Too-Systemic-To-Fail

What Option Markets Imply About Sector-wide Government Guarantees

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Puzzling Crisis Facts: Missing Aggregate Tail Risk

- Crisis an episode of elevated systemic risk
- Correlations among financials increase sharply
- Financial sector crash insurance surprisingly cheap
  - Financial index puts vs. individual bank OTM puts

$$r_{bank} = r_{index} + \epsilon_{bank}$$

- Specific to financial sector puts
- Alternative explanations
  1. Changes in risk + standard model
  2. Mispricing
  3. Counterparty risk
  4. Illiquidity

A Bailout Guarantee?

- Evidence: financial index puts cheap due to **collective bailout guarantee** for financial sector
- Model without bailout can't match facts
- Model with bailout can
- Highly sensitive to government announcements

How Does it Work?

$$r_{bank} = r_{index} + \epsilon_{bank}$$

- Government truncates sector-wide tail risk
- But does not eliminate any idiosyncratic tail risk

$$\text{Crisis} \Rightarrow \text{Aggregate risk} \uparrow \Rightarrow \begin{cases} \bullet \text{ Puts on } r_{bank} \text{ and } r_{index} \text{ diverge} \\ \bullet \text{ Return correlation} \uparrow \text{: more common variation over non-truncated region} \end{cases}$$

Basket-Index Put Spread

1. Insuring the index: $\max\left(0, K - S^{index}\right)$
2. Insuring each bank: $\sum_i x_i \max\left(0, K - S^i\right)$ *"the basket"*

If *aligned**, then the basket-index OTM put spread informative about:

1. Degree of underlying idiosyncratic vs. systematic risk
2. Government guarantees that potentially affect this risk

$$\text{cost per dollar insured} = \frac{\text{cost of insurance}}{\$ \text{ amount insured}}$$

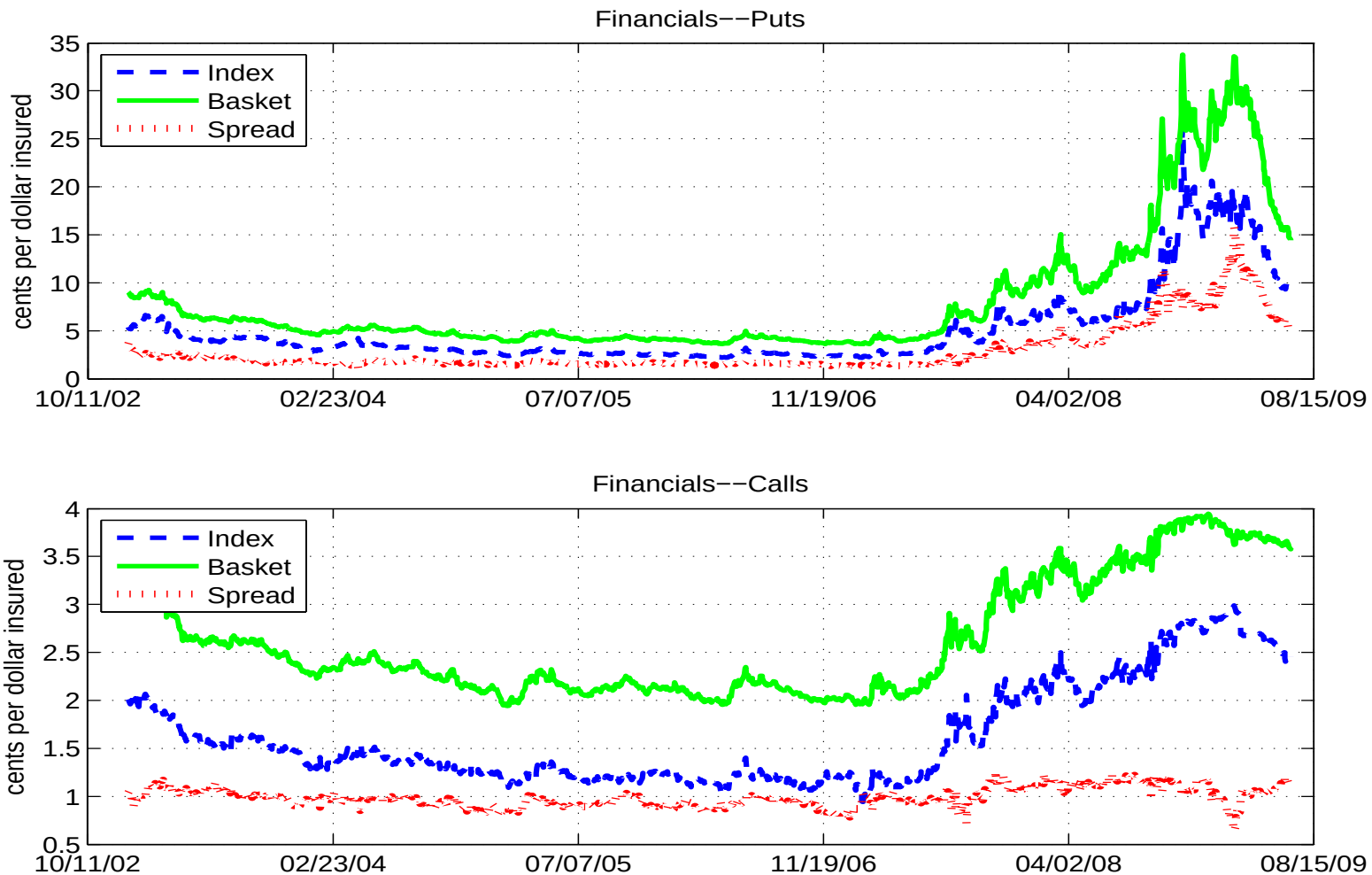
$$\text{basket-index spread} = \text{cpdi}_{\text{basket}} - \text{cpdi}_{\text{index}}$$

