Discussion of “Dynamic Debt Runs” by Zhiguo He and Wei Xiong

Alp Simsek

MIT

June 11, 2010

A model of dynamic debt runs

- **Perennial** and **contemporary** topic**:** Runs on financial institutions - potentially relevant for recent crisis (short term debt instead of deposits).

- **This paper:** Short term debt is **locked-in** until maturity, and **staggered**. This structure:
  - Also leads to runs (does not solve the coordination problem).
  - Offers new insights about nature of runs.

An alternative model in discrete time

- A dynamic economy with a single consumption good and periods $n \in \{0, 1, ..\}$.
- Two risk neutral creditors with discount factor $\frac{1}{1+\rho}$, and single firm.
- **Assets:** Two units, each yields dividends a_n ($\equiv a$ in the benchmark).

- **Assumption 1 (illiquidity):** Firm's end-of-period liquidation value is $l <$ pdv of dividends.

Firm is financed with staggered short term debt contracts

- **Liabilities:** Two units of (state contingent) short term debt contracts.

- **Assumption 2 (debt is short term, and its value depends on the fundamental value of the asset):** Debt contract issued at end of period n promises coupon payments of a_{n+1} and a_{n+2} in periods $n+1$ and $n+2$, and a principal payment of 1 at the end of period $n+2$.

- **Assumption 3 (debt is staggered):** **Even** (resp. **odd**) creditors hold contracts that mature in **even** (resp. **odd**) periods.

Equilibrium is a collection of creditors' withdrawal decisions

- At end of period (after coupon payments are made), maturing creditor decides to **keep** (roll over) or **withdraw**, $s_n \in \{K, W\}$.
- If $s_n = W$, the firm is liquidated. Assume $l \in [1, 2)$, so that liquidation value is sufficient to service one unit of debt, but not both.

- **Assumption 4 (first mover advantage):** After liquidation, maturing creditor receives 1, while locked in creditor receives $l - 1 < 1$.

- **Equilibrium** is a collection $\{s_n\}_{n=0}^{\infty}$ such that $\{s_{2n}\}_{n=0}^{\infty}$ is optimal given $\{s_{2n+1}\}_{n=0}^{\infty}$ (and vice versa).

Benchmark with no shocks to fundamentals features multiple equilibria

- If $a < a^l \equiv \rho$, then $s_n = W$ is dominant.
- If $a > a^h \equiv 2 - l + \rho$, then $s_n = K$ is dominant.
- If $a \in (a^l, a^h)$, then multiple equilibria: $\{s_n = K\}_{n=0}^{\infty}$ and $\{s_n = W\}_{n=0}^{\infty}$.

- Strategic complementarity as in Diamond and Dybvig (1983) (but dynamic).

Introducing shocks to fundamentals eliminates the multiple equilibria

- Next suppose dividends follow: $a_{n+1} = \begin{cases} a_n + \mu \text{ with prob. } 1/2 \\ a_n - \mu \text{ with prob. } 1/2 \end{cases}$.
- Equilibrium is a collection, $\{s(a)\}_{a \in \mathcal{A}}$, where $s(a) \in \{K, W\}$ is the optimal decision by **maturing** creditors.
- $V^M(a)$ and $V^L(a)$: end-of-period value functions of **maturing** and **locked-in** creditors.

Bellman:

$$V^M(a) = \begin{cases} 1 & \text{if } s(a) = W, \\ \frac{1}{1+\rho}\left(a + \frac{1}{2}V^L(a+\mu) + \frac{1}{2}V^L(a-\mu)\right) & \text{if } s(a) = K. \end{cases}$$

$$V^L(a) = \begin{cases} l - 1 & \text{if } s(a) = W, \\ \frac{1}{1+\rho}\left(a + \frac{1}{2}V^M(a+\mu) + \frac{1}{2}V^M(a-\mu)\right) & \text{if } s(a) = K. \end{cases}$$

