Mitigating fire sales with contracts: Theory and evidence

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Motivation

- **Fire sales cause severe inefficiencies**
  - Deviations of prices from fundamentals (Coval & Stafford, 2007)
  - Margins $\rightarrow$ Inefficient liquidations (Brunnermeier & Pedersen, 2009)
  - Predatory trading (Brunnermeier & Pedersen, 2005)
  - Ex ante liquidity hoarding (Acharya, Shin & Yorulmazer, 2011)
- **Fire sales often arise from coordination failures**
  - Collectively, investors are better off not selling
  - But... individually rational for each of them to sell

This paper

- Theory: **Agents can mitigate fire sales via private contracting**
  - Model of inefficient fire sales based on Bernardo & Welch (2004)
  - Contract: investors pre-commit to buy assets at above-market prices
  - Penalty for free-riding investors
  - $\rightarrow$ Contract interpreted as a CCP

- Empirics: **Fire sale mitigation by CCPs**
  - First historical example during the 1900 wool crisis
  - Coordination occurred in conditions implied by the model
  - Present-day CCPs run auctions with very similar effects

Model - Setup

- **Timing**: $t = 0, 1, 2$
- **Asset**: Risky security, normally distributed payoff $\tilde{R} \sim \mathcal{N}(\mu, \sigma^2)$
  - Endogenous prices $p_0(s_0)$ and $p_1(s_0, s_1)$ at dates 0 and 1
  - s_0, s_1: Sales at dates 0 and 1
- **Mass 1 of end-investors**
  - Risk-neutral, hold the asset at $t = 0$
  - With prob. λ, a fraction $\delta \in [0, 1]$ fails at date 1 $\rightarrow$ Assets liquidated
  - Date-1 capital constraint κ, given initial equity $\bar{e}$

$$\kappa \bar{e} \leq p_1,$$

- **Market-maker**: initial wealth $\bar{W}$
  - Risk-averse, with exponential utility $u(w) = -e^{-\gamma w}$
  - $\rightarrow$ Prices fall when market-maker inventory increases

Model - Efficient allocation

- **Efficient allocation**
  - Date 0: No asset sales
  - Date 1: Sell δ with prob. λ
  - Forced sales only if $p_1(0, \delta)$ binds capital constraint

- **Proposition 1**: If $\kappa\bar{e} \leq p_1(0, \delta)$, then $s_0 = 0$ and $s_1 = \delta$.
  - Do not expect constraint to bind $\rightarrow$ Do not sell

- **Date-1 asset price solves** (when defaults occur)

$$\mathbb{E}\left[-e^{-\gamma(\bar{W}+\delta(\tilde{R}-p_1(0,\delta)))}\right] = \mathbb{E}\left[-e^{-\gamma\bar{W}}\right].$$

$$\implies p_1(0, \delta) = \mu - \frac{\gamma\delta}{2}\sigma^2,$$

Model - Fire sales

- **Investor conjectures a fraction α will sell**
  - With prob. $(1-\lambda)$: No defaults, receive μ at $t=2$
  - With prob. $\lambda\delta$: He defaults at $t=1 \rightarrow$ utility is zero
  - With prob. $\lambda(1-\delta)$: A mass δ defaults $\rightarrow$ Forced sales $1-\alpha$

- $F(\alpha)$: **Expected net benefit of selling at $t=0$**

$$F(\alpha) = \underbrace{p_0(\alpha)}_{\text{If sell at } t=0} - \underbrace{\lambda(1-\delta)p_1(\alpha, 1-\alpha)}_{\text{If forced to liquidate at } t=1} - \underbrace{(1-\lambda(1-\delta))\mu}_{\text{If no liquidation}}$$

- **Proposition 2:** $\alpha^* = 0$ never an equilibrium when $\lambda(1-\delta) > 0$
  - Expectation of forced sales lead to preemptive sales at $t=0$
  - Inefficient since date-1 defaults occur only with prob. λ
  - $\alpha^* = 1$ if $\lambda(1-\delta) > 1/2$