*Align: Moneyness, time-to-maturity, and total amount insured

Data: Options on ETFs (1999-2009)

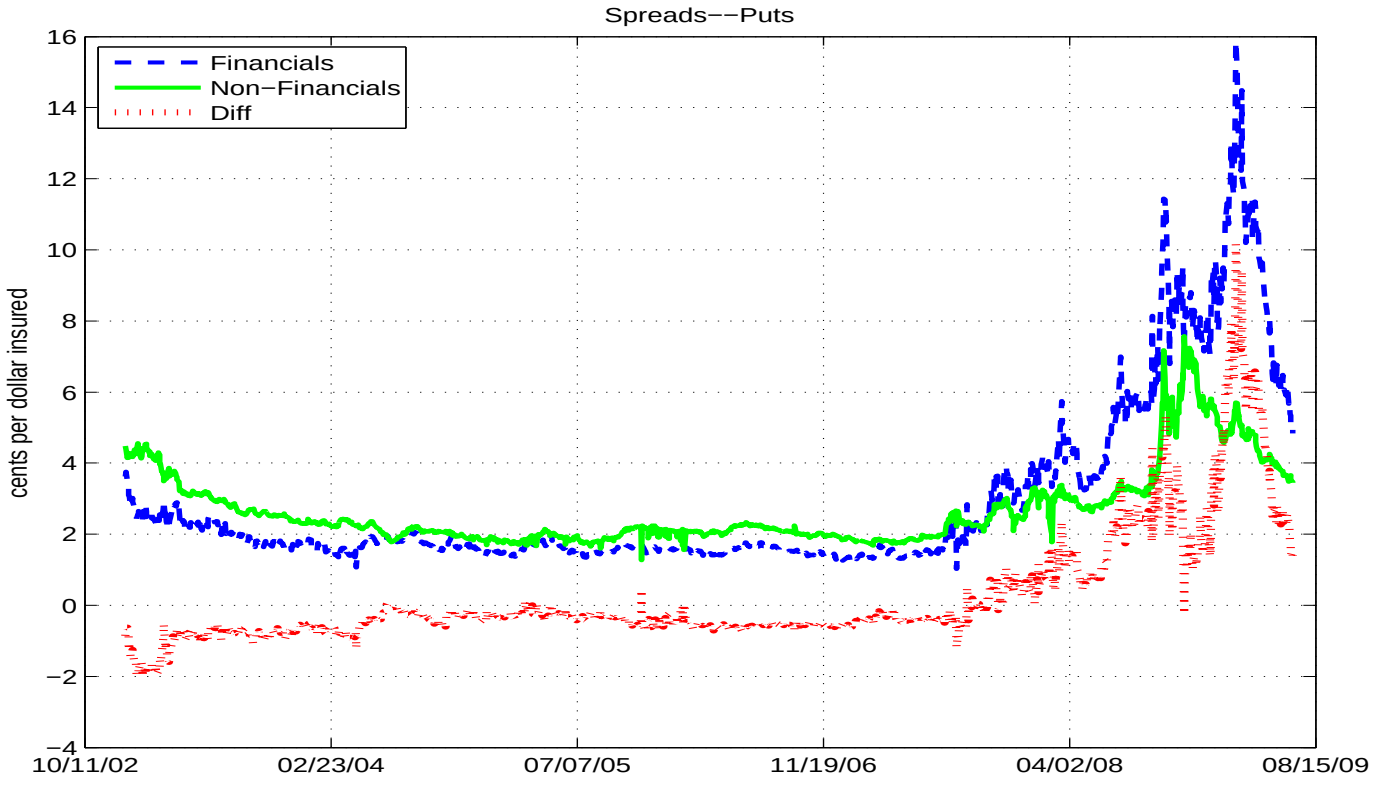
- Exchange-traded options (CBOE) on 9 iShares sector ETFs and on the S&P 500 ETF
  - ◇ Nine sector ETFs, no overlap, span S&P 500
  - ◇ Financial sector ETF: $\sim$90 banks, insurers
- Focus on 365 day *TTM* and $|\Delta| = 20$, similar across moneyness and maturity
- OptionMetrics Vol Surface, raw options for robustness

Basket-Index Put Spread



*Moneyness $|\Delta| = 20$ for individual and index options; *TTM* = 365 days.

