Understanding Financial Frictions in the Chinese Capital Market

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What are the common perceptions of the Chinese capital markets?

- Already quite big.
  - Stock market capitalization: $8.5 Trillion (vs. USA: $34 Trillion)
  - 2nd largest in the world
What are the common perceptions of the Chinese capital markets?

- High percentage of (unsophisticated) individual investors.
- High volatility, high turnover.

Figure 1.2: Volatility and Turnover of the Stock Market (1990-2016)

- Monthly turnover is measured as the total number of shares traded divided by the total number of floating shares outstanding. Monthly turnover is simply the sum of daily turnover in a month.

The high turnovers in the earlier years was mainly due to the limited number of stocks and the overwhelming enthusiasm in stock investment. The monthly turnover averaged around 20%, significantly higher than that in mature markets. In addition, the turnover exhibits substantial fluctuations over time, exceeding 120% in 1994, 1997 and 2007 while dropping below 10% in 2002, 2012 and 2013, but with no obvious time trend.

E Stock Market Organization

Different Types of Shares

- **A Shares** represent the shares listed on the two main stock exchanges that are denominated in Renminbi (RMB). In the following discussion of China's stock market, we will mainly focus on A shares, which comprise approximately 96% of all shares traded.

- **B Shares** were established in 1992 in both Shanghai and Shenzhen. Initially, the participants were exclusively foreign investors. Since February 19, 2001, however, this market was opened to domestic individual investors. On the Shanghai Stock Exchange, prices are denominated in U.S. dollars while on the Shenzhen Stock Exchange prices are...
What are the common perceptions of the Chinese capital markets?

- **Complicated institutional details (a lot of restrictions).**
  - Daily price limit
  - \( T + 1 \)
  - ST (special treatment)
  - Foreign access
  - ...

- **Global impact of Chinese financial shocks.**
  - Example: sudden devaluation of the Yuan in 08/2015
Two Examples


Circuit Breakers

- **What is it?**
  - Trading halt following extreme price movements.
  - Market-wide CBs; CBs for individual stocks.
  - First advocated by the Brady Commission following the Black Monday of 1987. Now widely adopted around the world.

- **Why?**
  - To reduce excess volatility and improve price efficiency?
  - To restore orderly trading in the market?
  - To protect investors?

- **What are the consequences?**
Circuit Breakers: Chinese Experience

First implemented on Jan 04, 2016, following the market crash in summer 2015. Abandoned after just 4 days.
Model Setup

- A continuous-time endowment economy over interval $[0, T]$.
- Aggregate stock: one unit, with terminal dividend $D_T$.
  
  $$dD_t = \mu D_t dt + \sigma D_t dZ_t, \quad D_0 = 1$$

- Riskless bond: net supply $\Delta$, pays off 1 at time $T$.

- Two competitive agents: $A$ and $B$
  - Endowed with $\omega$ and $1 - \omega$ shares of the stock and bond.
  - Log preferences over terminal wealth
    
    $$u_i(W^i_T) = \ln(W^i_T), \quad i = \{A, B\}$$

- No intermediate consumption $\Rightarrow$ riskless bond as numeraire.
Heterogeneous Beliefs

- The two agents disagree about the growth rate of dividend.
- Agent A has objective beliefs:
  \[ \mu^A = \mu \]
- Agent B's belief:
  \[ \mu^B_t = \mu + \delta_t \]
  - Constant disagreement: \( \delta_t \equiv \delta \)
  - Extrapolative disagreement: \( d\delta_t = \nu dZ_t \)
- The two agents “agree to disagree.”
- Need trading. Heterogeneous risk aversion works similarly.
The stock market will be closed until $T$ whenever the price of the stock $S_t$ falls below the level $(1 - \alpha)S_0$.

$$\tau = \inf\{t \geq 0 : S_t = (1 - \alpha)S_0\}$$

$\alpha$: circuit breaker limit, $\alpha \in [0, 1]$

$S_0$: initial stock price — endogenous

After stock market closure agents are not able to change their stock positions.

Bond market remains open throughout the interval $[0, T]$. 
Equilibrium: No Circuit Breakers

- Markets are dynamically complete ⇒ solve for equilibrium via the planner’s problem.

\[
\max_{\hat{W}_T^A, \hat{W}_T^B} \mathbb{E}_0 \left[ \lambda \ln(\hat{W}_T^A) + (1 - \lambda) \eta_T \ln(\hat{W}_T^B) \right]
\]

subject to resource constraint

\[
\hat{W}_T^A + \hat{W}_T^B = D_T + \Delta
\]

- Stock price when \( \Delta \to 0 \): wealth-weighted average of the prices under two agents’ beliefs

\[
\hat{S}_t = \left( \frac{\hat{\omega}_t^A}{\hat{S}_t^A} + \frac{\hat{\omega}_t^B}{\hat{S}_t^B} \right)^{-1}
\]

\( \hat{S}_t^i \): price in a single-agent economy with agent \( i \)
\( \hat{\omega}_t^i \): agent \( i \)’s wealth share
Equilibrium: Circuit Breakers

- Two scenarios:
  - CB is not triggered between 0 and $T$;
  - CB is triggered at time $\tau < T$.

