Deposit-based payments

- About 61% of organizations experienced attempted or actual payments fraud in 2012, and 87% of respondents from affected organizations reporting that checks were targeted (2013 AFP).

- In spite of the threat of fraud, the volume of non-cash payments continued to grow globally, partly because financial intermediaries have taken various measures to improve the safety of accepting the deposit-based payment instruments, including fraud-prevention technologies and overdraft protection.
Financial innovations and fraud-prevention technology

- EMV (microchip in cards) provides an extra layer of security for consumers which have helped drop the fraud levels down.

- The survey of FDIC (2008): 86% of banks operated overdraft programs, by which the bank honors a customer's overdraft obligations of the nonsufficient fund transaction.
Objective

To provide a microfoundation of monetary theory to explore

- how the fraudulent behavior affects the acceptability of deposit-based payments, and therefore, the liquidity of deposits;
- how financial innovations in overdraft coverage and improvements in the technology of clearing and fraud detection affect the incentive for committing payments fraud, and welfare.
Main features of the model

- Sellers cannot recognize the authenticity of payments.
- People may conduct fraudulent payments with a positive cost.
- Banks provide payments services and credit.
- Banks exclude agents who commit payments fraud, so they need to hold enough cash to finance unexpected spending.
- Liquidity of an asset: the extent to which it can facilitate exchange, as a means of payment or as collateral.
Main insights: endogenous liquidity constraints

- The threat of payments fraud results in an endogenous upper bound on the quantity of deposits that can be traded for consumption goods.
  - This upper bound depends on the fixed fraud cost, trading frictions, financial punishments, and inflation.

- A new transmission channel for monetary policy: Higher inflation relaxes the liquidity constraint through raising the self-financing cost. Agents are more willing to make deposits, leading to more loanable funds, and aggregate output rises.
Main insights: effects of overdraft coverage

- Buyers may issue NSF checks when the cost of holding deposits is larger than the overdraft fee.

- Inflation induces a tradeoff: liquidity of deposits is higher, but payments fraud is more severe (i.e., more NSF checks are issued).

- Overdraft improves welfare: When trade shuts down because high inflation makes it too costly to accumulate nominal assets, overdraft coverage offers an outlet to avoid the inflation cost and sustain the existence of equilibrium.
Related literature

- Moral hazard and the positive fraud cost: Li, Rocheteau, and Weill (2012) distinctions: we consider banks, financial punishments, and monetary policy.
- Endogenous credit constraint and inflation: Berentsen, Camera, and Waller (2007), Aiyagari and Williamson (2000), Li and Li (2013).
Timing of the representative period

Buyers decide to commit payments fraud (k), and adjust portfolio: (m, d)

Decentralized market
- *buyers* and *sellers*
  bilaterally match
- bargaining game

Walrasian market
- *banks* open and make loans
  - *the clearing house:*
    checks clearing and settlement services
  - *the financial punishment*

Walrasian market
- adjust portfolios of money and deposits

Portfolio: \((m_{+1}, d_{+1})\)
Model: Types of markets and agents

- A nonstorable and perfectly divisible consumption good.
- Each period is divided into three subperiods: $DM_1$, $CM_2$, and $CM_3$.
- Buyers want to consume good in the $DM_1$ and $CM_2$, but cannot produce; sellers can produce goods in both markets, but do not want to consume.
- Both types can produce and consume good in the $CM_3$.
- The lifetime expected utility of a buyer and a seller in $t = 0$:

$$
\mathbb{E} \sum_{t=0}^{\infty} \beta^t [u_1(x_{1,t}) + u_2(x_{2,t}) + u_3(x_{3,t}) - h_t],
$$

$$
\mathbb{E} \sum_{t=0}^{\infty} \beta^t [-x_{1,t} - x_{2,t} + u_3(x_{3,t}) - h_t].
$$
Terms of trade

- In the $DM_1$, terms of trade are determined according to a simple bargaining game: In each pairwise meeting the buyer makes a take-it-or-leave-it offer, which the seller accepts or rejects.
  - The offer specifies the quantity of the good in exchange for some quantities of assets.
  - Buyers’ portfolios are private information, but they can transfer any assets they hold.