Financial vs. Non-financial Basket-Index Put Spread



* Non-financial series is a value-weighted average

Basket-Index Spreads: Summary Statistics

Table: Basket-Index Spreads $|\Delta| = 20$, $TTM = 365$

		Financials		Non-financials	
		Puts	Calls	Puts	Calls
Pre-Crisis	mean	**1.71**	0.95	**2.26**	1.90
(Jan 03-Jul 07)	max	**3.76**	5.10	**9.65**	4.57
Crisis	mean	**5.85**	1.08	**3.70**	2.31
(Aug 07-Jun 09)	max	**15.87**	1.27	**7.58**	2.75

- $diff^2$: crisis – pre-crisis & financials – non-financials: **+2.70** (mean), **+14.18** (max)

Black-Scholes Basket-Index Spread

- One-factor model for log returns:

$$r^{bank} = \mu + \lambda r^{index} + \epsilon$$

  - Compute the BS value:

$$\begin{aligned} Put_F^{BS,index} &= BS(\sigma_{index}, K, r_f, T) \\ Put_F^{BS,basket} &= BS(\sigma_{bank}, K, r_f, T) \end{aligned}$$

  - Feed in index implied vol and realized correlation to back out individual vol:

$$\sigma_{t,index}^2 = \frac{N_t + N_t(N_t - 1)\rho_t}{N_t^2}\sigma_{t,bank}^2.$$

  - Impose symmetry: $N_t = (\sum_i \omega_t^2)^{-1}$

- BS cost per dollar insured for basket versus index:

$$\frac{Put_F^{BS,basket}}{K} - \frac{Put_F^{BS,index}}{K}$$

Basket-Index Spreads for Financials

		BS	data	data-BS
Pre-Crisis	mean	**3.06**	**1.71**	**-1.34**
	max	**6.37**	**3.76**	**1.47**
Crisis	mean	**4.03**	**5.86**	**1.83**
	max	**8.08**	**15.87**	**9.30**

* Basket-Index Spreads $|\Delta| = 20$, $TTM = 365$

Financials

- Pre-crisis: index options expensive relative to basket (**-1.34**)
- Crisis: index options cheap relative to basket (**+1.83**)
- $diff^2$: crisis – pre-crisis & data – BS: **+3.17** (mean) **+7.83** (max)

Non-financials

- Crisis: index options remain expensive relative to basket (**-0.47**)
- $diff^2$: crisis - pre-crisis, Data - B-S: **+1.59** (mean), **+3.77** (max)

Bailout Model

- One-factor model for log returns:

$$r^{bank} = \mu + \lambda r^{index} + \epsilon.$$

- Government announces bailout rule:

$$r^{index} = \min(\tilde{r}, \underline{r}), \quad \tilde{r} \sim \mathcal{N}(0, \delta_r^2).$$

- Compute the BS value:

$$\begin{aligned} Put_F^{Bail,index} &= BS^{Bail}(\sigma_{index}, K, r_f, T, \mu, \rho) \\ Put_F^{Bail,basket} &= BS^{Bail}(\sigma_{bank}, K, r_f, T, \mu, \rho) \end{aligned}$$

- Cost per dollar insured for **basket versus index**:

