

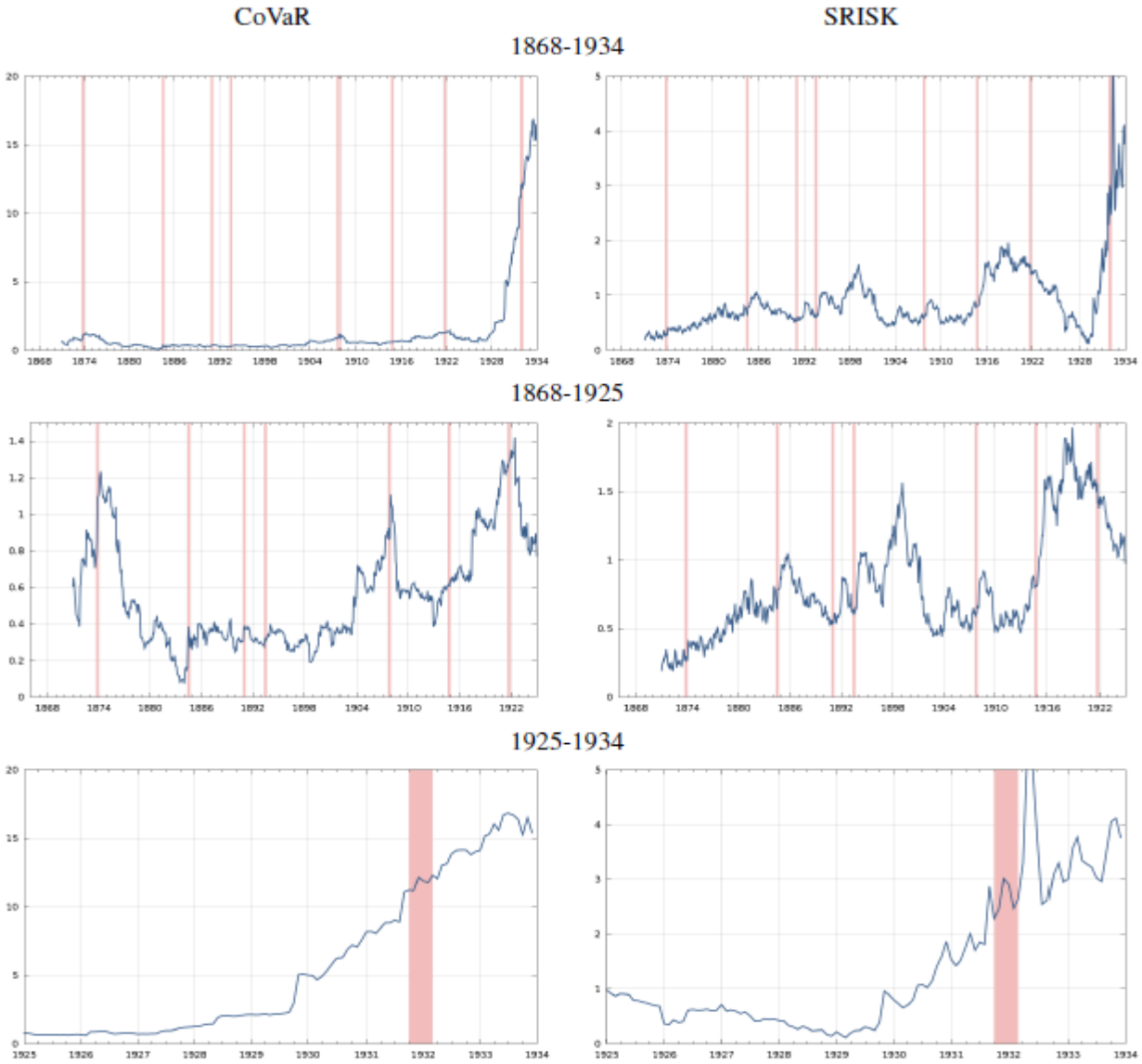
$$\mathrm{CS}_i = \alpha_0 + \alpha_1 \mathrm{SRISK}_i + u_i$$