- Markets are still dynamically complete over interval $[0, \tau \land T]$.

- Solution strategy:
  1. Pin down stopping rule $\tau$ consistent with a given stopping price $S$ through equilibrium conditions upon market closure.
  2. Given stopping time $\tau$, solve for equilibrium allocation at $\tau \land T$ via planner’s problem.
  3. Compute price at $t \leq \tau \land T$ for given $\tau$ and $S$, $S_t(\tau, S)$.
  4. Solve for $S$ through the fixed point problem,

\[
S = (1 - \alpha) S_0(S)
\]
Suppose agent $i$ has wealth $W^i_\tau$ at time $\tau \leq T$.

Portfolio problem at time $\tau$ for competitive agents:

$$V^i(W^i_\tau, \tau) = \max_{\theta^i_\tau, \phi^i_\tau} \mathbb{E}^i_\tau \left[ \ln(\theta^i_\tau D_T + \phi^i_\tau) \right]$$

s.t. $\theta^i_\tau S_\tau + \phi^i_\tau = W^i_\tau$

$$W^i_T \geq 0$$

$V^i(W^i_\tau, \tau)$: indirect utility function for agent $i$ at time $\tau$

Market clearing conditions:

$$\theta^A_\tau + \theta^B_\tau = 1 \quad \text{(stock market)}$$

$$\phi^A_\tau + \phi^B_\tau = \Delta \quad \text{(bond market)}$$
Equilibrium (Δ → 0 case): Upon Market Closure

- Market closure ⇒ inability to rebalance between τ and T
  - Illiquidity + log utility ⇒ no short or levered position at τ
  - Leverage constraint binds for the optimistic agent
    ⇒ pessimistic agent becomes the marginal investor.
  - Assumption Δ → 0 to be relaxed later.

Proposition

In the limiting case with Δ → 0, upon market closure at τ < T, both agents will hold all of their wealth in the stock with no bonds. The market clearing price is

\[ S_\tau = \min\{\hat{S}_A^\tau, \hat{S}_B^\tau\} \]

- Stopping rule τ is expressed in closed form as a function of state variables.
Lemma

Take the stopping price $S$ as given. Define a stopping time

$$\tau = \inf\{t \geq 0 : D_t = D(t, \delta_t, S)\}.$$  

Then the circuit breaker is triggered at time $\tau$ when $\tau \leq T$.

- We have managed to characterize a stopping time that is based on the endogenous stock price $S_t$ as one that is based on the exogenous processes of $D_t$ and $\delta_t$. 
Equilibrium: Before Market Closure

- Solve for optimal allocation at $\tau \wedge T$ through the planner problem, using the indirect utilities upon market closure:

$$\max_{W^A_{\tau \wedge T}, W^B_{\tau \wedge T}} \mathbb{E}_0 \left[ \lambda V^A(W^A_{\tau \wedge T}, \tau \wedge T) + (1 - \lambda) \eta_T V^B(W^B_{\tau \wedge T}, \tau \wedge T) \right]$$

subject to

$$W^A_{\tau \wedge T} + W^B_{\tau \wedge T} = S_{\tau \wedge T} + \Delta$$

- The price of the stock at time $t \leq \tau \wedge T$:

$$S_t = \mathbb{E}_t \left[ \frac{\pi^A_{\tau \wedge T}}{\pi^A_t} S_{\tau \wedge T} \right] = \left( \omega_t^A \mathbb{E}_t[S_{\tau \wedge T}^{-1}] + \omega_t^B \mathbb{E}_t[S_{\tau \wedge T}^{-1}] \right)^{-1}$$
Fixed point problem

\[ S = (1 - \alpha) S_0(\tau(S), S) \] (\text{\#})

Proposition

There is a unique solution to (\#) for any \( \alpha \in [0, 1] \).
Special Case: Constant Disagreement

Calibration:

- $T = 1$
- $\mu = 10%/250$
- $\sigma = 3$
- $\alpha = 5$
- $\delta = -2$
- $\omega = 90$

Agent B is pessimistic.

