Two Monetary Tools: Interest-Rates and Haircuts

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Motivation: Financial Frictions and the Macro Economy

- All agents face **margin constraints**
- Binding constraints for financial firms reduce credit supply
- Two monetary tools:
  - Interest-rates
  - Haircuts (lending facilities)
- Key questions:
  - How do financial frictions affect required returns, real investment, and output?
  - What are the effects of these monetary tools?
  - Which sectors are most affected?

What We Do

- Theory:
  - OLG production economy
  - Two types of agents facing margin constraints
  - Firms that differ in the haircut (i.e., margin requirement) of their securities
  - Consider effect of interest-rate cuts and haircut cuts
- Empirical evidence:
  - Unique survey evidence: how does demand for securities depend on haircuts?
  - Effect on market prices

Results: Theory

- Margin CAPM:
$$E_t(r^j) \;=\; r_t^f + \lambda_t \beta_t^j + \psi_t \, x \, m_t^j$$
- Output and real investment decrease with credit constraints
- Propagation of business cycles:
  binding constraint → high required return → low investment
  → low future income → future binding constraint → ...
- Interest-rate cuts
  - Increase shadow cost of capital ψ_t, steepen the haircut-return relation
  - Can increase the required return and lower real investment for high-haircut assets
- Haircut cuts
  - Lower required returns in affected sectors
  - Large or broad cuts: Lower required returns in all sectors

Results: Empirical

- Survey evidence:
  - Bid price increases on average 18% with access to 3-year low-haircut loan
  - This reduces the yield by 3% for super senior bonds
- Response of market prices
  - Study of bonds that are rejected vs. accepted from TALF
  - TALF reduced yields by more than 0.40% (likely much more)
- Model:

$$
\begin{aligned}
E_t(r^j) &= r^f_t + \lambda_t \beta^j_t + \psi_t x m^j_t \\
\Delta E_t(r^j) &\approx \psi_t x \Delta m^j_t = 10\% \cdot 40\% \cdot (-80\%) = -3\%
\end{aligned}
$$

Large effect on real investment, capital, and output

Related Literature

- Bagehot (1873): "If it is known that the Bank of England is freely advancing on what in ordinary times is reckoned a good security [...] the alarm of the solvent merchants and bankers will be stayed. [Otherwise] the alarm will not abate, the other loans made will fail in obtaining their end, and the panic will become worse and worse." (p. 198)
- Collateral value: Bernanke and Gertler (1989), Hindy and Huang (1995) Detemple and Murthy (1997), Geanakoplos (1997), Kiyotaki and Moore (1997,2007), Aiyagari and Gertler (1999), Caballero and Krishnamurthy (2001), Lustig and Van Nieuwerburgh (2005), Shleifer and Vishny (1992, 2009) Fostel and Geanakoplos (2008)
- Margin constraints and leverage:
  - "Margin-Based Asset Pricing and Deviations from the Law of One Price," Garleanu and Pedersen (2009)
  - Margin spirals: Brunnermeier and Pedersen (2009)
  - Evidence on leverage and repo markets: Adrian and Shin (2007), Gorton and Metrick (2009)
- Recent monetary economics: Kiyotaki and Moore (2008), Adrian and Shin (2009), Gertler and Karadi (2009), Gertler and Kiyotaki (2009), Curdia and Woodford (2009), Reis (2009)

Model: Firms

- OLG economy with multiple firms that operate two periods.
- Old firms produce
$$Y_t^j = A_t^j F_j(K_t^j, L_t^j) = A_t^j (K_t^j)^\alpha (L_t^j)^\beta$$
- Choose labor to maximize profit
$$\bar{P}(K_t^j, A_t^j, w_t^j) = \max_{L_t^j} A_t^j F_j(K_t^j, L_t^j) - w_t^j L_t^j$$
- Young firms choose investment $I_t^j = K_{t+1}^j$:
$$\max_{I_t^j} E_t \left(\xi_{t+1} \bar{P}(I_t^j, A_{t+1}^j, w_{t+1}^j) \right) - I_t^j$$
- 1 share sold for a price $P_t^j = E_t \left(\xi_{t+1} \bar{P}(I_t^j, A_{t+1}^j, w_{t+1}^j) \right)$
- Surplus $P_t^j - I_t^j$ goes to initial owner

