Minsky's Financial Instability Hypothesis and the Leverage Cycle[1]

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[1] The views expressed in this paper are those of the authors and do not necessarily represent those of the Banque de France.

Outline

Approaches to financial crises

1. From McKay's (1841) "extraordinary popular delusions" to Shiller's (2000) "irrational exuberance" there is a view that financial crisis results from a black-out of human reason
2. Diamond and Dybvig (1983), Morris and Shin (2004): a crisis results from a **coordination failure**, usually associated with a financial structure that has a built-in first-mover advantage, like demand deposits, or loss limits
3. Fisher (1933): The **debt-deflation** theory of Great Depressions
    - Over indebtedness and deflation
    - The main mechanism through which crises occur is the drop in the relative price of capital goods and industrial output relative to the value of corporate debt
4. Minsky's **Financial Instability Hypothesis** (1984)

Externalities

1. **Bank runs**: Coordination problem
2. **Fire sales**: Market liquidity and funding liquidity / marginal buyer
3. **Unduly pessimistic expectations** due to portfolio opacity
4. **Optimism and procyclicality** of price based risk measures: This presentation
5. **Network externalities**: Portfolio commonality and chain reaction of default

Tools

i. Leverage requirements
ii. Countercyclical capital buffers
iii. Systemic surcharge
iv. Haircuts regulation
v. LTV regulation
vi. Liquidity requirements
vii. Creditors Association to Losses/Contingent capital

- Each tool is trying to correct for the externalities above in a different way
- Thus, its implementation may correct one externality and make another one more severe
- A combination of tools may be needed (Kashyap, Berner & Goodhart, 2011)

- Financial Instability Hypothesis by Hyman Minsky:

  over periods of prolonged prosperity and optimism about future prospects, financial institutions invest in riskier assets, which can make the economic system more vulnerable in the case that default materializes

- Expectations formation varies across the economic cycle giving rise to a leverage cycle and inevitable harsher default

This paper:

- **Question 1a** What are the sources of excessive leverage: Optimizing behaviour of creditors and debtors?
- **Question 1b** How do portfolio choice and risk taking vary over the leverage cycle?
- **Question 2** Is controlling leverage the way to ensure financial stability?
- **Question 3** Can we predict the leverage cycle?

Framework:

- Financial institutions that invest in projects using both their own capital and borrowed funds from agents acting as lenders
- Two projects: A relative safer and a relative riskier
- There is uncertainty about the future payoff realization of the two projects
- Two states are possible: an ”up” state with higher payoff realizations and a ”down” state with lower payoff realizations for both projects
- All economic agents have rational expectations, but have incomplete information about the true realization of a future state of nature
- They update their beliefs by observing past realizations of good and bad outcomes (Bayesian learners)
- Default is endogenous as are the borrowing rates

Bank's Optimization Problem

$$\max_{w^i_{s_t,j}, v^i_{s_{t+1}}, \Pi^i_{s_{t+1}}, T^i_u, T^i_d} \sum_{t=0}^{1} \mathbb{E}_0 \tilde{U}^i_{s_{t+1}} - \lambda_{s_{t+1}} \mathbb{E}_0 \max\left[(1-\tilde{v}^i_{s_{t+1}})\tilde{w}_{s_t}(1+\tilde{r}_{s_t}), 0\right] =$$
$$= \mathbb{E}_0\left[\tilde{U}^i_{s_1} + \mathbb{E}_{s_1}\left[\tilde{U}^i_{s_2}\right]\right] - \lambda_{s_{t+1}} \mathbb{E}_0\left[\max\left[(1-\tilde{v}^i_{s_1})w_0(1+r_0)\right]\right]$$
$$- \lambda_{s_{t+1}} \mathbb{E}_0\left[\mathbb{E}_{s_1}\left[\max\left[(1-\tilde{v}^i_{s_2})\tilde{w}_{s_1}(1+\tilde{r}_{s_1})\right]\right]\right]$$

$w^i_{0,L} + w^i_{0,H} \leq \bar{w}^i_0 + w^i_0 \quad (\psi^i_0)$

i.e. investment in the safer and the riskier assets $\leq$ initial capital + leverage at t=0

$w^i_{s_t,L} + w^i_{s_t,H} \leq T^i_{s_t} + w^i_{s_t} \quad (\psi^i_{s_t}) \quad \forall\ \mathrm{s_t} \in \{\mathrm{u}, \mathrm{d}\}$

i.e. investment in the safer and the riskier projects $\leq$ reinvested profits + leverage