Most wealth initially owned by rational agent.
Price and Agent A’s Portfolio Holdings

Dotted line – complete markets, solid – circuit breakers, horizontal dashed – $S/D$ ratio in representative-agent economies
Dotted line – complete markets, solid – circuit breakers, horizontal dashed – volatility ratio in a representative-agent economy
Stronger Effects Earlier during Trading Session

$t = 0.25$

$t = 0.75$

Fundamental value: $D_t$

$S_t/D_t$

$\sigma_{S_t} (%)$

Fundamental value: $D_t$

$\sigma_{S_t} (%)$
Circuit breaker vs. pre-scheduled trading halt

Fundamental value: $D_t$

$S_t/D_t$ vs. $\sigma_s(t)$ (%)

$t = 0.25$

$t = 0.5$

Fundamental value: $D_t$
Welfare Loss as a Function of Rational Agent Initial Share of Wealth

- $\omega$ – initial wealth share of agent A
- Welfare loss is relative to the complete markets case.
Robustness and Extensions

- Non-zero bond supply
- Bounded shocks (discrete time)
  - No need to completely delever/close short positions.
  - Equilibrium can “flip” like with positive bond supply.

- Upside vs. downside CBs
- CBs based other variables: volatility, volume
- Multiple-tiered CBs
A competitive benchmark to study the dynamic effects of CBs.

CBs tend to have the following effects:

→ Lower the price-dividend ratio (increase price distortion)
→ Daily price range ↓, conditional and realized volatility ↑
→ Magnet Effect: raise probability of the stock price to reach the threshold limit

Main mechanism applies to other forms of disappearing liquidity: price limits, short-sale ban, trading frequency restrictions, sudden price jumps

Policy implications:

→ “Reduce volatility”: Which volatility?
→ Lucas critique: Danger of using historical data to estimate the likelihood of CB trigger after implementation.

Equilibrium asset prices depend on both fundamental and liquidity.

What exactly is “liquidity”?

Asset pledgeability: the ability to be used as collateral to borrow (and help reduce financing costs).

Closely related to repo specials (Duffie, 1996) and margin-based asset pricing (Garleanu & Pederson, 2010).

Why are the Chinese bond markets suitable for this question?

Same bonds are traded on two different markets, with different rules for repos.

An unexpected policy change on one of the two markets: an arguably exogenous shock to pledgeability.
Chinese bond market: 3rd in the world behind U.S. and Japan

China's Outstanding Corporate Bonds by Category

- ABS (CBIRC CSRC NAFMII)
- Private Placement Note (NAFMII)
- Commercial Paper (NAFMII)
- Mid-term Note (NAFMII)
- Corporation Bond (CSRC)
- Enterprise Bond (NDRC)

Notional Outstanding (trillion RMB)

Market Share

Dec-02, Dec-03, Dec-04, Dec-05, Dec-06, Dec-07, Dec-08, Dec-09, Dec-10, Dec-11, Dec-12, Dec-13, Dec-14, Dec-15, Dec-16, Dec-17

Corporate Bond/All Bond
Corporate Bond/GDP
Two corporate bond markets

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Trade Size</th>
<th>Trading Frequency</th>
<th>Participants</th>
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<tr>
<td>Exchange</td>
<td>Order-driven</td>
<td>Small</td>
<td>High</td>
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<tr>
<td>Interbank</td>
<td>Quote-driven</td>
<td>Large</td>
<td>Low</td>
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</table>

- Repo transactions are done differently in the two markets.

**Exchange (EX) market, centralized**
- Repos are done with the exchange.
- Haircut schedules set unilaterally by the exchange; mainly based on bond ratings and liquidity.

**Interbank (IB) market, over-the-counter**
- Repos are between two private parties.
- Haircuts set via negotiation; depend on counterparties as well as the bond.
(Limits to) arbitrage:

- Buying a bond in one market and selling it in the other requires the application for *custody transfer*.

- Lengthy process:
  - $\rightarrow$ EX $\rightarrow$ IB: 3 days for enterprise bonds (1 day for Treasuries);
  - $\leftarrow$ IB $\rightarrow$ EX: 5 days or more.
Differences in pledgeability + limits to arbitrage ⇒ same bond being traded at different prices in the two markets.

Other factors could also lead to price differences: participants; trading protocols

Exchange market premium:

\[
\text{EX premium} = s_{IB}^{EX} = \text{spread}_{IB} - \text{spread}_{EX}
\]
Rating-based haircuts

- **Pledgeability in EX market:**
  - Borrowing capacity quoted as a fraction of bond face value (discount factor).
  
  \[
  \text{haircut} = 1 - \frac{\text{discount factor} \times \text{book value}}{\text{market value}}
  \]

  - Haircuts largely depend on credit ratings (besides volatility, turnover).
    - Rating explains 96.1% of the variation in haircuts (vs. 96.3% in a kitchen-sink regression).