- In the $CM_2$ and $CM_3$, prices are determined competitively.
Payments fraud

- Means of payment: fiat money and deposits (checks or debit cards).
  - Fiat money is perfectly recognizable.
  - Deposit-based payments are threatened by payments fraud.

- Fraud of deposit-based payments: in $CM_{3,-1}$, a buyer can pay the fraud cost $k > 0$ to acquire a technology that allows him to write any dollar amounts on a fake check to trade $DM_1$ good
Banks and the clearing house

- Banks take nominal deposits, make nominal loans and provide payment services.
  - Making deposits in $CM_{3,-1}$ allows the account holder to pay for $DM_1$ transactions with checks.
  - Buyers can borrow money from banks in $CM_2$; the loan is repaid in $CM_3$.

- Before $CM_2$ opens:
  - Sellers deposit checks in banks, which then send to the clearing house.
  - The clearing house detects frauds and returns bad checks to banks.

- In the $CM_2$, banks decline the loan to dishonest buyers for a period ⇒ the self-financing cost
The bargaining game

The game starts in $CM_3$ of period $t - 1$ and ends in $CM_3$.

1. The buyer determines his $DM_1$ offer, $(x_1, y_m, y_d)$, at the beginning of the game.

2. The buyer chooses whether or not to commit payment fraud, and the portfolio of money and deposits, $(m, d)$.

3. He is matched with a seller in the $DM_1$, who chooses whether or not to accept the offer.

4. When the seller accepts the offer in a match, he produces $x_1$ units of the good, in exchange for $y_m$ units of money and $y_d$ units of deposits from the buyer.

5. Agents who had trade opportunity in the $DM_1$ can trade in the $CM_2$, in which a dishonest buyer cannot receive loans.
Seller’s acceptance rule

- $i_d$: deposit interest rate
- $\phi$: real value of money in period $t$
- $\eta$: the prob. of making deposits
- $\pi$: the prob. of accepting buyer’s offer

Given the terms of trade in a match, $(x_1, y_m, y_d)$, the decision of sellers to accept or reject an offer satisfies

$$\begin{align*}
-x_1 + \phi [y_m + \eta (1 + i_d) y_d] &< 0 \implies \pi = 0 \\
&= 0 \quad \in [0, 1]
\end{align*}$$
Buyer’s payments fraud decision

Given $\pi$, the decision rule to commit payments fraud is

\[
\left\{ [\gamma - \beta(1 + i_d)] + \beta \sigma \pi (1 + i_d) \right\} \phi y_d > k + B \implies \eta = 0
\]

the self-financing cost

\[
B \equiv (\gamma - \beta) \phi p \hat{x}_2 + \beta \sigma \left\{ [u_2(x_2) - \phi p x_2] - [\hat{u}_2(\hat{x}_2) - \phi p \hat{x}_2] \right\} - \beta \sigma \phi i \ell
\]

the cost of holding money

the cost of differences in consumption between a genuine buyer and a counterfeiter payment

interest payment
Proposition 1

The equilibrium offer, \((x_1, y_m, y_d)\), satisfies

\[
\max_{(x_1, y_m, y_d)} -(\gamma - \beta)\phi y_m - [\gamma - \beta(1 + i_d)]\phi y_d + \beta \sigma \{ u(x_1) - \phi[y_m + (1 + i_d)y_d] \}
\]

s.t. \(-x_1 + \phi[y_m + (1 + i_d)y_d] = 0\)

\[
\phi y_d \leq \frac{k + B}{\gamma - \beta(1 - \sigma)(1 + i_d)}
\]

- Note: in equilibrium, \(\eta = 1\) and \(\pi = 1\).
Endogenous liquidity constraint

\[ \phi y_d \leq \frac{k + B}{\gamma - \beta(1 - \sigma)(1 + i_d)} \]

\[ B \equiv (\gamma - \beta)\phi p\hat{x}_2 + \beta\sigma \{ [u_2(x_2) - \phi px_2] - [u_2(\hat{x}_2) - \phi p\hat{x}_2] \} - \beta\sigma \phi il \]

- Even if buyers hold enough deposits, they may not be able to use them because of the threat of fraud.