Model: Agents

- Two types of agents $n = a, b$:
  - Risk *a*verse: γ^a
  - Risk tolerant (*b*rave): γ^b
- Inelastic labor supply with share η^n, technology share ω^n
- Initial wealth of young agent

$$W_t^n = \sum_j w_t^j \eta^n + \sum_j (P_t^j - I_t^j)\omega^n$$

- Wealth evolution depends on number of shares θ and rate r^f:

$$C_{t+1} = W_{t+1} = W_t(1 + r^f) + \theta^\top(\bar{P}_{t+1} - P_t(1 + r^f)).$$

- Maximize quadratic utility

$$\max_\theta \mathrm{E}_t(C_{t+1}) - \frac{\gamma^n}{2}\mathrm{var}(C_{t+1})$$

- Margin constraint $\sum_j m_t^j |\theta^j| P_t^j \leq W_t^n$

Portfolio Choice and Required Returns

$$\max_{\theta} W_t(1+r^f) + \theta^\top (E_t(\bar{P}_{t+1}) - P_t(1+r^f)) - \frac{\gamma^n}{2}\theta^\top \Sigma_t \theta,$$

subject to $\sum_j m_t^j |\theta^j| P_t^j \le W_t^n$. FOC:

$$0 = E_t(\bar{P}_{t+1}) - P_t(1+r^f) - \gamma^n \Sigma_t \theta - \psi_t \, \mathrm{D}(m_t) P_t$$

Optimal portfolio:

$$\theta_t^n = \frac{1}{\gamma^n}\Sigma_t^{-1}(E_t(\bar{P}_{t+1}) - P_t(1+r^f) - \psi_t \, \mathrm{D}(m_t) P_t)$$

Market clearing $\bar{\theta} = \theta_t^a + \theta_t^b$ implies:

$$\bar{\theta} = \frac{1}{\gamma}\Sigma_t^{-1}(E_t(\bar{P}_{t+1}) - P_t(1+r^f)) - \psi_t \frac{1}{\gamma^b}\Sigma_t^{-1} \, \mathrm{D}(m_t) P_t$$

where γ is given by $\frac{1}{\gamma} = \frac{1}{\gamma^a} + \frac{1}{\gamma^b}$. Equilibrium price

$$P_t = \mathrm{D}(1 + r^f + \psi_t \frac{\gamma}{\gamma^b} m_t)^{-1} \left(E_t(\bar{P}_{t+1}) - \gamma \Sigma_t \bar{\theta} \right)$$

Margin CAPM

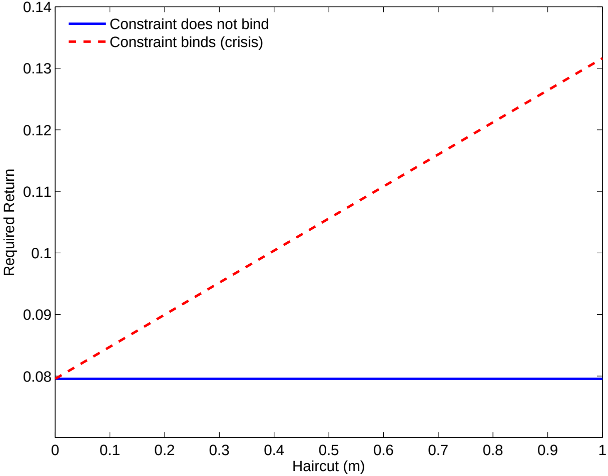
Proposition (Margin CAPM)

The required return on security i depends on its market beta and its margin requirement:

$$E_t(r^j_{t+1}) \;=\; r^f + \lambda_t \beta^j_t + m^j_t \psi_t x$$

where the risk premium is $\lambda_t = E_t(r^{mkt}_{t+1}) - r^f - \left(\sum_j m^j_t q^j\right) \psi_t x$ *and* $x = \frac{\gamma}{\gamma^b}$.