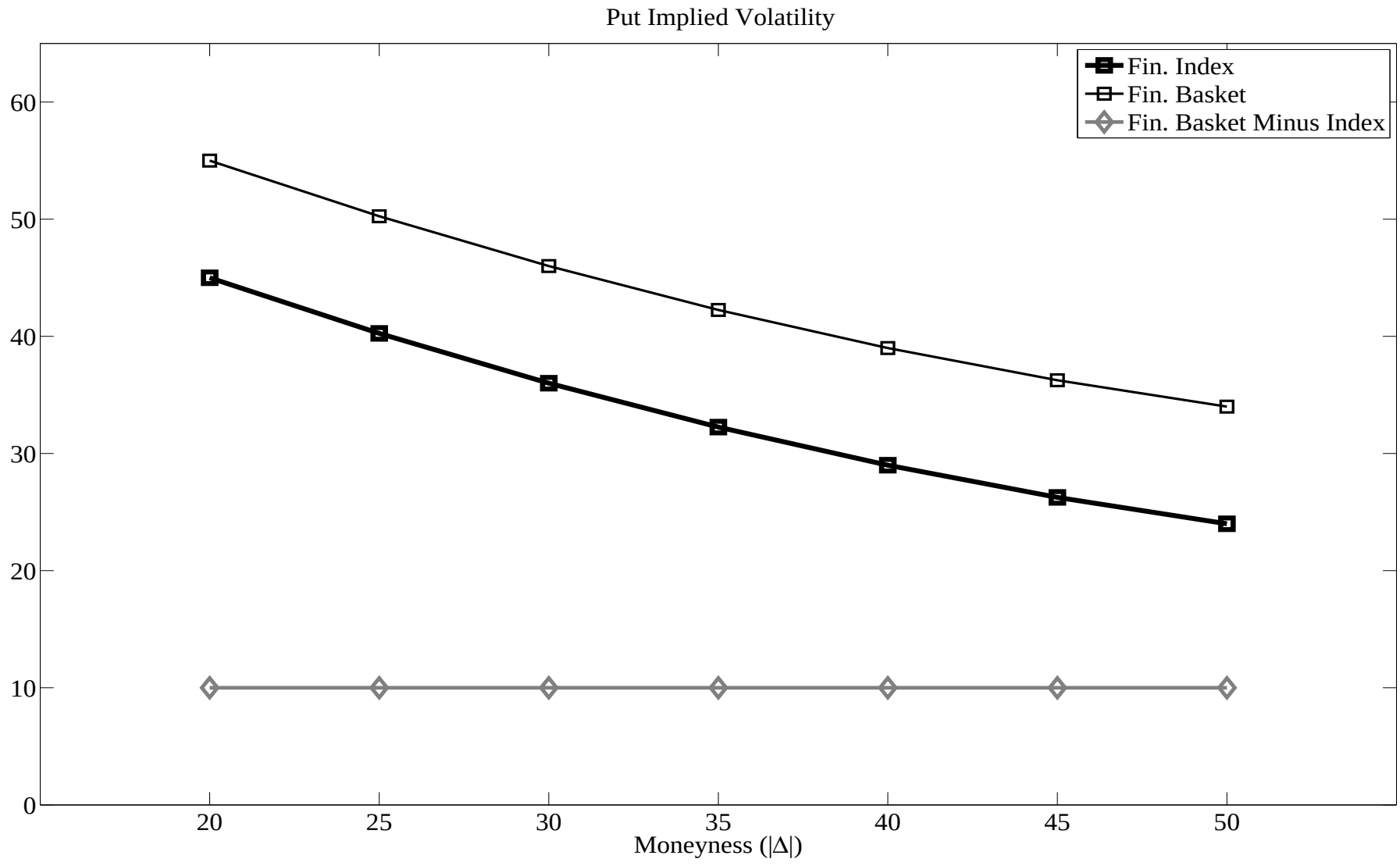
$$\frac{Put_F^{Bail,basket}}{K} - \frac{Put_F^{Bail,index}}{K}$$

Basket-Index Spread With Bailout

		Data minus BS	Bailout $\underline{r} = 0.60$ minus BS
Pre-Crisis	mean	**-1.34**	**-0.01**
	max	**1.47**	**0.01**
Crisis	mean	**1.83**	**1.58**
	max	**9.30**	**8.44**

