Econ135: Lecture 2 Supplement on U.S. Payment Systems
The Diffusion of RTGS

- In most countries, the central bank provides the medium to settle the smallest payments (cash) and the means to settle the largest payments, which typically are wholesale payments between banks.
- For the latter purpose the central bank usually operates a system through which banks can settle payments in central bank money.
- Historically, interbank payments have been settled via (end of day) netting systems, but as volume increased central banks became worried about the risks inherent in netting systems.
- Most central banks opted for the implementation of a Real Time Gross Settlement (RTGS) system.
The Diffusion of RTGS

• RTGS:
  – processes payments individually, immediately and with finality throughout the day
  – eliminates settlement risk (unwinding)
  – increased need for liquidity either from banks
RTGS 1996
Comparing RTGS Systems

- **Fedwire (USA)**
  - 7600 direct participants, Avg. daily vol. = 500,000 worth $2.6 Trillion
  - Turnover = US GDP every 5.5 business days
- **CHAPS (UK, £)**
  - 15 direct participants, Avg. daily vol. = 130,000 worth $409 Billion
  - Turnover = UK GDP every 6 business days
- **CHATS (Hong Kong, HKD)**
  - 142 participants, Avg. daily vol. = 21,000 worth $77 Billion
  - Turnover = HK GDP every 3 business days
- **Target2 (EU, €)**
  - 866 direct participants, 3,585 indirect participants and 12,950 correspondents
  - Avg. vol. = 336,000 worth $3.2 Trillion
## U.S. Payment Services

<table>
<thead>
<tr>
<th></th>
<th>Large Value Payment System</th>
<th>Retail Payment System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Federal Reserve Payment Service</strong></td>
<td>The Fedwire Funds Service</td>
<td>Federal Reserve Check Services; Federal Reserve ACH</td>
</tr>
<tr>
<td><strong>Privately Operated Systems</strong></td>
<td>CHIPS; CLS</td>
<td>Commercial ACH (e.g. NYCH, American); Commercial Check Services</td>
</tr>
</tbody>
</table>
## Transaction Amounts for Various Payment Services (2011)

<table>
<thead>
<tr>
<th>Payment Service</th>
<th>Transaction Volume (million)</th>
<th>Transaction Value (billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fedwire</td>
<td>127</td>
<td>664,000</td>
</tr>
<tr>
<td>CHIPS</td>
<td>95</td>
<td>405,000</td>
</tr>
<tr>
<td>CLS</td>
<td>214</td>
<td>1,241,000</td>
</tr>
<tr>
<td>Checks&lt;sup&gt;1&lt;/sup&gt;</td>
<td>159 (63)</td>
<td>242 (141)</td>
</tr>
<tr>
<td>ACH&lt;sup&gt;2&lt;/sup&gt;</td>
<td>10,349 (11,620)</td>
<td>17,802 (19,891)</td>
</tr>
</tbody>
</table>

<sup>1</sup> Updated to 2014. Source: http://www.federalreserve.gov/paymentsystems/check_govcheckprocannual.htm

<sup>2</sup> Updated to 2014. Source: http://www.federalreserve.gov/paymentsystems/fedach_yearlycomm.htm
Fedwire: Facts & Figures

- Real-time gross settlement system (RTGS) of the Federal Reserve
- 7600 direct participants, Avg. daily vol. = 500,000 worth $2.6 Trillion
  - Turnover = US GDP every 5.5 business days
- Individual payment size (no minimum)
  - average: $6.4 M, median $20 K
  - 90 percentile: 740 K, 95 percentile: 2.7M, 99 percentile: 57.7M
- Operates 21.5 hours/day on business days: 9pm to 6:30pm
- Daylight overdrafts permitted
  - Revised Payment System Risk policy as of 3/24/11
  - Zero fee for collateralized daylight overdrafts
  - 50 basis point (annual rate) charge for uncollateralized
- Variety of access solutions: FedLine
Fedwire Participants

- U.S. Depository institutions
- U.S. branches of foreign banks
- Member banks of the Federal Reserve System
- U.S. Treasury and authorized agencies
- Foreign central banks, foreign monetary authorities, foreign governments, and certain international organizations.
- Any other entities authorized by a Reserve Bank (e.g. CHIPS, CLS)
# Fedwire Fees 2013

## Volume-Based Pricing Fees (Origination and Receipts)

<table>
<thead>
<tr>
<th>Service</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Transfer for the First 14,000 Transfers per Month</td>
<td>$0.65</td>
</tr>
<tr>
<td>Per Transfer for Additional Transfers up to 90,000 per Month</td>
<td>$0.25</td>
</tr>
<tr>
<td>Per Transfer for Every Transaction over 90,000 per Month</td>
<td>$0.145</td>
</tr>
</tbody>
</table>

**Surcharge**

| Off-line Transfer Originated or Received | $45.00 |
| Monthly participation fee               | $85.00 |

Note: Both sender and receiver pay!