Margin CAPM


Constraint does not bind
Constraint binds (crisis)
Required Return
Haircut (m)
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Wages and Profits

Old firm's labor choice:

$$\max_{L_t^j} \quad A_t^j (K_t^j)^\alpha (L_t^j)^\beta - w_t^j L_t^j$$

$$FOC \quad w_t^j = \beta_j A_t^j (K_t^j)^\alpha (L_t^j)^{\beta-1} =^{equilibrium} \beta_j A_t^j (K_t^j)^\alpha$$

Optimal labor for firm that initially invested I_{t-1}^j:

$$L_t^j = \left(\frac{\beta_j A_t^j (I_{t-1}^j)^\alpha}{w_t^j}\right)^{\frac{1}{1-\beta}} = \left(\frac{\beta_j A_t^j (I_{t-1}^j)^\alpha}{\beta_j A_t^j (K_t^j)^\alpha}\right)^{\frac{1}{1-\beta}} = (I_{t-1}^j)^{\frac{\alpha}{1-\beta}} (K_t^j)^{-\frac{\alpha}{1-\beta}}$$

Profit with optimal labor supply: $(1-\beta) Y_t^j \quad =$

$$(1-\beta) A_t^j (I_{t-1}^j)^\alpha (L_t^j)^\beta = (1-\beta) A_t^j (I_{t-1}^j)^{\frac{\alpha}{1-\beta}} (K_t^j)^{-\frac{\alpha\beta}{1-\beta}}$$

Real Investment

Young firm's investment choice is:

$$\max_{I_t^j} \left\{ \mathrm{E}_t \left[\xi_{t+1}(1-\beta_j) A_{t+1}^j \left(I_t^j\right)^{\frac{\alpha_j}{1-\beta_j}} \left(K_{t+1}^j\right)^{\frac{-\alpha_j \beta_j}{1-\beta_j}} \right] - I_t^j \right\}$$

First order condition

$$\frac{\alpha_j}{1-\beta_j} \mathrm{E}_t \left[\xi_{t+1}(1-\beta_j) A_{t+1}^j \left(I_t^j\right)^{\frac{\alpha_j}{1-\beta_j}-1} \left(K_{t+1}^j\right)^{\frac{-\alpha_j \beta_j}{1-\beta_j}} \right] - 1 \quad = \quad 0$$

Positive value of technology

$$P_t^j \quad = \quad \frac{1-\beta_j}{\alpha_j} I_t^j \quad \geq \quad I_t^j .$$

Putting Firms and Investors Together

Investment decisions determine profits and risks:

$$\begin{aligned} \bar{P}^j_{t+1} &= (1-\beta)A^j_{t+1}(I^j_t)^\alpha \\ \Sigma_t &= (1-\beta)^2 D(I^\alpha_t)\Sigma_A D(I^\alpha_t) \end{aligned}$$

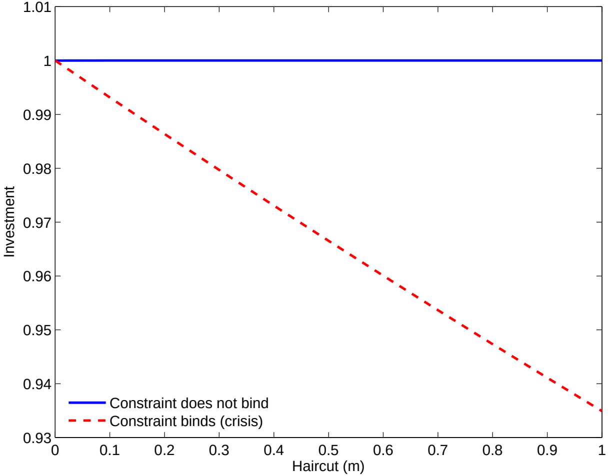
Combining these with Margin CAPM gives equation that determines I:

$$(1+r^f+\psi_t x m_t)\frac{1}{\alpha} = D\left(I_t^{\alpha-1}\right)E_t(A_{t+1}) - \gamma(1-\beta)D\left(I_t^{\alpha-1}\right)\Sigma_A I_t^\alpha \bar{\theta}$$