* Basket-Index Spreads $|\Delta| = 20$, $TTM = 365$

Guarantee and Implied Volatility Skew: Hypothesis



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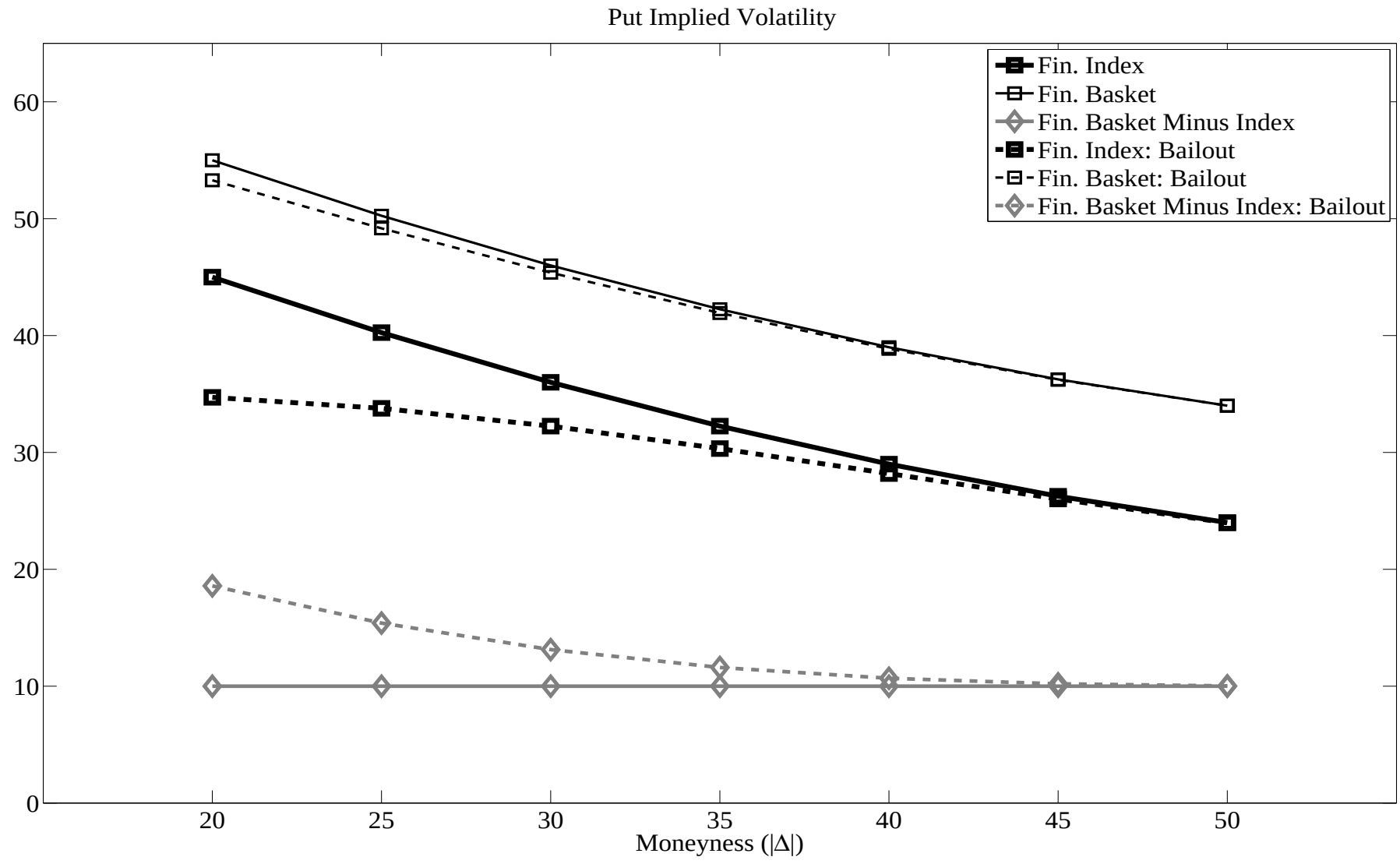
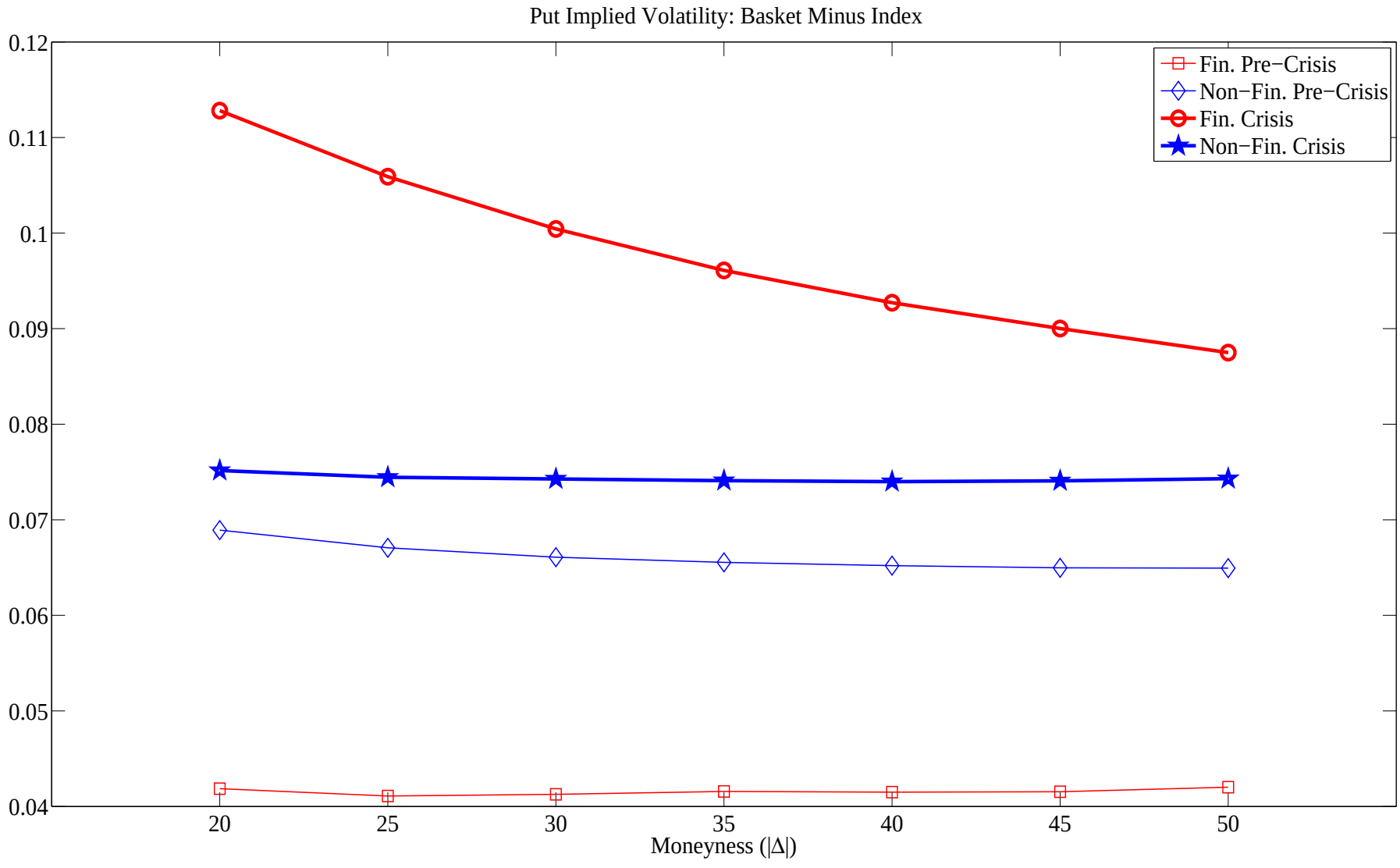