Table 6: PREDICTED VS ACTUAL CAPITAL SHORTAGES AROUND PANIC EVENTS

	$k = 0.15$			$k = 0.20$			$k = 0.25$		
Panic	α_0	α_1	R^2	α_0	α_1	R^2	α_0	α_1	R^2
1873	0.0021^{***}	-0.4809^{***}	0.05	0.0021^{***}	0.4256^{**}	0.05	0.0017^{***}	0.8302	0.27
	(0.0003)	(0.2894)		(0.0003)	(0.2611)		(0.0003)	(0.1914)	
1884	0.0023^{***}	0.7036	0.11	0.0016^{***}	1.1468	0.40	0.0010^{**}	1.2045^{*}	0.61
	(0.0004)	(0.2951)		(0.0004)	(0.2059)		(0.0004)	(0.1432)	
1890	0.0028^{***}	1.3881	0.14	0.0012^{**}	2.1136^{***}	0.57	0.0004	1.8907^{***}	0.79
	(0.0005)	(0.4583)		(0.0005)	(0.2430)		(0.0004)	(0.1303)	
1893	0.0024^{***}	1.4542	0.16	0.0006	2.0362^{***}	0.64	0.0001	1.7334^{***}	0.85
	(0.0005)	(0.4449)		(0.0004)	(0.2027)		(0.0003)	(0.0965)	
1907	0.0044^{*}	2.6414^{***}	0.41	0.0011	2.1600^{***}	0.76	0.0002	1.6890^{***}	0.87
	(0.0022)	(0.4799)		(0.0016)	(0.1839)		(0.0013)	(0.0977)	
1914	0.0090^{**}	1.7083^{*}	0.27	0.0027	1.9262^{***}	0.68	0.0005	1.6738^{***}	0.85
	(0.0039)	(0.4445)		(0.0030)	(0.2135)		(0.0022)	(0.1108)	
1921	0.0058	2.0834^{***}	0.80	0.0023	1.7442^{***}	0.91	0.0008	1.5243^{***}	0.95
	(0.0054)	(0.1962)		(0.0043)	(0.1047)		(0.0037)	(0.0663)	
1931	0.0352	0.9831	0.58	0.0171	1.0250	0.80	0.0054	1.0042	0.90
	(0.0263)	(0.2071)		(0.0231)	(0.1285)		(0.0200)	(0.0852)	

For each panic event we run a Mincer-Zarnowitz type regression to assess whether SRISK provides an unbiased prediction of such a shortage, that is we consider $\mathrm{CS}_i = \alpha_0 + \alpha_1\ \mathrm{SRISK}_i + u_i$, where CS_i is the realized capital shortage suffered by bank i at the end of the panic window and SRISK_i is measured in dollars.

Figure 4: SYSTEMIC RISK MEASURES



The figures plot the time series of aggregate CoVaR and SRISK over the full sample and over the sub-samples 1868-1925 and 1925-1934. The red vertical shaded area represent the panic periods described in table 1.

$$\Delta\overline{\text{Dep}}_{t+h} = \alpha_0 + \sum_{l=1}^{3} \alpha_l \Delta\overline{\text{Dep}}_{t-l} + \sum_{l=1}^{3} \beta_l \Delta\overline{\text{SRM}}_{t-l} + \sum_{k=1}^{p}\sum_{l=1}^{3} \gamma_{kl} x_{k\,t-l} + u_{t+h} \,,$$

