

# Measuring Stress in Money Markets: The CDSS Index

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# Money Market Stress

- The money market is part of the financial market for low-risk, highly liquid short-term assets, that used to function smoothly.
- On August 9, 2007, money market conditions changed notably, with an abrupt jump in rates and risk spreads marking the beginning of a remarkably long period of turbulence.

# Motivation

- For the real economy and financial system, there exist indices that summarize a wide range of data. No such index has been developed specifically for the money market.
- Policy makers would like to monitor conditions in the money markets closely so that they can act to relieve funding stress when needed.

# The Idea

- The key rates and spreads have a tendency to move together with the degree of general money market stress.
- Combine information from various segments of the money market to measure funding stress at any point in time.
- Utilize co-movement in the money market to extract a common latent factor that reflects the condition of the broader market, filter out the idiosyncratic variation.

## Brief Overview of the Literature

- Aruoba, Diebold, Scotti (2009): ADS Business Conditions Index
- Hakkio and Keaton (2009): Kansas City Financial Stress Index (KCFSI)
- Oet, Eiben, Bianco, Gramlich, Ong (2011): The Cleveland Financial Stress Index
- Carlson, King, Lewis (2011): Financial Stress Index and Economic Activity
- Hollo, Kremer, Lo Duca (2012): CISS-A Composite Indicator of Systemic Stress in the Financial System

# Why Money Markets?

- Narrow focus to rule out fluctuations in general financial markets
- Money markets could be a good leading indicator of broader stress
- Recessions caused by financial crises may be different from other recessions

# Key Variables of Money Market Stress

- Libor-OIS Spread
- FRA-OIS Spread
- Treasury GC Repo-Fed Funds
- TED Spread: 3-month Libor-T-bill rate



# Key Variables of Money Market Stress

- Fed Funds Volume
- Fed Funds Rate Volatility
- Commercial Paper Spreads
  - A2/P2 spread: A2P2-AA 30-day nonfinancial CP
  - AA unsecured financial CP - nonfinancial CP
  - Asset backed CP - AA unsecured nonfinancial CP
- Fraction of unsecured financial CP maturing in 1-4 days
- Foreign Exchange Swap Implied Basis

# Constructing the CDSS index

- Express all variables in same units by standardization.
- Construct a dynamic factor model that serves as a signal extractor.
- Cast the model in state space form.
- Estimate the model using Kalman Filter.

# Common Dynamic Factor Model of Money Market Stress

- Measurement equation:

$$Z_{it} = \beta_i F_t + u_{it}, \quad u_{it}$$

- Transition equation:

$$F_t = \phi_1 F_{t-1} + v_t, \quad v_t \sim NID(0, \sigma_v^2)$$

$$u_{it} = \psi_i u_{i,t-1} + \varepsilon_t, \quad \varepsilon_t \sim NID(0, \omega_i^2)$$

- $Z_{it}$ : all observable variables for  $i = 1, \dots, 11$   
 $\beta_i$ : Factor loadings  
 $u_{it}$ : Idiosyncratic components  
 $F_t$ : unobservable common factor

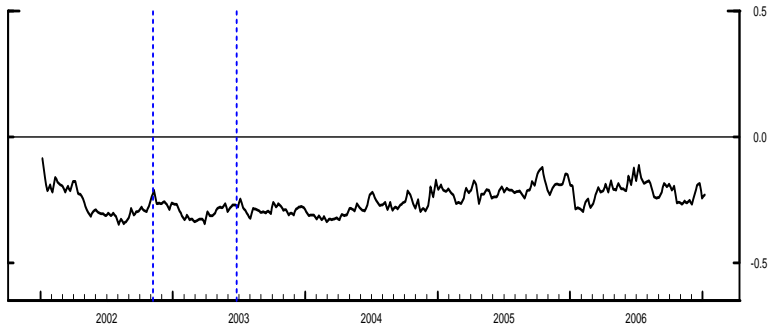
# Estimates of the Dynamic Factor Model of MM Stress

