Interventions in markets with adverse selection: Implications for discount window stigma

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THE FED’S DISCOUNT WINDOW

- The discount window is one of the main programs by which the government intervenes in financial markets
  - always open: during crisis, and during normal times
  - has been in place for a long time

- The discount window is regularly used as a source of funding by institutions in sound financial conditions (primary credit)
  - during normal times (from July 2010 to June 2015)
    - 578 primary credit loans of $10 million or more and 23 for $100 million or more
    - even with a lot of excess reserves in the system and a penalty rate (50 bp over IOR)
  - during the crisis: primary credit peaked at $112 billion in early November 2008
TWO ROLES FOR THE DISCOUNT WINDOW

- Monetary policy implementation: creates a ceiling on short term (overnight) money markets interest rates
  - less of a role in a floor-like system with plentiful of reserves (as currently in place in the U.S.)

- Financial stability: back-up source of funding for banks during periods of liquidity stress (idiosyncratic or aggregate)
  - this is the traditional lender-of-last-resort function

A long-standing view is that there is stigma associated with borrowing from the DW

- reluctance of banks to use the DW for fear that market participants will draw adverse inference about the financial conditions of the borrower if those DW borrowings were to become known (Bernanke, 2008)
- undermines the workings of the DW in both of its (main) roles
  - banks borrow at high rates in the market not to have to borrow from the DW
Many policymakers consider DW stigma a “real” problem

- in his *JEL* review of Geithner’s memoir, Gorton highlights the critical role played by stigma in the design of policy during the crisis
- Bernanke recently argued that a bill introduced in May 2015 by two U.S. senators was a mistake because it would exacerbate stigma at the discount window

The issue has received some attention in the academic literature

- **theoretical**: Ennis-Weinberg (2013), La’O (2014), Gorton and Ordoñez (2016), others
On the empirical side:
- Furfine studied the issue empirically in the early 2000s, but his methodology was not giving conclusive results
  - his focus was mainly on the role of the DW for monetary policy implementation
- Armentier et al. (2015) provide pretty convincing evidence of DW stigma during the financial crisis
  - focus on the role of the DW as LOLR during crises

On the theory side:
- recently, Philippon and Skreta (2012) study how to optimally design government programs aimed at intervening in financial markets suffering from adverse selection
  - Philippon-Skreta use a canonical model (security-design under adverse selection) and have firms deciding to participate in the government program while knowing that they could instead go to a private market
  - stigma could play a role in the model, but the issue is left largely unexplored in the paper
**Objective of this paper**

- To study in detail the implications of the Philippon-Skreta model for the issue of discount window stigma
  - take an equilibrium approach for a given government program: a discount window lending facility
  - discuss issues of multiplicity of equilibrium and general implications for the idea of stigma
  - extend the model in various relevant ways to further its ability to speak to the issues associated with DW stigma
**The model**

- The economy lasts for three periods: 0, 1, 2; there are firms (banks), investors, and a central bank.
- Investors are risk-neutral, do not discount the future and have deep-pockets.
- Firms have resources $c_0$ at time 0 and a “legacy” asset that pays a random return $a \in [0, \bar{A}]$ at time 2.
- Legacy assets are heterogeneous across firms
  - $\theta$ indicates asset type
  - $H(\theta)$ is the distribution of asset types across firms
  - $F_A(a | \theta)$ is the distribution of return $a$ for an asset of type $\theta$
  - Type $\theta$ is private information.
- Each firm has an opportunity to make an investment at time 1
  - Cost $x$
  - Random return $v$ independent of $\theta$; with $E[v] > x > c_0$
  - Call $y$ the random variable $a + v \in [0, \bar{A} + \bar{V}]$
THE PRIVATE MARKET FOR LOANS

- At time 1 firms can borrow from investors
- Firms propose debt contracts \((l, r)\) for loan size \(l\) and gross interest rate \(r\) and investors compete
- At time 2, investors only observe firms’ total income
  - cannot observe firm’s investment decision
  - cannot distinguish between income from legacy assets or investment (or other sources)
- Assume that assets with higher \(\theta\) are more productive in the first-order stochastic dominance sense
- The repayment function:

\[
\rho(\theta, rl) = \int_Y \min(y, rl) f_Y(y \mid \theta) dy
\]

is increasing in \(r\) and \(\theta \rightarrow\) higher \(\theta\)-types repay more in expected value
THE CENTRAL BANK

- The central bank runs a discount window at time 0
  - offer loans of size $m$ at gross interest rate $R$
  - to be paid back at time 2
  - DW loans are junior to private claims

- Assume that investors at time 1 can observe if a firm has borrowed at the discount window
THE EQUILIBRIUM CONCEPT