- The upper bound \( \phi y_d \leq \frac{k + B}{\gamma - \beta(1 - \sigma)(1 + i_d)} \) depends on
  - the fraud cost, \( k \)
  - self-financing cost, \( B \)
  - the rate of return of deposits, \( \frac{\beta(1 + i_d)}{\gamma} \)
  - trading frictions, \( \sigma \).
Optimal choices in the $CM_2$ and $CM_3$.

- The seller’s problem is
  \[
  \max_{x^s_2} -c_2(x^s_2) + W^s_3(m)
  \]
  FOC:
  \[
p = \frac{c'(x^s_2)}{\phi}
  \]

- The buyer’s problem is
  \[
  \max_{x^b_2, \ell} u_2(x^b_2) + W^b_3(m, d, \ell)
  \]
  s.t. \quad px^b_2 \leq m - y_m + d - y_d + \ell
  
  FOC:
  \[
  \frac{u'_2(x^b_2)}{c'_2(x^s_2)} = (1 + i)
  \]

- In $CM_3$: $u'_3(x_3) = 1$
Proposition 2: interest rate and value of money

There exists a monetary equilibrium if and only if $u'_1(0) > \frac{\gamma - \beta + \beta \sigma}{\beta \sigma}$.

Denote $\bar{k} = \frac{[\gamma - \beta (1 - \sigma)]x_1 d}{M_{-1}} - B$ and $k = \frac{\sigma \gamma x_1 d}{M_{-1}} - B$.

- If $k \geq \bar{k}$,
  \[ i = 0, \quad \phi = \frac{x_1}{M_{-1}}. \]

- If $\bar{k} < k < k$,
  \[ i = \frac{(k + \hat{B})M_{-1} + [\beta (1 - \sigma) - \gamma]x_1}{\beta \sigma x_1 - (k + \hat{B})}, \]
  \[ \phi = \frac{x_1}{M_{-1} + (\frac{u'_2(x_2)}{c'_2(x_2)} - 1)d}. \]

- If $k \leq \bar{k}$,
  \[ i = \frac{\gamma - \beta}{\beta}, \]
  \[ \phi = \frac{x_1 - \frac{k + B}{\beta \sigma}}{m}. \]
Proposition 3

Consider the equilibrium under $k < k < \bar{k}$; i.e., the liquidity constraint of deposits binds.

1. $\frac{\partial x_1}{\partial \gamma} < 0$, $\frac{\partial x_2}{\partial \gamma} > 0$, $\frac{\partial i}{\partial \gamma} < 0$, $\frac{\partial \phi y_d}{\partial \gamma} > 0$.

2. $\frac{\partial x_1}{\partial k} = 0$, $\frac{\partial x_2}{\partial k} > 0$, $\frac{\partial i}{\partial k} < 0$, $\frac{\partial \phi y_d}{\partial k} > 0$.

3. $\frac{\partial x_1}{\partial \sigma} > 0$, $\frac{\partial x_2}{\partial \sigma} < 0$, $\frac{\partial i}{\partial \sigma} > 0$, $\frac{\partial \phi y_d}{\partial \sigma} < 0$.

- $\gamma \uparrow \Rightarrow$ money holding cost $\uparrow \Rightarrow$ relaxing the liquidity constraint of deposits ($\phi y_d \uparrow$) $\Rightarrow$ loanable funds $\uparrow$ $\Rightarrow$ interest rate $i \downarrow$, and consumption financed by loan $x_2 \uparrow$
- $k \uparrow \Rightarrow$ relaxing the liquidity constraint of deposits ($\phi y_d \uparrow$)
- $\sigma \uparrow \Rightarrow$ tightening the liquidity constraint ($\phi y_d \downarrow$)
Identity theft

- Technological developments and growing on-line transactions have made identity theft occur at much lower cost and with a greatly reduced chance of arrest.

- Payment does not go through the clearing process with correct identity of the payer, and so an identity thief cannot be excluded from the banking system; $B = 0$. Moreover, there is some probability that the cost of committing identity theft, $k = 0$, is zero.