Parameter	Estimate	Parameter	Estimate
$\phi_1$	0.97 (82.51)	$\beta_7$	1.00 (14.84)
$\beta_2$	0.52 (8.95)	$\beta_8$	1.41 (16.65)
$\beta_3$	0.86 (7.85)	$\beta_9$	1.55 (19.48)
$\beta_4$	1.24 (22.24)	$\beta_{10}$	0.28 (2.64)
$\beta_5$	0.18 (2.03)	$\beta_{11}$	1.16 (9.79)
$\beta_6$	1.14 (12.65)	$\sigma_v$	0.16 (21.41)

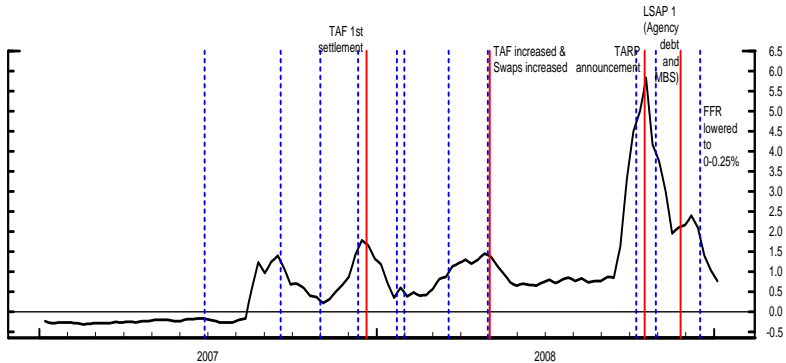
# Estimates of the Dynamic Factor Model of MM Stress

Parameter	Estimate	Parameter	Estimate
$\sigma_{u1}$	0.12 (23.11)	$\psi_1$	0.97 (81.51)
$\sigma_{u2}$	0.19 (31.59)	$\psi_2$	0.97 (98.78)
$\sigma_{u3}$	0.73 (32.21)	$\psi_3$	0.51 (13.27)
$\sigma_{u4}$	0.12 (19.63)	$\psi_4$	0.93 (47.97)
$\sigma_{u5}$	0.31 (32.49)	$\psi_5$	0.95 (67.42)
$\sigma_{u6}$	0.62 (31.58)	$\psi_6$	0.36 (8.04)
$\sigma_{u7}$	0.19 (28.95)	$\psi_7$	0.93 (51.62)
$\sigma_{u8}$	0.35 (28.39)	$\psi_8$	0.55 (9.77)
$\sigma_{u9}$	0.18 (22.21)	$\psi_9$	0.71 (12.65)
$\sigma_{u10}$	0.37 (32.46)	$\psi_{10}$	0.94 (60.29)
$\sigma_{u11}$	0.38 (31.01)	$\psi_{11}$	0.89 (41.87)