- Define the functions:
  - \( i(\theta), m(\theta), \) and \( l(\theta) \) → decisions of a type \( \theta \) firm (invest, borrow from the central bank and from the market, resp.)
  - \( r(l; m) \) → market interest rates
  - \( B(\theta | l, m) \) → beliefs system

- A Perfect Bayesian Equilibrium is a set of functions \( \{i^*(\theta), l^*(\theta), m^*(\theta)\} \), \( r^*(l; m) \), and \( B^*(\theta | l, m) \) such that:
  - Individual Rationality: \( i^*(\theta), l^*(\theta), m^*(\theta) \) maximize the objective of the firm given \( r^*(l; m) \) and \( R \);
  - Break-even: given \( B^*(\theta | l, m) \), \( r^*(l; m) \) satisfies:
    \[
    \int_{\Theta} \rho(\theta, r^*(l, m)|l) dB^*(\theta | l, m) = l
    \]
  - Belief consistency: Beliefs are consistent with Bayes’ rule for values of \( l \) and \( m \) observed in equilibrium
EQUILIBRIUM WITHOUT A DISCOUNT WINDOW

- Call \( l_0 = x - c_0 \) and let \( \theta^* \) and \( r^* \) solve

\[
l_0 - x + E[v] - \rho(\theta^*, r^*l_0) = 0
\]

\[
\int_{\theta}^{\theta^*} \rho(\theta, r^*l_0) \frac{dH(\theta)}{H(\theta^*)} = l_0
\]

- first equation: determines the marginal type that would want to take a loan at rate \( r^* \) and invest
- second equation: break-even condition for investors (given that all firms with types below \( \theta^* \) take a loan and invest)

- In principle, there can be multiple solutions to these eqns
  - multiplicity due to adverse selection: larger threshold \( \theta^* \) ⇒ better average quality of the pool of borrowers ⇒ break-even consistent with lower interest rates ⇒ more firms willing to borrow an invest (justifying the larger threshold)
  - concentrate attention in the case of a unique solution
In this example $H(\theta)$ is uniform in $[-0.8, 0.8]$ and $F_Y(y \mid \theta)$ is a beta distribution with parameters $2 + \theta$ and $2 - \theta$.
• **Proposition:** when the discount window is not active, there is an equilibrium where:

  - \( i^*(\theta) = 1 \) for all \( \theta \leq \theta^* < \bar{\theta} \) and zero otherwise
  - \( l^*(\theta) = l_0 \) for all \( \theta \leq \theta^* < \bar{\theta} \) and zero otherwise
  - the market interest rate is equal to \( r^* \)

• Only firms with \( \theta \leq \theta^* \) invest

  - when \( \theta^* < \bar{\theta} \), firms with \( \theta \in [\theta^*, \bar{\theta}] \) do not undertake positive net present value investments → *an inefficiency*

• There are several specifications of off-equilibrium beliefs that can sustain \( l^*(\theta) \) as an equilibrium

  - for example: for all \( l > l_0 \), \( B(\bar{\theta}|l) = 1 \)
Suppose the central bank offers loans of size $l_0$ at rate $R^T < r^*$

- a way to increase investment and reduce the inefficiency

There are multiple equilibria depending on which firms borrow from the central bank

The Philippon-Skreta beliefs

- firms with low $\theta$ access the discount window
- define $\theta^T$ as the solution to

$$l_0 - x + E[v] - \rho(\theta^T, R^T l_0) = 0$$

- there exist the threshold $\theta^P \in [\theta, \theta^T]$ that solves

$$\int_{\theta^P}^{\theta^T} \rho(\theta, R^T l_0) \frac{dH(\theta)}{H(\theta^T) - H(\theta^P)} = l_0$$
**Proposition:** when the discount window offers loans of size $l_0$ at rate $R^T < r^*$, there are thresholds $\theta^P$ and $\theta^T$ and an equilibrium where:

- $i^*(\theta) = 1$ for all $\theta \leq \theta^T$ and zero otherwise
- $m^*(\theta) = l_0$ for all $\theta < \theta^P$ and zero otherwise
- $l^*(\theta) = l_0$ for all $\theta \in [\theta^P, \theta^T]$ and zero otherwise
- the market interest rate equals $R^T$

- Firms with low values of $\theta$ ($< \theta^P$) borrow from the discount window

- Induces more firms to invest: all $\theta < \theta^T$ with $\theta^T > \theta^*$
Implications for stigma

- In this equilibrium, the pool of firms borrowing from the discount window has higher repayment risk than those borrowing from the market
  - but no firm at the discount window borrows later from the market ⇒ not much scope for “observable” stigma
  - selection (of riskier firms) at the discount window improves the pool of firms borrowing from the market, allowing the market rate to come down

- Both firms that borrow from the market and firms that borrow from the discount window pay the same for funds