Implied Volatility Skew for Puts: Basket Minus Index



Announcement Effects

Six “positive” events that *ex-ante* suggest increased likelihood/size of bailout, e.g.

- 07/11/2008: Paulson announces bailout plan for Fannie and Freddie
- 10/3/2008: Revised bailout plan (TARP) passes the U.S. House

Subsequent 5 day average spread increase:

- (data – BS, financials – non-financials): 1.27 cents or 40%
- (data – BS): 1.64 cents or 64%

Six “negative” events, e.g.

- 03/3/2008: Bear Stearns is bought for $2 per share
- 09/29/2008: House votes no on the bailout plan

Subsequent 5 day average spread decrease:

- (data – BS, financials – non-financials): 0.91 cents or 28%
- (data – BS): 1.92 cents or 23%

Alternative Explanations

Counterparty Risk

- Marked-to-market daily (margin: market val plus 2-day cushion)
- (Percentage) effect should be larger on short-dated options
- Exchange-traded, guaranteed by the OCC
- Announcement effects should have opposite effect

Mispricing

- Arbitrage involves less capital (vs. CDS basis or TIPS-Treasuries trades)
- Short sale ban was shortlived
- Hedging costs would suggest weaker effect for deep OTM versus ATM options

Liquidity

- Financial index options more liquid than other sectors
- Differential liquidity between individual and index options smaller in financial sector
- No differential liquidity between puts and calls

Summary

- Normally, catastrophe insurance (OTM financial index put) is relatively expensive
- During crisis became cheap (flattened implied vol skew)
- Other facts:
  - Next biggest put spread: Consumer discretionary (autos)
  - Large bank puts much cheaper than small banks (too-big-to-fail)
- Evidence of “too-systemic-to-fail” government guarantee
- Why does this matter?
  - Policy effects: Debt bailout implies prop-up of financial sector equity
  - Guidance for systemic risk measurement
- Structural model suggests that 50% of the equity value of the U.S. financial sector was due to collective bailout guarantee

EXTRA SLIDES

Basket-Index Put Spreads: Other Sectors

Sector		Full Sample	Pre-Crisis	Crisis	Crisis – Pre-Crisis
Financials	mean	2.94	1.71	5.86	4.15
	max	15.87	3.76	15.87	12.11
Consumer Disc.	mean	3.58	2.92	5.12	2.20
	max	12.40	6.35	12.40	6.05
Materials	mean	3.04	2.28	4.84	2.57
	max	10.34	4.54	10.34	5.80
Technology	mean	3.30	2.89	4.27	1.38
	max	9.54	6.27	9.54	3.27
Healthcare	mean	2.52	2.02	3.69	1.67
	max	8.59	5.33	8.59	3.26
Industrials	mean	2.90	2.62	3.57	0.95
	max	7.04	5.17	7.04	1.87
Consumer Staples	mean	2.28	1.96	3.05	1.09
	max	7.90	3.82	7.90	4.08
Utilities	mean	1.87	1.55	2.63	1.08
	max	6.79	3.90	6.79	2.89
Energy	mean	1.99	1.79	2.46	0.67
	max	5.74	5.35	5.74	0.39