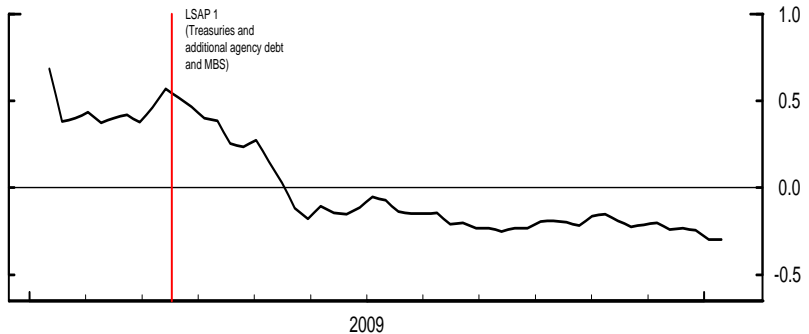
# CDSS Index - Jan. 2002-Dec. 2006



# CDSS Index - Jan. 2007 - Dec. 2008

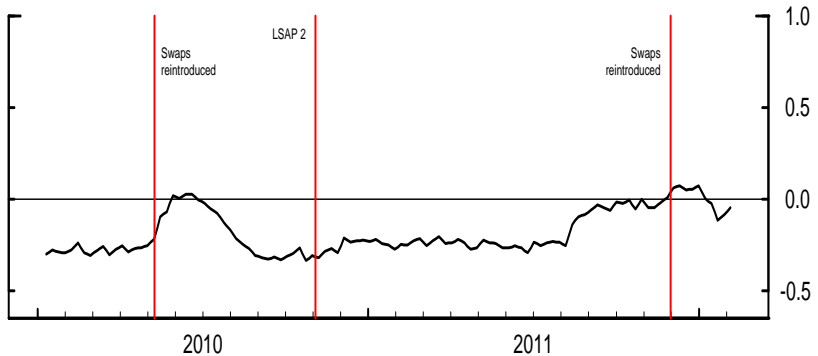


# CDSS Index - Jan. 2009 - Dec. 2009





# CDSS Index - Jan. 2010 - Jan. 2012



# Modeling Cyclical Phases of the Money Market: Markov-switching Factor Analysis

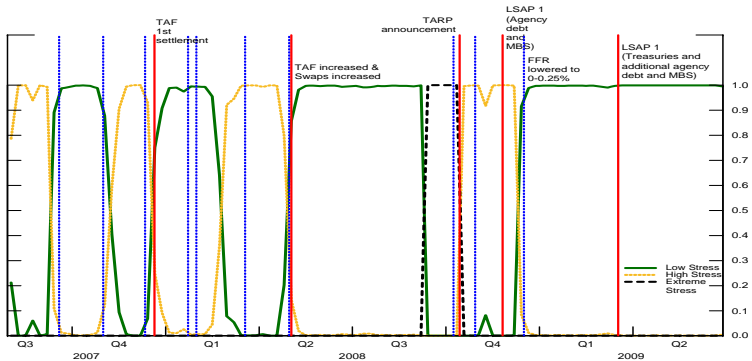
$$\text{Measurement Equation : } Z_{it} = \beta_i F_t + u_{it}, \quad u_{it} \sim NID(0, \sigma_{u_i}^2)$$

$$\text{Transition Equation : } F_t = \alpha_{S_t} + \phi_1 F_{t-1} + v_t, \quad v_t \sim ND(0, \sigma_v^2)$$

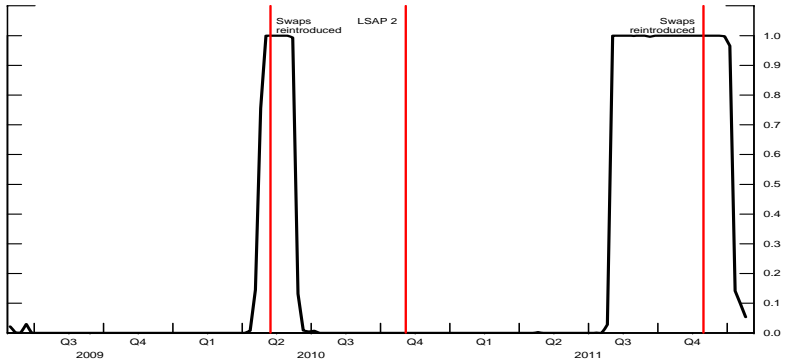
where  $S_t \in \{1, \dots, N\}$ : discrete-state homogeneous Markov chain

$$p_{ij} = Pr(S_t = j | S_{t-1} = i), \quad i, j \in \{1, \dots, N\}$$

# Probability of Degree of Financial Stress: Crisis Period



# Probability of Degree of Financial Stress: Post-Crisis



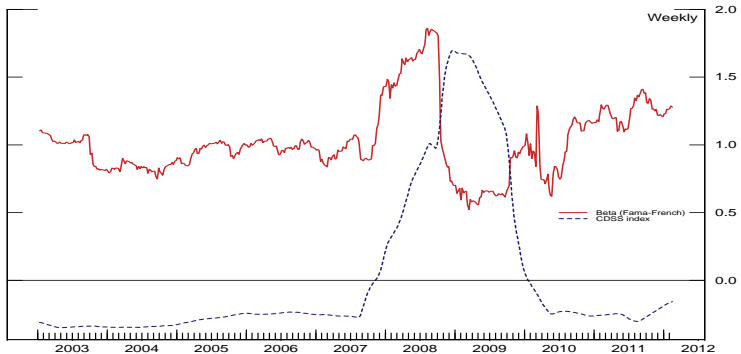
# Money Market Stress and Bank Performance