Model - Contract

- **Contract between investors and market-maker**
  - Market-maker commits to buy at $p_1^C = \kappa \bar{e}$ in default states
  - In exchange, investors pay q^C in non-default states
  - $\rightarrow p_1^C$ exactly sufficient to avoid fire sales

- **Participation constraint of investors**

$$q^C \leq \frac{1-\lambda\delta}{1-\lambda} \underbrace{\alpha(\mu - p_0(\alpha))}_{\text{Date-0 inefficiency}} + \frac{\lambda - \lambda\delta}{1-\lambda} \underbrace{(1-\alpha)(\mu - p_1(\alpha, 1-\alpha))}_{\text{Date-1 inefficiency}}$$

- **Participation constraint of market-maker** (when binds)

$$q^C = \frac{\ln(1-\lambda) - \ln(1-\lambda e^{\gamma\delta\left[p_1^C - p_1(0,\delta)\right]})}{\gamma},$$

Model - Contract

- **Proposition 3**: Fire sales eliminated for a set of parameters
  - If the capital shortfall is low enough
  - But there is an upper bound to p_1^C

- **Potential for free-riding**
  - Assume all other investors have signed the contract
  - A given investor (of mass 0) is better off not signing
  - $\rightarrow$ Fire sales are avoided, but save q^C

- **Eliminating fire sales**
  - Penalty for free-riding investors must satisfy

$$f^C \geq (1-\lambda)q^C$$

Model - Contract as a CCP

- **Contract implemented as a CCP**
  - CCPs run auctions to liquidate positions at above-market prices
  - Penalty? Exclusion from market if refuse to participate
  - $\rightarrow$ Centralization helps coordination to avoid free-riding
- **Contract feasibility requires observability of shocks**
  - Among all liquidity shocks, defaults are the most observable
  - $\rightarrow$ Can explain why CCPs focus on default events
  - Variation margins $\rightarrow$ Make liquidity shocks observable
- **Other functions of CCPs?**
  - Multilateral netting + counterparty risk mitigation
  - If other benefits, penalty for not abiding to CCP rules are larger
  - $\rightarrow$ Makes free-riding even more costly

Evidence - Historical background

- **Wool market of Roubaix-Tourcoing**
  - Major center of industrial revolution ("French Manchester")
  - Wool trade gives risk to price risk for dealers
  - Futures market with CCP (created in 1888) to hedge this risk
  - CCP did not initially play any role to mitigate fire sales

- **Wool crisis in 1900**
  - Massive drop in prices $\rightarrow$ 46% in a few months
  - August 1900: 18 trading houses suspend payments
  - Risk of "liquidity spiral" $\rightarrow$ Forced sales leading to forced sales

- **Data**
  - Multiple archive sources
  - Daily *Bulletin des laines* published by the exchange

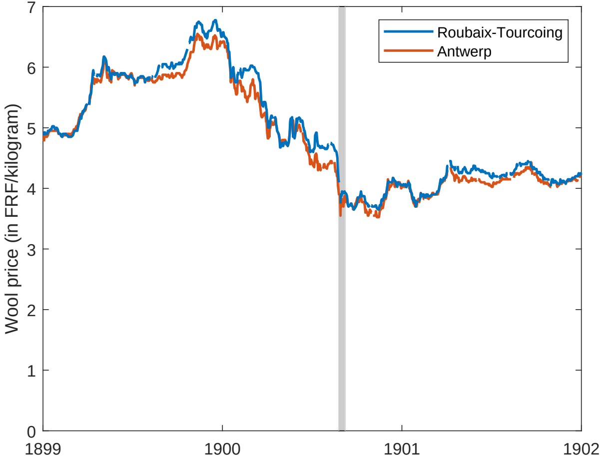
Evidence - Decisions to mitigate fire sales