$\Pi^i_{s_t} + T^i_{s_t} \leq w^i_{0,L} X^L_g + w^i_{0,H} X^H_g - w^i_0 v^i_{s_t}(1+r_0) \quad (\phi_{s_t}) \quad \forall\ \mathrm{s_t} \in \{\mathrm{u}, \mathrm{d}\}$

i.e. distributed + retained profits $\leq$ safer and riskier investments' payoff - loan repayment

$\Pi^i_{s_t} \leq w^i_{s_{t-1},L} X^L_g + w^i_{s_{t-1},H} X^H_g - w^i_{s_{t-1}} v^i_{s_t}(1+r_{s_{t-1}}) \quad (\phi_{s_t}) \quad \forall\ \mathrm{s_t} \in \{\mathrm{uu}, \mathrm{ud}, \mathrm{du}, \mathrm{dd}\}$

i.e. distributed profits $\leq$ safer and riskier investments' payoff - loan repayment

Creditors' Optimization Problem

$$\max_{c^c_{s_t}, w^c_{s_t}} \sum_s \mathbb{E}_0 \tilde{c}^c_{s_t} = c^c_0 + \pi_0 c^c_u + (1-\pi_0) c^c_d + \pi_0 \pi_u c^c_{uu} + \pi_0 (1-\pi_u) c^c_{ud}$$

$$+ (1-\pi_0)\pi_d c^c_{du} + (1-\pi_0)(1-\pi_d) c^c_{dd}$$

$s.t.\ c^c_0 \leq \bar{w}^c_0 - w^c_0$

i.e. consumption $\leq$ initial endowment - credit extension at t=0

$c^c_{s_t} \leq \bar{w}^c_{s_t} + v^i_{s_t}(1+r_0) w^c_0 - w^c_{s_t} \quad \forall\ \mathrm{s_t} \in \{\mathrm{u}, \mathrm{d}\}$

consumption $\leq$ endowment + loan repayment - credit extension in $s_t \in \{u, d\}$

$c^c_{s_t} \leq v^i_{s_t}(1+r_{s_{t-1}}) w^c_{s_{t-1}} \quad \forall\ \mathrm{s_t} \in \{\mathrm{uu}, \mathrm{ud}, \mathrm{du}, \mathrm{dd}\}$

consumption $\leq$ loan repayment in $s_t \in \{uu, ud, du, dd\}$

$$\mathbb{E}_{s_t}\left[v^i_{s_{t+1}}\right] \cdot (1+r_{s_t}) = 1,\ \ \mathrm{s_t} \in \{0, \mathrm{u}, \mathrm{d}\}$$

Leverage Cycle

- As expectations become more optimistic, banks reallocate their portfolios towards the riskier asset
- In order to fund their position, they increase their leverage, since they cannot go short in the safer asset
- Once uncertainty is resolved, banks need to repay their loans and they are confronted with the decision to default
- If realizations turn out to be bad after a period of previously good news, they will default more on their loans, since they would have invested more in the riskier asset
- One might have expected that creditors would reduce their credit extension and leverage would go down, since loss given default would be higher
- However, this is not the case since the probability of a good outcome has increased and consequently the interest rate creditors charge is lower

Table: Portfolio weight of the riskier project

Portfolio weight on the risky project at $t = 0$	$w^i_{0,H}$=0
Portfolio weight on the risky project after bad news	$w^i_{d,H}$=0
Portfolio weight on the risky project after good news	$w^i_{u,H}$=65.25%
Risky-to-safe project ratio of weights at t=0	$w^i_{0,H}/w^i_{0,L}$=0
Risky-to-safe asset ratio of weights after bad news	$w^i_{d,H}/w^i_{d,L}$=0
Risky-to-safe asset ratio of weights after good news	$w^i_{u,H}/w^i_{u,L}$=1.88

Table: Interest rates, leverage and default

Increase in leverage after good news	177%	Interest rate change after good news	-10.82%
Decrease in leverage after bad news	16.79%	Interest rate change after bad news	10.32%
Expected default at $s_t = 0$	9.08%	Realized default at $s_t = d$	51.52%
Expected default at $s_t = u$	8.16%	Realized default at $s_t = ud$	64.15%
Expected default at $s_t = d$	9.90%	Realized default at $s_t = d$	24.40%
Loss given default at $s_t = d$	2.35	Loss given default at $s_t = ud$	8.02
Loss given default at $s_t = dd$	0.93		