- **High rating bonds enjoy an EX premium.**
  - The ease of repo transactions in exchange market: the counterparty is always there + potentially more favorable haircuts
  - Transparency in the ability to obtain collateralized borrowing
Event: Dec 8, 2014

- Background (Chen, He, & Liu, 2017)
  - 2009 stimulus funded by massive local government debt
  - Rapid growth of Municipal Corporate Bonds (MCB) in 2012-2013
    - MCB is a form of enterprise bonds, largely dual-listed
  - In 2014, regulators started several rounds of coordinated effort to curb the local government debt problem
    - E.g., swap program (swap between MCB and municipal bonds)

- After market closing on Dec 8, 2014, EX market suspended the repo eligibility of all enterprise bonds rated AA+ and below.

- Interesting policy shock
  - Exchange market is not the main gate-keeper/regulator of MCB, but took an unexpected aggressive move.
  - It caused significant market reactions.
  - Blunt policy tool that depends on coarse (and often uninformative) ratings
Haircuts across ratings before and after the event

Haircut of Dual-Listed Bonds across Ratings


AAA  AA+  AA  AA-
Haircut distributions

Haircut for each rating group (Half year before event)
Haircut distributions

Haircut for each rating group (Half year after event)

- AAA
- AA
- AA+
- AA-

excludes outside values
Yield spreads across ratings: EX

Credit Spreads of Dual-listed Bonds: EX Market

AAA  AA+  AA  AA−
Yield spreads across ratings: IB

Credit Spreads of Dual-listed Bonds: IB Market

AAA  AA+  AA  AA-
Exchange premia before and after the shock

IB and EX credit spreads, pre event

IB and EX credit spreads, post event
**EX premium during event**

- **Diff-in-diff: first cut**
  - Dual-listed and *same-day trading* ⇒ fundamentals fully controlled for.
  - Across ratings, treatment and control groups

- Control group consists of both higher- (AAA) and lower-rated (AA-) bonds.
  - Ruling out “lower-rating bonds are just more sensitive to macro shocks”.

![EX Premia across ratings, sample with same-day trading](chart)
EX premium during event

- **Diff-in-diff: with controls**
  - Rating-time dummy: For bond $i$ on date $t$, define $I_{i,t}^{j,\tau} = 1$ when it has rating $j$ during period $\tau$, where $j \in \{AAA, AA+, AA, AA-\}$ and $\tau$ is one of the sub periods around the event.
  - Regression specification:
    \[
    s_{i,t}^{IB-EX} = \sum_{j,\tau} k_{j,\tau} I_{i,t}^{j,\tau} + controls_{i,t} + \epsilon_{i,t}
    \]

- **Controls:**
  - Bond level characteristics: coupon, leverage, size, time to maturity, turnover ratio
  - Macro factors: term spread, SHIBOR, CDBSpot, stock market index
EX premium during event

EX Premia, with control, dual-listed and same-day trading

- HighRating (AAA)
- MidRating (AA+&AA)
- LowRating (AA-)

(-45,-27) (-27,-9) (-9,0) (0,9) (9,27) (27,45)
IV estimate of the effect of pledgeability on pricing

- **Instrumental Variable:**

  $$shock_{i,t} = \begin{cases} 
  1 & \text{if rating } \in \{AA+, AA\} \& t \text{ is after 12/08/14} \\
  0 & \text{otherwise}
  \end{cases}$$

- **Two-stage procedure:**
  - First stage: Regress haircuts on shocks.
  - Second stage: Regress EX premium on fitted haircuts.
  - Similar control variables as before
    - Bond level characteristics: coupon, leverage, size, time to maturity, turnover ratio
    - Macro factors: term spread, SHIBOR, CDBSpot, stock market index

- **Sample:** dual-listed and same-day trading
## First Stage

<table>
<thead>
<tr>
<th>Dependent Var:</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
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<td>R-sq</td>
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*Clustered by Bond and Year-Week*
### Second Stage

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<tr>
<td><strong>EX premium</strong></td>
<td>Full</td>
<td>AA+ &amp; AA</td>
<td>AA+</td>
<td>AA</td>
<td><strong>Haircut</strong></td>
<td>-0.003*** (-5.414)</td>
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<td><strong>Turnover Ratio</strong></td>
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<td>0.000</td>
<td>0.001</td>
<td>(0.338)</td>
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*Clustered by Bond and Year-Week*
IV estimate of the effect of pledgeability

- Our estimate based on the EX premium is likely to be downward biased.
  - The IB prices of bonds hit by EX policy are affected as well due to potential arbitrage and over-controlling.