## Fama-French Three-Factor Framework:

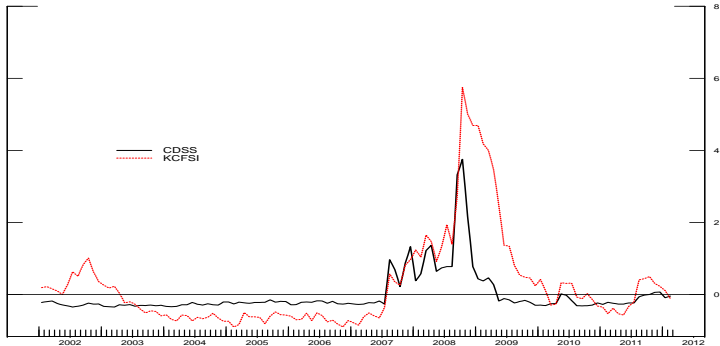
$$\begin{aligned}\Delta \ln(SP_{bank,t}) - r_{f,t} &= \alpha + \beta_1(\Delta \ln(SP_{bank,t}) - r_{f,t}) + \beta_2 SMB_t \\ &+ \beta_3 HML_t + \gamma_1(\Delta \ln(SP_{bank,t}) - r_{f,t}) I_t \\ &+ \gamma_2 SMB_t I_t + \gamma_3 HML_t I_t + \epsilon_t.\end{aligned}$$

		I Full sample 1/9/02-2/1/12	II Pre-crisis 1/9/02-7/25/07	III Crisis I 8/1/07-10/15/08	IV Crisis II 10/22/08-6/24/09	V Crisis III 7/1/09-2/1/12
1.	$\beta_1$	1.23** (15.62)	0.98** (3.79)	2.09** (6.68)	1.09** (2.03)	1.17** (10.45)
2.	$\beta_2$	-0.16** (-1.95)	-0.28 (-0.75)	0.10 (0.24)	0.48 (0.77)	0.16 (0.93)
3.	$\beta_3$	1.12** (5.3)	0.26 (0.51)	2.60** (5.8)	2.70 (2.78)	0.45 (1.58)
4.	$\gamma_1$	-0.17** (-3.17)	0.10 (0.12)	-0.34** (-4.78)	-0.13 (-0.52)	0.12 (0.20)
5.	$\gamma_2$	0.05** (0.62)	-0.35 (-0.29)	-0.10 (-0.76)	0.09 (0.24)	0.91 (1.17)
6.	$\gamma_3$	0.35 (1.41)	0.55 (0.35)	0.04 (0.22)	-0.60 (-1.32)	-1.10 (-1.06)
7.	$\alpha$	-0.23** (-2.21)	-0.01 (-0.16)	-0.53 (-1.51)	-0.37 (-0.47)	-0.10 (-0.62)
	Adjusted $R^2$	0.66	0.66	0.73	0.76	0.72
	No. of obs.	526	290	64	36	136

# The CDSS Index and Rolling Regression Results of the Fama-French Three-Factor Model



# CDSS index versus the KC financial stress index





## Concluding Remarks

- CDSS index reflects funding stress in the money market and matches the cyclical phases of stress.
- Turning points of money market stress cycles are associated with most of the Fed policy actions.
- Banking industry dynamics becomes more idiosyncratic when funding stress is high.

## In progress and future work

- Comparison with broad financial stress indices.
- Funding stress and bank credit channel of monetary policy.
- Contagion in hedge fund industry and funding liquidity channel.