- If $k = 0$ and $B = 0$, then it is optimal to commit identity theft, irrespective of seller’s acceptance probability $\pi$. 
Overdraft coverage

- A buyer who issues a nonsufficient fund (NSF) check will be charged a usage fee, $k$, if the overdraft coverage is used.
  - Banks do not impose financial punishment, $B = 0$.
  - The buyer repays the amount of overdraft in the $CM_3$.

- The issuer of a bad check is charged a NSF fee, $k$, and is excluded from the banking sector for a period.

- When a buyer issues a NSF check, the seller will receive funds when the buyer’s account is under overdraft protection, and no funds are transferred otherwise.
Overdraft coverage: buyer’s strategy

• For a buyer with overdraft coverage, given an offer, \((x_1, y_m, y_d)\), and the seller’s probability of accepting \(\pi\), his strategy satisfies

\[
< \left( \gamma - \beta (1 + i_d) \right) \phi y_d > k \implies \zeta = 0 \quad \in [0, 1]
\]

• For a buyer without overdraft coverage:

\[
\left\{ \left( \gamma - \beta (1 + i_d) \right) + \beta \sigma \pi (1 + i_d) \right\} \phi y_d > k + B \implies \eta = 0 \quad \in [0, 1]
\]
Possibility of payments fraud

- equilibrium I: \( \{\eta = 1, \zeta = 1\} \);
- equilibrium II: \( \{\eta = 1, \zeta \in (0, 1)\} \);
- equilibrium III: \( \{\eta = 1, \zeta = 0\} \).
Existence of equilibrium

- Equilibria with NSF transactions exist more likely under higher inflation.
- A trade-off: equilibria suffering from more severe payments fraud entail higher liquidity of deposits.
Policy implications

We set up utility function $u_1(x_1) = x_0.5 x_1$, $u_2(x_2) = x_0.5 x_2$, cost function $c_1(x_1) = 0.9 x_1$, $c_2(x_2) = x_2$

The parameter values for the benchmark are $\sigma = 0.2$, $\beta = 0.95$, $M^{-1} = \gamma^* 10$, $\xi = 0.6$, $\omega = 0.98$, $k = 0.009$. $\gamma$
Effects of inflation

- Negative effect: Inflation lowers the real value of money and deposits ⇒ lower incentives to produce.

- Positive effect: Inflation relaxes the liquidity constraint of deposits ⇒ raising the incentives to make deposits ⇒ increasing loanable funds to finance CM2 consumption.

- Our model identifies a positive relationship between inflation and output in a low-inflation economy (equilibrium I), and a negative relationship if inflation is above some threshold (equilibria II and III).
Welfare-improving role of overdraft coverage

- Under high inflation, agents use overdraft coverage to avoid holding costs of nominal assets. Equilibria do not exist without overdraft coverage.
- Using overdraft implies NSF checks circulate and payments fraud is intensified.
Proposition 4

Consider the case where the liquidity constraint of deposits binds.

1. in three types of equilibria, \( \frac{\partial x_1}{\partial k} = 0, \frac{\partial x_2}{\partial k} > 0, \frac{\partial i}{\partial k} < 0; \) and in equilibria I and III, \( \frac{\partial \phi y_d}{\partial k} > 0; \)

2. in equilibria I and III, \( \frac{\partial x_1}{\partial \omega} = 0, \frac{\partial x_2}{\partial \omega} > 0, \frac{\partial i}{\partial \omega} < 0. \)

• \( \omega \uparrow \Rightarrow \) payments fraud is subject to more severe punishment
  \( \Rightarrow \) buyers are more willing to make deposits
  \( \Rightarrow \) loanable funds and \( CM_2 \) output \( x_2 \) increase.
Conclusion

- Derive endogenous liquidity constraints, that provide a different transmission channel for monetary policy.

- We observe a trade-off when overdraft coverage is available: equilibria suffering from more severe payments fraud entail higher liquidity of deposits than others.

- Our model identifies a positive relationship between inflation and output in a low-inflation economy, and a negative relationship if inflation is above some threshold.

- When trade shuts down due to high inflation, overdraft program offers an outlet to avoid the inflation cost and payments fraud is intensified.