- A second estimate is based on matched AAA exchange bonds.
  - AAA bonds with the same pledgeability and yield spread; but free of policy shock.

- Based on dual-listed sample (instead of “dual-listed and same-day trading”)
## Second Stage (Versus matched AAA)

<table>
<thead>
<tr>
<th>Dependent Var:</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Spread of matched AAA-Spread of the bond)</td>
<td>AA+ &amp; AA</td>
<td>AA+</td>
<td>AA</td>
<td></td>
</tr>
<tr>
<td><strong>Haircut</strong></td>
<td>-0.008***</td>
<td>-0.006***</td>
<td>-0.006***</td>
<td>-0.006***</td>
</tr>
<tr>
<td></td>
<td>(-16.962)</td>
<td>(-6.593)</td>
<td>(-5.858)</td>
<td>(-4.778)</td>
</tr>
<tr>
<td><strong>Maturity</strong></td>
<td>0.002</td>
<td>0.001</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.856)</td>
<td>(0.404)</td>
<td>(1.238)</td>
<td></td>
</tr>
<tr>
<td><strong>Turnover Ratio</strong></td>
<td>0.011*</td>
<td>0.011</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.960)</td>
<td>(1.612)</td>
<td>(1.196)</td>
<td></td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>-0.005***</td>
<td>-0.007***</td>
<td>-0.003</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-2.910)</td>
<td>(-3.058)</td>
<td>(-1.084)</td>
<td></td>
</tr>
<tr>
<td><strong>Leverage</strong></td>
<td>-0.023***</td>
<td>-0.018***</td>
<td>-0.029***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-4.043)</td>
<td>(-2.851)</td>
<td>(-3.143)</td>
<td></td>
</tr>
<tr>
<td><strong>CDBSpot</strong></td>
<td>0.012</td>
<td>0.001</td>
<td>0.055</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.225)</td>
<td>(-0.026)</td>
<td>(0.657)</td>
<td></td>
</tr>
<tr>
<td><strong>Term Spread</strong></td>
<td>0.107</td>
<td>0.066</td>
<td>0.182*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.200)</td>
<td>(0.680)</td>
<td>(1.879)</td>
<td></td>
</tr>
<tr>
<td><strong>SHIBOR</strong></td>
<td>-0.087**</td>
<td>-0.086**</td>
<td>-0.089*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-2.556)</td>
<td>(-2.453)</td>
<td>(-1.987)</td>
<td></td>
</tr>
<tr>
<td><strong>Stock Index</strong></td>
<td>-0.008</td>
<td>-0.054</td>
<td>0.072</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-0.104)</td>
<td>(-0.697)</td>
<td>(0.685)</td>
<td></td>
</tr>
<tr>
<td><strong>FE_bond</strong></td>
<td>Control</td>
<td>Control</td>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>16735</td>
<td>16611</td>
<td>10612</td>
<td>5995</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.677</td>
<td>0.687</td>
<td>0.667</td>
<td>0.710</td>
</tr>
</tbody>
</table>

*Clustered by Bond and Year-Week*
IV estimate of the effect of pledgeability

- Economic magnitude
  - 1% change in haircut translates to 0.6 bps change in yield, or about 3.7 cents change in price for an average dual-listed bond.

- Sensitivity table
  - Price change given an X% change in haircut for Y year maturity
  - Yield: 6.45%, coupon rate: 6.62%, face value: 100
### Sensitivity Table

<table>
<thead>
<tr>
<th>Magnitude = 0.6 bps</th>
<th>Magnitude = 0.5 bps</th>
<th>Magnitude = 0.8 bps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5%</td>
<td>20%</td>
</tr>
<tr>
<td>5 Y</td>
<td>0.13</td>
<td>0.50</td>
</tr>
<tr>
<td>10 Y</td>
<td>0.22</td>
<td>0.87</td>
</tr>
<tr>
<td>20 Y</td>
<td>0.34</td>
<td>1.35</td>
</tr>
</tbody>
</table>
Conclusion

- Causal effect of pledgeability on asset prices
  - Dual-list bonds, free of fundamental concerns
  - Differential reactions based on ratings

- Quantify the effect of asset pledgeability
  - First paper (to our knowledge) to estimate the effect of changes in pledgebality on asset prices
  - 20% increase in haircut translates into 12 bps increase in yield change.
  - For a 10-year bond, the price change is about 87 cents (per $100).

- Chinese bond markets are at least equally interesting compared to US bond market.