Leverage Requirements

- A leverage requirement can take the form of a maximum ratio of borrowing over the total investment in projects
- We show that such a requirement achieves the exact opposite result than expected: it results in increased loss given default instead of bringing it down

Intuition

- Banks will divert their own funds away from the safer asset and put them to the riskier one
- Although borrowing goes down, they will invest even more in the riskier asset to compensate for the loss in gearing, since expectation are optimistic

Leverage Requirements

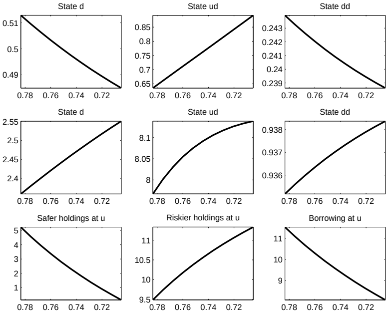

Figure: Percentage default (top), loss given default (middle) and portfolio holdings (bottom) under various leverage requirement in state *u*

- The x-axis denotes the leverage requirement (the ratio of borrowing over total asset portfolio value) in the up-turn of the cycle, i.e. state *u*. The requirement gets tighter to the right.
- Banks divert funds from the safer to the riskier project to make up for the loss in gearing. Increased risk-taking leads to higher loss given default.

An alternative requirement

- Our analysis highlights that the adverse consequences of the leverage cycle depend on financial institutions shifting their portfolios towards previously riskier projects due to the fact that beliefs have been updated upwards
- Policy could restrict relative portfolio holdings
- A requirement on the difference between riskier and safer holdings per unit of leverage results in higher financial stability

Intuition

- It is the shift towards riskier projects in combination with high leverage that creates the problem, which is something that leverage requirements by themselves cannot handle
- It is leverage that goes directly to risky investment which is the appropriate variable to control

An alternative requirement

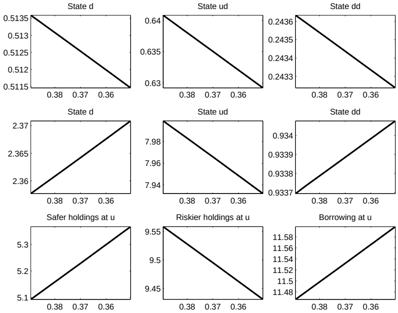

Figure: Percentage default (top), loss given default (middle) and portfolio holdings in state *u*

- The requirement is defined as riskier minus safer investment per unit of borrowing. It gets tighter to the right.
- Given that it targets directly risk-taking behaviour, riskier holdings in state *u* go down, as do loss given default and percentage default in state *ud*.

- Measuring the <u>time-dimension</u> in riskiness of banking portfolios or of the financial sector as a whole over the leverage cycle is not an easy task
- Commonly used measures to capture risk building up, such as the volatility of banking assets or credit spreads, fail to do so due to the fact that they are biased by optimistic expectations

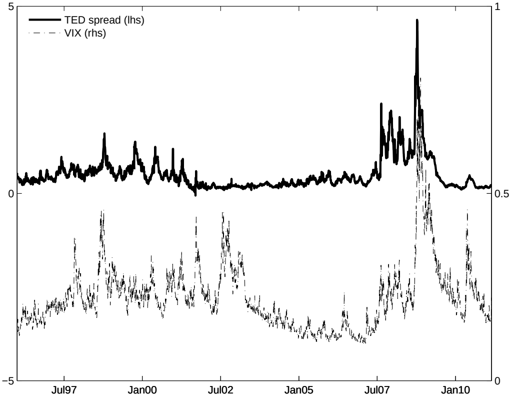

Figure: VIX and TED spread evolution over time

- The index we propose is the difference between riskier and safer portfolio holdings per unit of leverage
- Although absolute riskiness goes down for both types, their ranking is preserved (assuming bank are *beta* long..*and that risk is captured in the cross-section*)
- We normalize by leverage, because it is default on debt that causes a financial crisis, tightening in credit and forced liquidations that lead to fire sales externalities