- **Decisions to mitigate predatory short-selling**
  - Increase margins in several steps (from 1,000 FRF)
  - Aug. 28th: Special margins of 10,000 FRF for short positions
  - Penalty for positions settled without physical delivery
- **Settlement at above-market prices**
  - Did not liquidate positions in open market
  - Organized sale with members
  - Delcambre (1907): "*Instead of throwing defaulted positions in the open market, the CLG sold them amicably. They were bought at a single price by houses which, having sold futures in the past, agreed to close their positions.*"
- **Decisions not mandated by rulebook**
  - Criticized by some parties early on
  - But soon widely praised $\rightarrow$ Mutually beneficial

Evidence - Achieving coordination

- **Close family ties helped achieve coordination**
  - Landes (1976): Family values, endogamy within textile industry
  - Family relationships substitute for formal legal arrangements
  - Deviating is more costly if family values are strong
- **CCP took decisions to prevent side trades**
  - CCP refused to register trades of members doing side trades
  - $\rightarrow$ They would de facto be excluded from the market
  - CCP suspended publication of prices

Evidence - From prices



- **No evidence of price dislocation** → Confirmed by tests

Evidence - From trade flows

- **Test for effects on real economic activity**
  - Focus on trade flows More volatile than production
  - Data: 14 textiles, 24 customs, over 1896-1905

- **Difference-in-differences estimation**

$$Trade_{ct} = \beta_1 \cdot Post_t \cdot TrCity_c + \beta_2 \cdot Post_t + \beta_3 \cdot TrCity_c + \epsilon_{ct},$$

  - $Trade_{ct}$: Share of imports/exports of city c in year t
  - $TrCity_c$: Equals 1 for Roubaix and Tourcoing
  - $Post_t$: Equals 1 after 1900

- **Triple difference-in-differences estimation**
  - At the product-city-year level
  - Additionally compare wool to other textiles

Evidence - From trade flows

	Share of imports			Log volume of imports		
$TrCity_c \cdot Post_t$	-0.002	0.000	0.001	-0.053	0.016	-0.026
	(0.016)	(0.021)	(0.014)	(0.479)	(0.626)	(0.448)
$TrCity_c$	-0.015	-0.040***	-0.017*	-1.442***	-2.331***	-1.514***
	(0.011)	(0.015)	(0.010)	(0.339)	(0.443)	(0.316)
$Post_t$	0.000	-0.000	-0.000	0.101	0.090	0.079
	(0.006)	(0.006)	(0.006)	(0.195)	(0.180)	(0.182)
Treated: Dunkerque	Yes	No	Yes	Yes	No	Yes
Treated: Lille	Yes	No	Yes	Yes	No	Yes
Trade type	Gen.	Gen.	Spe.	Gen.	Gen.	Spe.
R^2	0.006	0.044	0.009	0.127	0.179	0.154
N. Obs.	240	240	240	240	240	240

- **No significant effect on total trade flows**
  - Robust to including post-treatment year dummies
  - Robust to triple-difference estimation

Implications for CCP design

- **Similar mechanisms are now widespread in CCPs**
  - Auctions with incentivized participation
  - Incentivization via default fund juniorization + Fines
  - $\rightarrow$ But often only seen as a protection for CCPs
  - Anecdotal evidence from the Lehman auction by LCH in 2008
- **Implications of the model**
  - Auctions should be run even when CCP is away from distress
  - Incentive mechanisms should bind whenever large defaults occur
  - CCPs can limit ex ante potential for fire sales via position limits

Conclusion

- **Fire sales can be eliminated via private contracting**
  - Contract with pre-commitment to buy + penalties
  - Contract resembles a CCP and explains several of its features
  - Historical evidence consistent with theory
- **For future work**
  - Can the contract be implemented by other institutions?
  - Can CCPs mitigate fire sales that are not arising from defaults?
  - Relative role of contracts and policy to mitigate fire sales?