Example: $\alpha = 1/2$; productivity shocks independent across firms:

$$(I^j_t)^{1/2} = \frac{\frac{1}{2}E_t(A^j_{t+1})}{1 + r^f + \gamma\frac{1-\beta}{2}\,\mathrm{var}_t(A^j_{t+1}) + \psi_t x m^j_t}$$

Haircuts and Real Investment



Margin-Constraint Accelerator

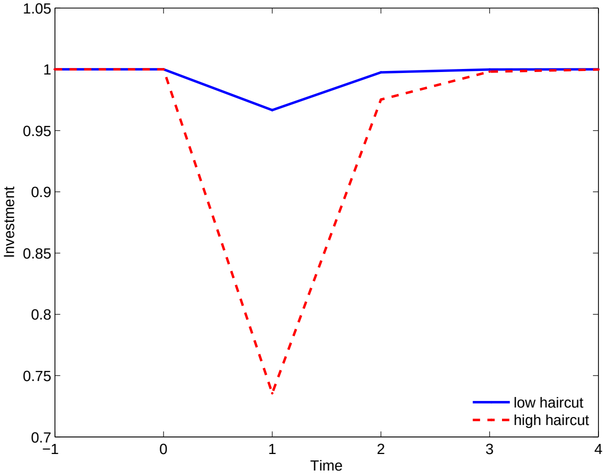
Proposition

- *Without margin constraints, i.i.d. productivity leads to i.i.d. output, wages, and income*
- *With margin constraints, output, income, real investment, consumption, wages, and risk premia are correlated over time.*

This follows from the propagation of a productivity shock that is so severe that investors' margin requirement binds:

- the required return increases
- reducing real investment
- reducing next period's expected output and income
- the low income then weakly increases the required return
- and so on

Margin-Constraint Accelerator



Interest Rate Cuts

Proposition

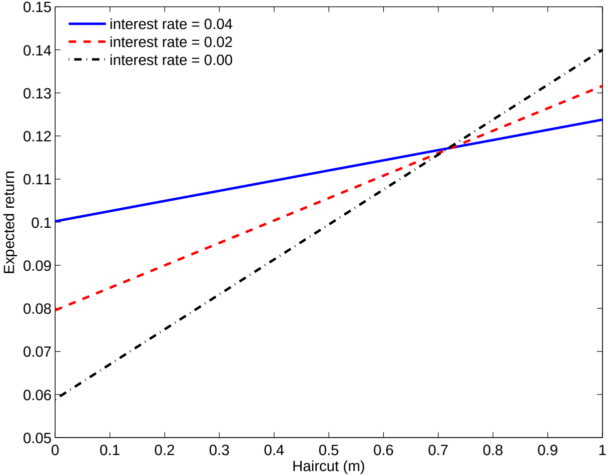
Suppose that the interest rate is reduced at time t when the constraint is binding. Then:

- *the required return decreases and real investment increases for assets with low haircuts* ($m_t^j < \bar{m}_t$).

If a agents are sufficiently risk averse

- *the shadow cost of capital* ψ_t *increases*
- *the required return increases and the real investment decreases for high-haircut assets* ($m_t^j > \bar{m}_t$)

Interest-Rate Cut: Steepening the Haircut-Return Curve



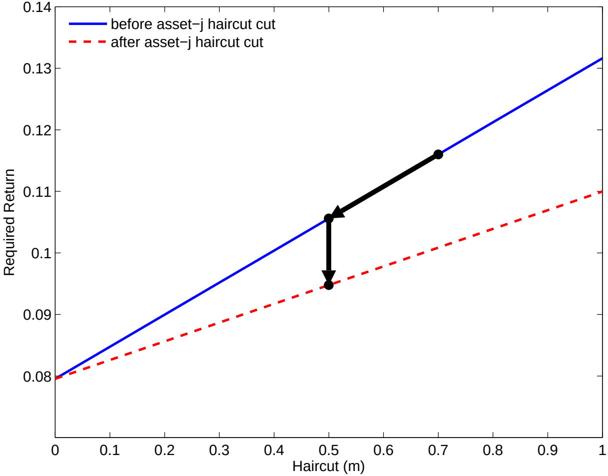
Haircut Cuts

Proposition

Suppose the haircut m_t^j on asset j is reduced at time t when the constraint is binding. Then:

- *The required return for that asset decreases and its real investment increases. The real investments in other assets either all increase or all decrease.*
- *If m_t^j is reduced sufficiently or if the haircuts on sufficiently many assets are reduced by a given fraction, then required returns on all assets decrease and their real investment increase.*

Haircut Cuts



Capital Injection and Asset Purchases

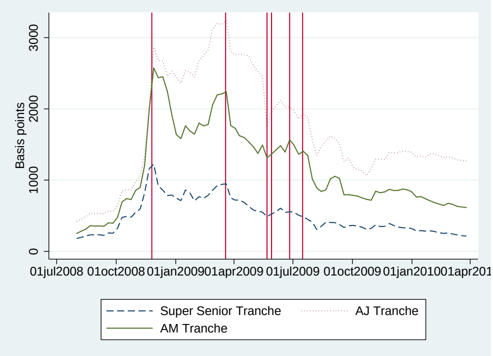
Proposition

- *If agent b's wealth is increased, required returns go down and real investment increases for all assets.*
- *If the government buys shares in asset i, then the real investment in that asset increases and the investments in all other assets either all increase or decrease. If the government purchase is sufficiently large, then all real investments increase.*

Monetary Policy and Lending Facilities

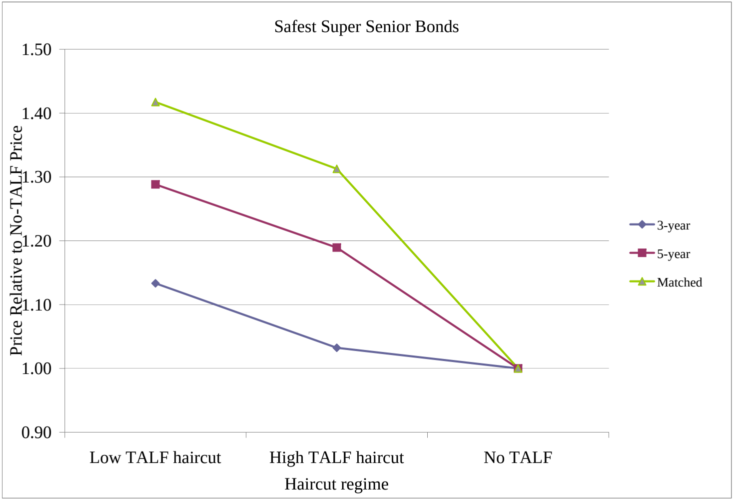
- Term Auction Facility (TAF) – 12/2007
- Term Securities Lending Facility (TSLF) – 3/2008
- Term Asset-Backed Securities Loan Facility (TALF) – 11/2008, 6/2009
- Goal: Improve funding conditions and "help market participants meet the credit needs of households and small businesses by supporting the issuance of asset-backed securities"
- The model suggests that when the Fed offers lower haircuts, required returns go down:
$$E(r^{i,Fed}) - E(r^{i,no\ Fed}) \approx \psi x(m^{Fed,i} - m^i) + \Delta\psi\, x m^i < 0$$
- I.e., ABS yield down, access to credit eases, helping the real economy