Table 7: AGGREGATE DEPOSIT LOSS REGRESSIONS AROUND PANIC EVENTS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Horizon	1				3			
DG_t	0.925***	0.924***	0.942***	0.946***	0.717***	0.728***	0.766***	0.794***
	(0.051)	(0.062)	(0.053)	(0.060)	(0.074)	(0.067)	(0.075)	(0.072)
DG_{t-1}	0.060**	−0.168***	0.052*	−0.303***	0.026	−0.124**	−0.015	−0.118
	(0.028)	(0.053)	(0.027)	(0.059)	(0.044)	(0.058)	(0.046)	(0.091)
DG_{t-2}	−0.001	−0.004	0.035	0.028	0.025	0.028	0.026	0.006
	(0.064)	(0.075)	(0.064)	(0.077)	(0.060)	(0.061)	(0.071)	(0.067)
$CoVaR_t$	−0.039		−0.035		−0.022		−0.071	
	(0.028)		(0.030)		(0.040)		(0.051)	
$CoVaR_{t-1}$	−0.119***		−0.116***		−0.338***		−0.371***	
	(0.042)		(0.044)		(0.064)		(0.058)	
$CoVaR_{t-2}$	0.006		−0.023		0.102**		0.015	
	(0.029)		(0.025)		(0.050)		(0.053)	
$SRISK_t$		−0.039		−0.091		0.007		0.077
		(0.046)		(0.073)		(0.044)		(0.085)
$SRISK_{t-1}$		−0.074*		−0.060		−0.327***		−0.372***
		(0.041)		(0.045)		(0.070)		(0.068)
$SRISK_{t-2}$		−0.009		0.026		0.024		0.067
		(0.031)		(0.054)		(0.059)		(0.095)
Lev_t			−0.023	0.026			0.015	0.067
			(0.025)	(0.054)			(0.053)	(0.095)
Lev_{t-1}			−0.164***	−0.065**			−0.135***	−0.096***
			(0.017)	(0.026)			(0.025)	(0.034)
Lev_{t-2}			−1.848	−9.999***			−0.181	−3.606
			(1.124)	(2.023)			(1.600)	(2.879)
Siz_t			0.031	0.003			0.084	0.070
			(0.056)	(0.046)			(0.177)	(0.180)
Siz_{t-1}			−0.003	−0.014			−0.085	−0.069
			(0.051)	(0.049)			(0.113)	(0.110)
Siz_{t-2}			−0.029	0.038			0.084	0.068
			(0.067)	(0.065)			(0.157)	(0.158)
Vol_t			−0.031**	−0.003			0.006	−0.016
			(0.015)	(0.022)			(0.024)	(0.032)
Vol_{t-1}			−0.353	−3.040			1.668	3.875
			(1.607)	(2.224)			(1.468)	(2.512)
Vol_{t-2}			0.084	0.106***			0.020	0.031
			(0.056)	(0.040)			(0.094)	(0.086)
$Beta_t$			−0.034	−0.047			−0.024	−0.006
			(0.051)	(0.041)			(0.082)	(0.078)
$Beta_{t-1}$			−0.081	−0.099			0.126	0.056
			(0.072)	(0.064)			(0.114)	(0.105)
$Beta_{t-2}$			0.009	−0.010			0.029	0.007
			(0.016)	(0.019)			(0.022)	(0.030)
VaR_t			0.256	1.812			2.617	4.788*
			(1.166)	(1.486)			(2.054)	(2.565)
VaR_{t-1}			−0.102	−0.041			−0.085	−0.077
			(0.105)	(0.112)			(0.103)	(0.105)
VaR_{t-2}			0.065	0.034			0.008	0.004
			(0.070)	(0.069)			(0.102)	(0.109)
F-test	3.308**	1.498	3.008**	1.037	9.925***	9.091***	13.867***	11.863***
R^2	73.26	71.20	78.17	76.50	31.22	30.43	36.40	36.13
ΔR^2	2.35	0.29	7.26	5.59	1.37	0.58	6.55	6.29

The entries pertain to the time series regressions appearing in equation (9) projecting $\Delta\overline{\text{Dep}}_t$, is the monthly change in aggregate deposits onto its own lags as well as lags of $\Delta\overline{\text{SRM}}_t$, the monthly change is the aggregate systemic risk measures (either CoVaR or SRISK) and controls. An F-test is used to see whether the systemic risk measure are jointly significant (all three lags considered). The ΔR^2 also measures the incremental contribution of the systemic risk regressors.

Conclusion

- CoVar and SRISK are clearly useful – That is good news
- Both measures predicted which banks are likely to suffer runs during past financial panics
- Neither measure is particularly useful for predicting when a panic is likely to occur.
- Thank You!