- In this model, negative selection at the discount window (a feature of stigma) allows the central bank to increase total investment and efficiency
More on the issue of multiplicity

- For any pool of firms borrowing from the market consistent with a market interest rate equal to $R_T$ there is an equilibrium with the same features as before
  - some higher $\theta$ firms could be borrowing from the DW (as long as the average quality in the market stays the same)

- With a simple DW policy there is also an equilibrium where the private market for loans is inactive
  - this happens when investors believe that borrowers in the market are likely to have low values of $\theta$ ("bad" credit)
  - off-equilibrium beliefs are crucial
  - here stigma would seem to come from borrowing in the market
**Other (more general) DW policies**

- Suppose the central bank offers loans of size $\pi l_0 < l_0$ to target the same level of investment: all firms with $\theta < \theta^T$ invest
  - now firms borrowing from the discount window at time 0 will have to borrow from the market at time 1 at rate $r^*(l, m)$ with $l = (1 - \pi)l_0$ and $m = \pi l_0$
  - potential for on-equilibrium implications of stigma

- Suppose all firms with $\theta < \theta^P$ borrow from the DW
  - then, investors break-even interest rate on loans of size $(1 - \pi)l_0$, denoted $r^S$, satisfies
    $$\int_{\theta}^{\theta^P} \rho(\theta, r^S(1 - \pi)l_0) \frac{dH(\theta)}{H(\theta^P)} = (1 - \pi)l_0$$
    - note the seniority of private debt
    - note also that $r^S$ depends on $\pi$
**Proposition:** when the discount window offers loans of size $\pi l_0$ at interest rate $\hat{R}$ there is an equilibrium where:

- $i^*(\theta) = 1$ for all $\theta \leq \theta^T$ and zero otherwise
- $m^*(\theta) = \pi l_0$ for all $\theta \leq \theta^P$ and zero otherwise
- $l^*(\theta) = \begin{cases} (1 - \pi)l_0 & \text{for } \theta \leq \theta^P \\ l_0 & \text{for } \theta \in (\theta^P, \theta^T] \\ 0 & \theta > \theta^T \end{cases}$
- there are two market interest rates
  \[ r^*((1 - \pi)l_0, \pi l_0) = r^S \]
  \[ r^*(l_0, 0) = R^T \]
- the discount window rate satisfies
  \[ \hat{R}\pi l_0 + r^S(1 - \pi)l_0 = R^T l_0 \]
- In this equilibriums $r^S$ may be smaller or greater than $R^T$
As $\pi$ increases, the private (senior) loan becomes smaller and the repayment risk falls, allowing the market interest rate to decrease.

$\hat{R}$ is the discount window rate compatible with market rates $r^S$ for loans of size $(1 - \pi)l_0$ and $R^T$ for loans of size $l_0$. 

\[ l_0 = 0.25, \quad x = 0.27, \quad E[v] = 0.285 \]
**Implications for stigma**

- If $\pi$ is small (large private loans) then $r^S > R^T > \hat{R}$
  - the discount window rate is lower than market rates
  - firms borrowing at the DW pay higher rates in the market ($r^S$)
  - firms only borrowing from the market pay a higher rate than they could get at the window
  - this looks like “observable” discount window stigma

- If $\pi$ is large (small private loans) then $r^S < R^T < \hat{R}$
  - the discount window rate is a “penalty” rate
  - firms borrowing at the DW pay lower rates in the market
  - by lowering the amount of funds needed from the market, the DW lowers private repayment risk and private interest rates

- In both situation, total interest expense from borrowing $l_0$ is the same for all investing firms

- For these results $\rightarrow$ crucial to have private loans as senior claims
Choosing the quantity borrowed at the DW

- To choose how much to borrow, agents need to use the full price function $r(m)$ that depends on off- and on-equilibrium beliefs
  - assume investors believe any borrowing firm (regardless of quantity) is a random draw from the firms investing
  - the equilibrium price function $r^{**}(m)$ solves
    $$\int_{\theta}^{\theta^{**}} \rho[\theta, r^{**}(m) (l_0 - m)] \frac{dH(\theta)}{H(\theta^{**})} = l_0 - m$$
    where all firms with $\theta < \theta^{**}$ are expected to invest
  - $r^{**}(m)$ is decreasing

- Firms choose $m$ to solve
  $$\max_{m} \int_{\gamma} \{y - \min[y, Rm + r^{**}(m) (l_0 - m)]\} f_{\gamma}(y | \theta) dy$$
  - solution $m^{**}$ is independent of $\theta$: all firms choose the same
• **Proposition**: when the discount window offers loans of any size \( m \leq l_0 \) at interest rate \( R \) there is an equilibrium where:
  