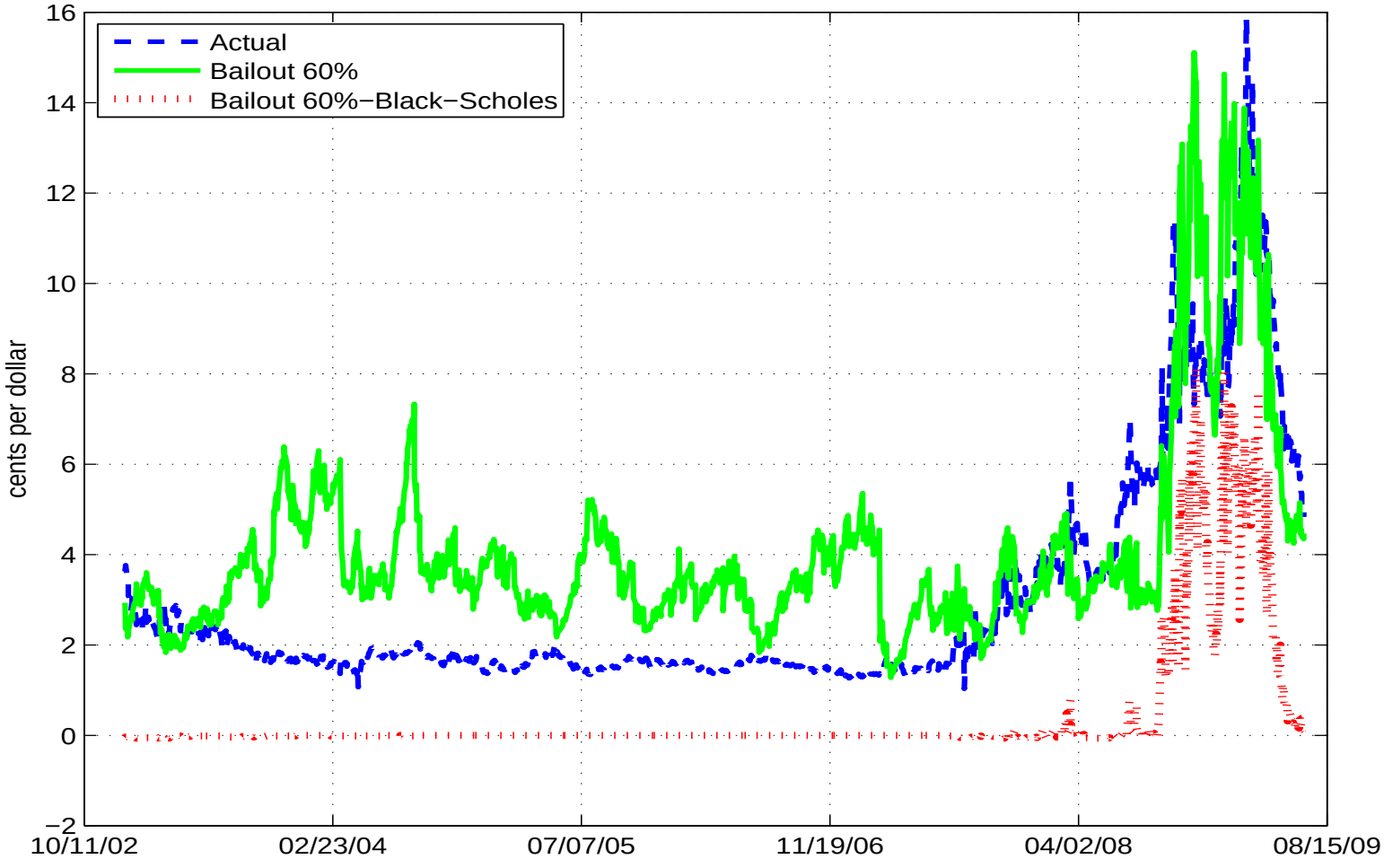
Too-Big-to-Fail?

Put Prices of Largest Banks (differenced versus Black-Scholes)

Table: Volatility-Adjusted Put Prices ($\Delta = 20$, $TTM = 365$)

		Basket	Big 12	*C*	*AIG*	*BoA*	*JP*	*Wells*	*Wach*	*GS*	*Amex*	*MS*	*Mer*	*Fan*	*Fred*
Pre-Crisis	mean	0.20	-0.16	-0.02	0.77	-0.95	-0.58	1.08	0.24	-0.34	-0.07	-1.08	-0.38	-0.57	0.02
	max	3.70	2.89	2.26	3.04	4.21	3.32	3.16	3.21	1.69	2.42	2.37	2.27	3.11	3.61
Crisis	mean	1.69	-1.11	-0.92	-0.59	-3.70	-0.49	-0.10	-5.35	-0.48	1.79	-4.60	-1.05	0.63	1.51
	max	13.58	19.49	27.71	18.38	41.78	14.00	15.39	13.49	17.48	18.84	25.77	9.12	12.88	19.10

Bailout-adjusted Basket-Index Spreads: Actual Minus Black Scholes.