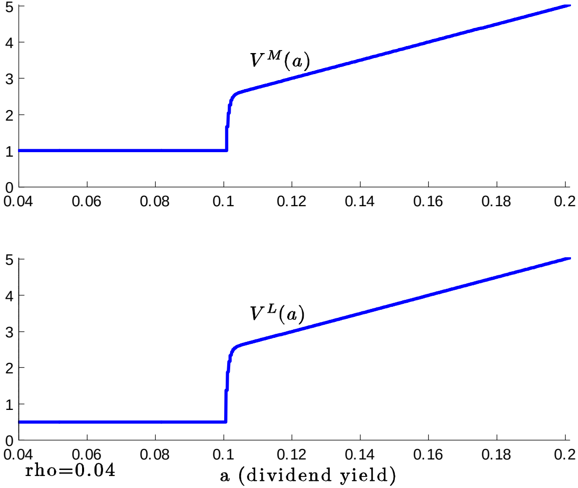
Unique equilibrium with threshold form

- The unique equilibrium takes a threshold form:

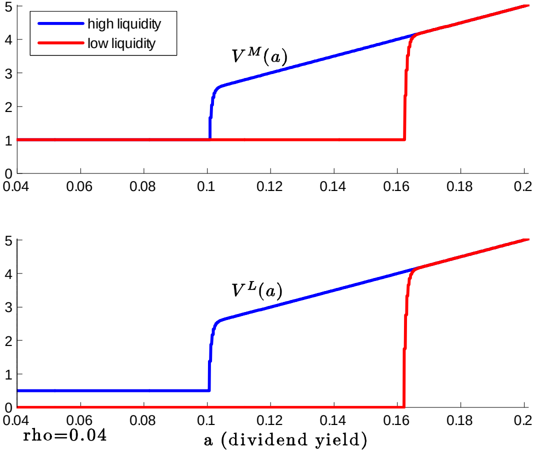
$$s(a) = \begin{cases} W \text{ if } a < a^* \\ K \text{ if } a > a^* \end{cases}.$$

- Insight of Frankel and Pauzner (2000): If $a \in \left(a^l, a^l + \mu\right)$, future maturing creditors withdraw at least with probability $1/2$. This leads to a greater lower bound, $a^{l,1} > a^l$, and so on.

Debt runs: some "solvent" firms are liquidated

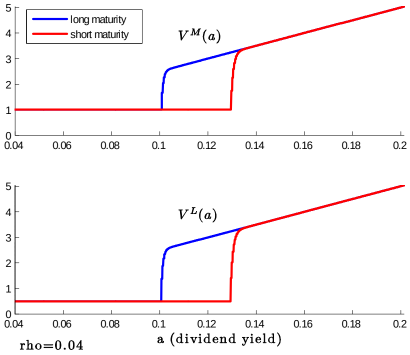


Reducing liquidity leads to more frequent runs



Shortening maturity leads to more frequent runs

- Suppose dividends and the required rate of return are given by $\bar{a} = a\Delta t$ and $\bar{\rho} = \rho\Delta t$, and consider a reduction in Δt.
- This captures a shortening of maturity. It leads to more frequent runs because of the loss of **safety cushion** (i.e., the coupon payments collected until the next creditors' decision).



Q1. Is the whole greater than the sum of the parts?

- So far, we have Diamond and Dybvig (1983) + Frankel and Pauzner (2000).
- **Question 1A:** This is similar to Goldstein and Pauzner (2005). What **additional insights** do we get from the dynamic framework?
  1. Shorter maturity increases the frequency of runs.
  2. Higher uncertainty (volatility of fundamental) increases the frequency of runs.
- **Question 1B:** Does the staggered debt structure lead to more or less frequent runs than non-staggered structure? Next:

Frankel and Pauzner vs. **Carlsson, van Damme, Morris, and Shin** .

Consider a comparable static game with incomplete information

- Consider the same model with $a_n = a$, with two differences:
  - Both debt contracts are issued **simultaneously** at end of date 0.
  - Debt contracts promise payment a in all future periods $n \geq 1$ and they do not mature.

$\Longrightarrow$ **Single withdrawal decision**, denoted by $s_0^{odd}, s_0^{even} \in \{K, W\}$.