  • \( i^*(\theta) = 1 \) for all \( \theta \leq \theta^{**} \) and zero otherwise
  
  • \( m^*(\theta) = m^{**} \) and \( l^*(\theta) = l_0 - m^{**} \) for all \( \theta \leq \theta^{**} \) and zero otherwise
  
  • market interest-rate function is \( r^*(l_0 - m, m) = r^{**}(m) \)
  
• When \( m^{**} \) is interior, \( R > r^{**}(m^{**}) \)
  
  • firms borrow some at the discount window even though it is more expensive: it allows them to lower their repayment risk and the interest rate in the private market
  
  \( \Rightarrow \) firms may voluntarily borrow from the discount window at *penalty rates*
  
• When \( m^{**} \) is interior, lower DW rates have two effects
  
  • intensive margin: \( m^{**} \) increases (firms borrow more from DW)
  
  • extensive margin: \( \theta^{**} \) increases (more firms borrow and invest)
Seniority and penalty rates

- In the U.S., DW loans are collateralized and offered at a “penalty” rate
  - in the model, when DW loans are senior, the penalty-rate configurations described before cannot survive as equilibrium

Two important caveats:

- on seniority → collateralized discount window lending does not guarantee “effective” seniority: historically, many investors were able to withdraw before FDIC intervention, while discount window loans remain outstanding
- on penalty rates → important to determine the appropriate benchmark: in the model, all positive DW rates are “penalty” rates relative to the risk-free rate
Seniority of DW loans changes investors break-even condition

- The expected repayment function becomes

\[ \xi(\theta, Rm, rl) = \int_Y \min\{\max(0, y - Rm), rl\} f_Y(y | \theta) \, dy \]

- The (net) interest rate at the DW would have to be negative for the central bank to be able to increase investment in equilibrium.

- Which would require an administrative procedure to ensure that funds are used for investment → as before 2003 in the U.S.

Consistent with the direction in which the Fed modified the DW program during the crisis:

- Reduce the “penalty” spread

- Increase the maturity from overnight to a month and more → which effectively makes DW loans more junior claims
CONCLUSION

- Consensus building in policy circles around the idea that banks are reluctant to borrow form the Fed’s discount window → stigma

- I study the implications for discount window stigma of the model by Philippon and Skreta (2012)

- The model suggests novel ways to think about stigma-like effects:
  - Stigma does not “limit” (Bernanke’s words) “the efficacy of the discount window,” but instead is part of the process by which the central bank increases investment and efficiency
  - Borrowing at the discount window allows firms to manage their repayment risk in the private market: potentially enough to compensate for stigma effects and penalty rates
**Fed lending during the crisis**

- During the crisis, policymakers concluded that the normal discount-window arrangements were not sufficient.

- The discount window only lends to depository institutions (banks, credit unions, FBOs):
  - the flow of liquidity from eligible institutions to other financial firms appeared impaired
  - eligible institutions appeared reluctant to borrow from the DW

- Policy response:
  - created various facilities that broaden the set of counter-parties directly dealing with the Fed
  - redesigned the process for lending through the discount window (by using an auction format: TAF)
TAKING SOME PERSPECTIVE

- Some primary credit during normal times

Data from the H.4.1 Fed data release: weekly averages

(i.e., some days, outstanding balances are much higher since most loans are overnight)
Adding some perspective

- A lot more primary credit during the crisis

Source: Federal Reserve Board 2018
Adding some perspective

- Lending at the TAF during the crisis dwarfed primary credit

Source: Federal Reserve Board 2018
An empirical case for studying DW stigma

- Armentier et al. (2015) changed the state of affairs: they pretty convincingly showed evidence of *market stigma* by looking at bids submitted to the TAF during the 2007-2008 financial crisis
  - bids are accurate reflection of banks willingness to pay
  - both discount window and TAF are collateralized
  - both types of loans have the same regulatory standing (central bank lending)

- They find that many banks were willing to pay significantly higher rates to borrow from TAF than what they would have had to pay to borrow from the discount window
  - banks were willing to accept (and indeed experience) significant extra interest cost to avoid (the stigma from) borrowing at the regular discount window
THE DEFINITION OF STIGMA

- Providing a working definition of DW stigma is not obvious
  - Bernanke (2008):
    - “arises primarily from banks’ concerns that market participants will draw adverse inferences about their financial condition if their borrowing from the Federal Reserve were to become known.”
    - “the efficacy of the discount window has been limited by the reluctance of depository institutions to use the window as a source of funding.”
  - Gorton (2015): “a bank’s reluctance to go to the discount window because of fears that depositors, creditors, and investors will view this as a sign of weakness, causing its borrowing costs to rise or maybe generating a bank run.”

- Two possible pragmatic model-checks
  - discount-window borrowing is a negative signal of the firm’s credit quality
  - firms borrow at higher rates in the market than the one they could obtain at the discount window