Implied Correlations

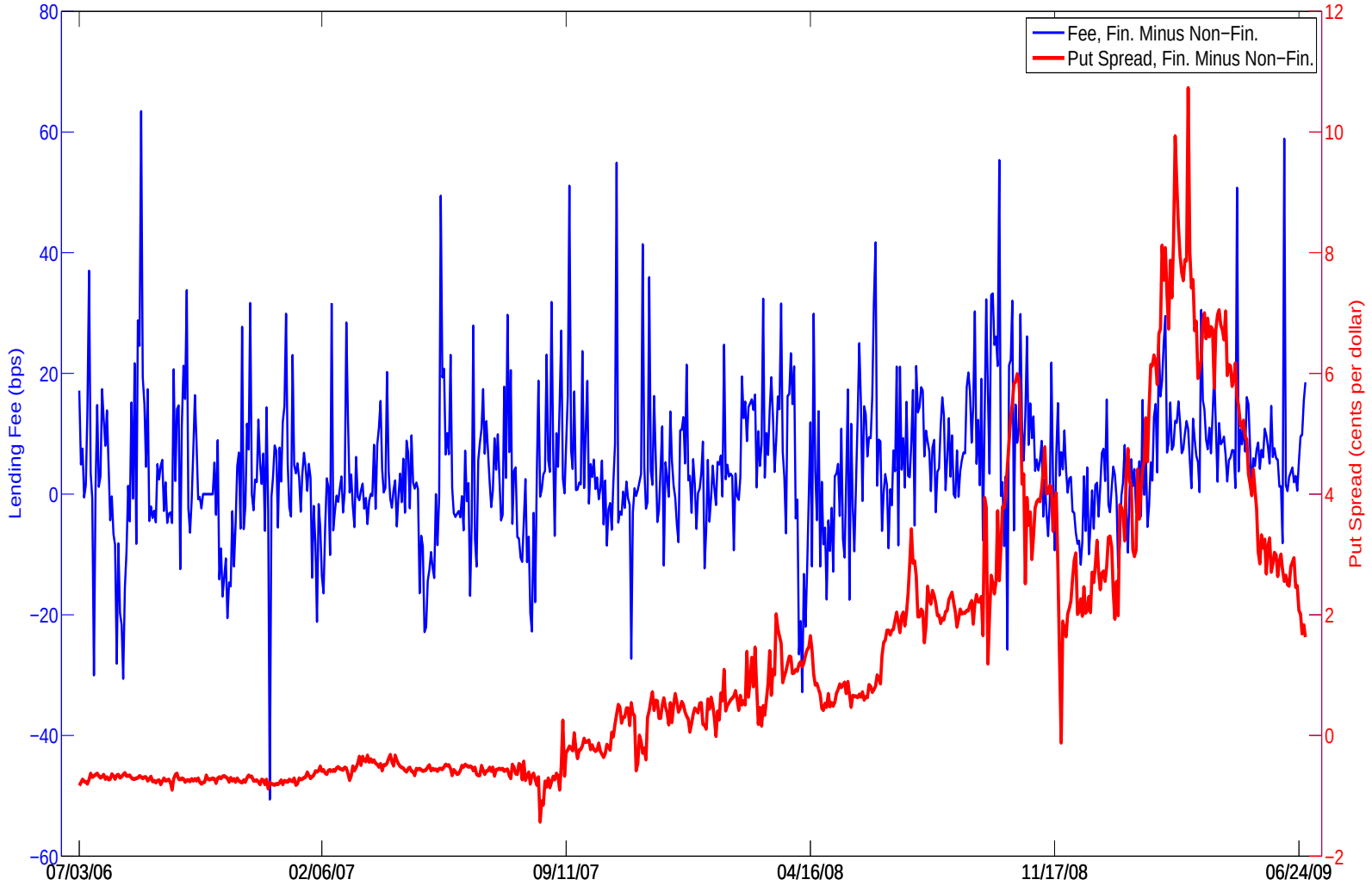
Table: Implied Correlation, $|\Delta| = 20$, $TTM = 365$

		Puts						Puts min Calls
		Fin.		Non-fin.		Diff.		Diff-Diff.
		IC	IC-RC	IC	IC-RC	IC	IC-RC	IC-RC
Pre-Crisis	mean	0.69	0.23	0.55	0.21	0.14	0.03	0.04
Crisis	mean	0.65	0.00	0.61	0.09	0.04	-0.09	-0.18

The implied correlation is chosen such that the B-S basket-index spread matches the actual spread.

- Put implied correlation falls for F, rises for NF
- Correlation risk premium falls much more for F than for NF; F puts become cheap rel. to NF
- F puts become cheap also relative to calls

Short Sale Lending Fees



Put Spread Around Announcement Dates: *diff*^{2}