CMBS Yield Spreads

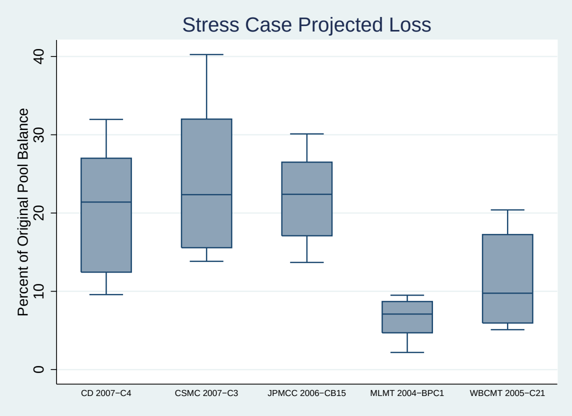


Date	Announcement
11/25/2008	Initial TALF for ABS, suggesting possible expansion for CMBS
3/19/2009	Legacy securities will be part of TALF
5/19/2009	Super senior legacy fixed-rate conduit CMBS eligible for TALF
5/26/2009	S&P considers methodology change for fixed-rate conduit CMBS
6/26/2009	S&P implements new methodology
7/16/2009	First subscription for legacy TALF

Survey Bid Price vs. Haircut

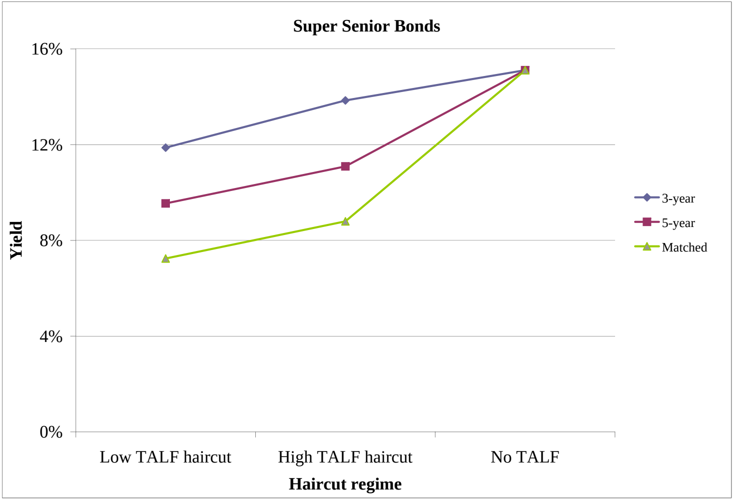


Potential Stress Loss for Each CMBS Pool

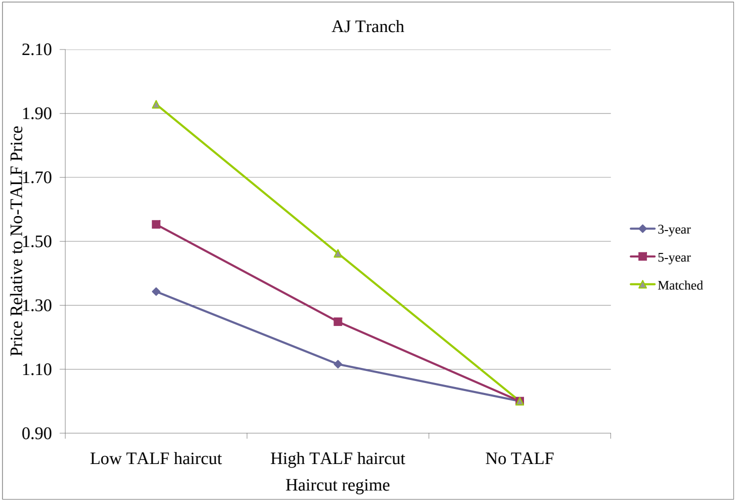


Most Pessimistic Participant: No Stress Loss for Safest Super Senior Bonds

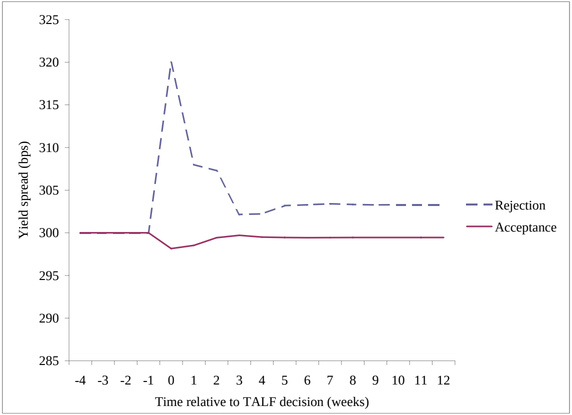
Implied Survey Yield vs. Haircut



Survey Bid Price vs. Haircut: Riskier AJ Bonds

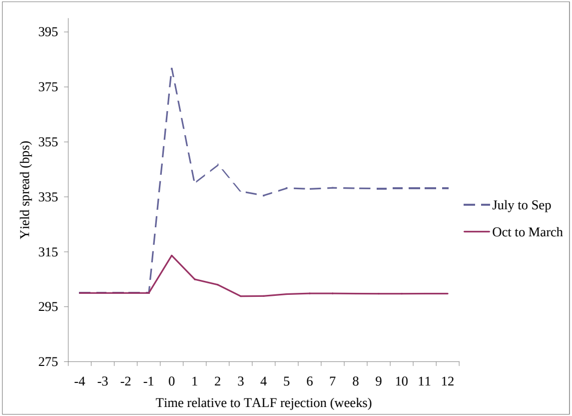


The Price Effect of TALF Rejections



- The yield spread of rejected bonds rises as these bonds will not benefit from the low haircuts provided by TALF
- Acceptance is expected an therefore associated with small effect

The Price Effect of TALF Rejections by Sub-Sample



- The effect of rejections is significantly larger July-September 2009 (the ending of the financial crisis) than October 2009-March 2010 (when conditions improved)
- Consistent with model's prediction that haircuts have a larger effect when capital constraints are tight

Regulatory Capital Requirements

- Basel requirement is similar to the margin constraint

$$\sum_i m^{Reg,i}|\theta^i|P^i \quad \leq \quad W$$

- Required return increased by $m^{Reg,i}\psi$
- Pressure to free capital by moving assets off the balance sheet or titling portfolios towards low capital-requirement assets
- Two monetary policy tools
  1. Interest rate