- **Payoffs:**

$$\begin{array}{ccc} & K & W \\ K & \left[\frac{a}{\rho}, \frac{a}{\rho}\right] & [l-1, 1] \\ W & [1, l-1] & \left[\frac{l}{2}, \frac{l}{2}\right] \end{array}.$$

Consider a comparable static game with incomplete information

- **Incomplete information:**
  - Creditors observe private noisy signals of a, which are i.i.d. and uniform over $[a-\mu, a+\mu]$.
  - They have a common uniform prior for a.
- **Problem:** There is no upper-dominance region!
- Consider a slight variant: In case of only one withdrawal, firm survives with small prob. ϕ (credit lines):

$$\begin{array}{ccc} & K & W \\ K & \left[\frac{a}{\rho}, \frac{a}{\rho}\right] & \phi\frac{a}{\rho} + (1-\phi)\left[l-1, 1\right] \\ W & \phi\frac{a}{\rho} + (1-\phi)\left[1, l-1\right] & \left[\frac{l}{2}, \frac{l}{2}\right] \end{array}$$

There is a unique equilibrium with threshold form

- As $\mu \to 0$, **unique equilibrium**:

$$s_0^{even} = s_0^{odd} = \begin{cases} W \text{ if } a < a^* \\ K \text{ if } a > a^* \end{cases},$$

where a^* is solved from the indifference condition for the creditor with signal a^*:

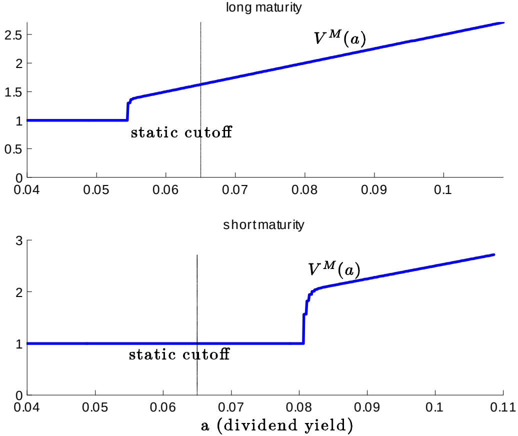
$$\underbrace{\frac{1}{2}\frac{a^*}{\rho} + \frac{1}{2}\left(\phi\frac{a^*}{\rho} + (1-\phi)(I-1)\right)}_{\text{payoff from choosing } K} = \underbrace{\frac{1}{2}\left(\phi\frac{a^*}{\rho} + (1-\phi)\right) + \frac{1}{2}\frac{I}{2}}_{\text{payoff from choosing } W}.$$

- We have:

$$\lim_{\phi \to 0} a^* = \rho\left(2 - \frac{I}{2}\right).$$

Staggered debt is more robust to runs when maturity is long, but less robust when maturity is short

- Two forces in opposite directions: **safety cushion** against **first mover advantage**.



Q2: Why staggered short term debt?

- **Question 2A:** Why short term debt?
  - Equity would solve the problem in the model, but...
- **Question 2B:** Given short term debt, why staggering?

Q3: Magnitudes

- **Comment 3A:** Given that some of the insights are in previous literature, it would be useful to go more quantitative.

- **Question 3B:** Are the effects quantitatively significant (in particular, the effect of uncertainty).

Thinking outside the global games "box": Knightian uncertainty as an equilibrium selection mechanism

- Consider the above static model, but suppose there are multiple tuples of firms and creditors:

$$\left(F_1, C_1^{even}, C_1^{odd}\right), \left(F_2, C_2^{even}, C_2^{odd}\right), \ldots \left(F_n, C_n^{even}, C_n^{odd}\right).$$

- One of the odd creditors is distressed, and has to withdraw regardless of the level of fundamental.
- Even creditors face **Knightian uncertainty** about who is distressed, and they respond to this uncertainty with **maxmin** optimization, as in Gilboa and Schmeidler (1989).
    - **Worst case scenario:** their co-creditor is distressed.
- Suppose K is not dominant. At date 0, the unique equilibrium is such that all creditors withdraw.
- Knightian uncertainty (typically) coordinates on the bad equilibrium. Potentially large effect of uncertainty.

Conclusion

- Important and timely topic: dynamic runs on short term debt.
- New insights about the nature of modern runs (volatility and maturity structure of debt).
- **Excellent paper:** resolves some issues and raises new questions!