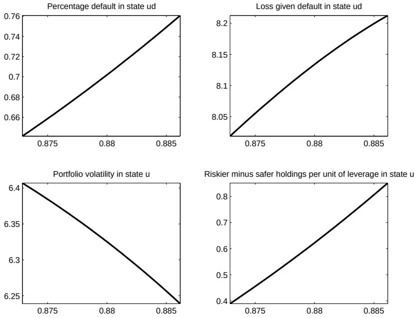

Figure: Optimism and riskiness

- Financial agents are Bayesian learners and update their beliefs about future good realisations by observing the sequence of past ones
- After a prolonged period of good news, expectations are boosted and financial institutions find it profitable to shift their portfolios towards projects that are on average riskier, but promise higher expected returns
- Creditors are willing to provide them with funds, since their expectations have improved as well
- When bad news realise, default is higher and the consequences for financial stability are more severe
- Leverage requirements do not yield the desired outcome
- Price based measures, such as VIX or TED spread, may not be adequate to predict the leverage cycle

Expectations formation

- Multiperiod economy. Two states possible at any point in time, u and d
- Set of all states: $s_t \in S = \{0, u, d, \ldots, uu, ud, du, dd, \ldots, s_t u, s_t d, \ldots\}$
- The probability that a good state occurs is constant at any point in time and denoted by θ
- Nature decides at t=0 whether $\theta = \theta_1$ or $\theta = \theta_2$, $\theta_1 > \theta_2$
- Agents do not know this probability and try to infer it by observing past realizations
- No asymmetry of information among agents
- Cogley and Sargent (2008)

Agents become more optimistic after they observe good outcomes in the past

Agents' subjective belief is given by:

$$\pi_{s_t} = Pr_{s_t}(\theta = \theta_1 \,|s_t\,) \cdot \theta_1 + Pr_{s_t}(\theta = \theta_2 \,|s_t\,) \cdot \theta_2$$

Their conditional probability given past realizations is:

$$\begin{aligned} Pr_t(\theta = \theta_1 \,|s_t\,) &= \frac{Pr_t(s_t \,|\theta = \theta_1\,) \cdot Pr(\theta = \theta_1)}{Pr(s_t)} \\ &= \frac{Pr_t(s_t \,|\theta = \theta_1\,) \cdot Pr(\theta = \theta_1)}{Pr_t(s_t \,|\theta = \theta_1\,) \cdot Pr_t(\theta = \theta_1) + Pr_t(s_t \,|\theta = \theta_2\,) \cdot Pr(\theta = \theta_2)} \\ &= \frac{\theta_1^n(1-\theta_1)^{t-n} \cdot Pr(\theta = \theta_1)}{\theta_1^n(1-\theta_1)^{t-n} \cdot Pr(\theta = \theta_1) + \theta_2^n(1-\theta_2)^{t-n} \cdot Pr(\theta = \theta_2)} \end{aligned}$$

where n is the number of good realization up to time t

$$\pi_{s_t} = \frac{\theta_1^n(1-\theta_1)^{t-n} \cdot Pr(\theta=\theta_1)}{\theta_1^n(1-\theta_1)^{t-n} \cdot Pr(\theta=\theta_1) + \theta_2^n(1-\theta_2)^{t-n} \cdot Pr(\theta=\theta_2)}\theta_1 + \frac{\theta_2^n(1-\theta_2)^{t-n} \cdot Pr(\theta=\theta_2)}{\theta_1^n(1-\theta_1)^{t-n} \cdot Pr(\theta=\theta_1) + \theta_2^n(1-\theta_2)^{t-n} \cdot Pr(\theta=\theta_2)}\theta_2$$

Proof.

$$Pr_{s_t}(\theta=\theta_1\,|s_t) > Pr_{s_{t-1}}(\theta=\theta_1\,|s_{t-1})$$

$$\frac{\theta_1^{n+1}(1-\theta_1)^{t+1-(n+1)}}{\theta_1^{n+1}(1-\theta_1)^{t+1-(n+1)} + \theta_2^{n+1}(1-\theta_2)^{t+1-(n+1)}} > \frac{\theta_1^n(1-\theta_1)^{t-n}}{\theta_1^n(1-\theta_1)^{t-n} + \theta_2^n(1-\theta_2)^{t-n}}$$

$$\left(\frac{\theta_2}{1-\theta_2}\frac{1-\theta_1}{\theta_1}\right)^n\left(\frac{1-\theta_2}{1-\theta_1}\right)^t > \left(\frac{\theta_2}{1-\theta_2}\frac{1-\theta_1}{\theta_1}\right)^{n+1}\left(\frac{1-\theta_2}{1-\theta_1}\right)^{t+1}$$

$$1 > \frac{\theta_2}{1-\theta_2}\frac{1-\theta_1}{\theta_1}\frac{1-\theta_2}{1-\theta_1}$$

$$1 > \frac{\theta_2}{\theta_1}$$

$\square$

Return