  2. Capital/margin requirement:
     - Good times: capital requirement
     - Bad times: lending facilities at moderate haircut

Haircuts Two Thousand Years Ago

- Use of haircuts:

  "One lends money with a mortgage on land which is worth **more than** the value of the loan. The lender says to the borrower, 'If you do not repay the loan within three years, this land is mine.'"

  — Mishnah, circa 200 AD.

- Return the haircut?

  "Rav Huna: If this condition was made when the money was given, then it is binding, even if the field is worth more than the loan. If the condition was made after the money was given, then the lender can only take **the portion of the land equivalent to the value of the loan**."

  — Talmud

Conclusion

- Binding margin requirements
  - Affects required returns
  - Propagates business cycles, esp. high-haircut sectors
- Interest-rate cuts:
  - Steepen haircut-return curve
- Haircut cuts:
  - Move assets down the haircut-return curve
  - Flatten the haircut-return curve itself
  - Effect of TALF, survey evidence: 3%
  - Effect of TALF, price effect of rejections: more than 0.40%
  - Large implied effect on investment, capital, and output

Appendix: Magnitude of Real Effect

TALF effect on required returns

$$\begin{aligned} E_t(r^j) &= r_t^f + \lambda_t \beta_t^j + \psi_t x m_t^j \\ \Delta E_t(r^j) &\approx \psi_t \, x \, \Delta m_t^j = 10\% \cdot 40\% \cdot (-80\%) = -3\% \end{aligned}$$

Large effect on real investment, capital, and output

$$\begin{aligned} \frac{\Delta K}{K} &\approx -\frac{1}{1-\alpha} \frac{\Delta(E(r)+\delta)}{E(r)+\delta} = -\frac{1}{1-1/3} \cdot \frac{-3\%}{15\% + 10\%} = 18\% \\ \frac{\Delta Y}{Y} &\approx \alpha \frac{\Delta K}{K} = \frac{1}{3} \cdot 18\% = 6\% \end{aligned}$$