- >10m                                       | $0.12  |
- >100m                                     | $0.30  |
CHIPS (Clearing House Interbank Payment System): Facts and Figures

- Real-time, final payments system for U.S. dollars that uses bi-lateral and multi-lateral netting

- Processes over 378,000 payments a day with a gross value of about $1.61 trillion in 2011.

- Historically, CHIPS handled a large fraction of U.S. dollar cross-border payments

- More than 45 member banks
How CHIPS Works

1. Banks pre-fund via Fedwire no later than 9am

2. Banks Send and Receive Payments All Day (9am-5pm)

3. **Balanced Release Algorithm**
   - CHIPS continuously off-sets payments individually, bilaterally, and multi-laterally throughout the day

4. Payments are immediately final when offset and released (throughout the day)

5. At the end of the day (5pm)
   - CHIPS nets all unmatched payments
   - Banks fund their respective negative closing positions
   - CHIPS releases remaining payments at approximately 5:15 pm

6. Via Fedwire, CHIPS sends payment orders to banks in positive closing positions (5:15pm)
ACH (Automated Clearing House): Facts and Figures

- Electronic interbank payment system for small and recurring payments
- Transactions not processed individually
- Banks send transactions to ACH operators
- Batch processing store-and-forward
- Sorted and retransmitted within hours
- Daily settlement by Fedwire
- Posted to receiver’s account within 1-2 business days
ACH (Automated Clearing House): Facts and Figures

• Both debits and credits allowed
• One function is for processing dematerialized checks (digital data only)
• ACH processors:
  – Federal Reserve System (processes roughly 90% of all ACH payments)
  – Commercial ACHs are governed by the National Automated Clearing House Association (NACHA).
  – The other large processor is the Electronic Payments Network
• 2011: 10B ACH network transactions totaling $18T
• ACH cost: less than 1 cent per transaction
Payment Processing Behavior: Game Theory
Trade-off Between Liquidity Cost and Payment Delay

- Most payments originate in the real sector and are exogenous to the bank that process them.
- Banks have flexibility in terms of when they process a vast majority of these payments.
  - 4% of values in CHAPS are time critical according to Ball et al (2011).
- Delaying can result in liquidity savings as it allows you to utilize incoming liquidity.
- But delay is costly:
  - Loss of goodwill and future business.
  - Uses up computing resources and requires additional staff (Furfine and Sterm, 1998).
Priced Credit

Fee $F$ charged by central bank for overdrafts

<table>
<thead>
<tr>
<th></th>
<th>Bank B</th>
<th></th>
<th>Bank A</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>Morning</td>
<td>Afternoon</td>
<td>Morning</td>
<td>Afternoon</td>
</tr>
<tr>
<td></td>
<td>0, 0</td>
<td>D, F</td>
<td>0, 0</td>
<td>3, 4</td>
</tr>
<tr>
<td>Afternoon</td>
<td>4, 3</td>
<td>D, D</td>
<td>4, 4</td>
<td>4, 4</td>
</tr>
</tbody>
</table>

Total cost = 0 (FIRST BEST)

Time is money (also intraday) so delay is costly. The cost is $D > 0$ per dollar

Total cost = 0 or (6)
Breakdown in Payment Coordination after 9/11

\[ \text{Payments Sent}_t = \alpha + \beta \cdot \text{Payments Received}_t + \epsilon_t \]

Slope of Reaction Function of Payments Sent to Payments Received: Fixed-Effects Tobit Model

Source: Federal Reserve Bank of New York

McAndrews and Potter (2002)
Move to the “bad” equilibrium

McAndrews and Potter (2002)
Settlement dynamics following Lehman bankruptcy

- The increase in uncertainty and erosion of trust that followed the bankruptcy of Lehman Brothers on September 15, 2008 led banks to curtail the provision of intraday credit to customers.
- It also made banks reluctant to submit payments to one another out of fear that funds would not return, thereby hindering their ability to make critical payments later in the day.
- Credit risk leads to an increase in the cost of early processing and a reduction in the cost of delay
  - increase in cost arises from possibility that morning payments may not be returned leading to additional borrowing costs
  - Delay is not penalized if intended receiver defaults
Empirical Evidence

September 15, 2008

Average Time of Settlement (Value Weighted)  Reserves (Right Axis)

$ Billions

Bech and Garratt (2012)
Fedwire Funds, timing and endogenous liquidity

Nodes = 16 important Participants; scaled by value  
Links = 1 payment between participants  
Coloring Scheme: Time at which 70% of value has settled along each links  

Gray: Time is less than or equal to 95th percentile of reference period = No Delay  
Red: Greater than 95th percentile of reference period = Delay
One participant may delay (idiosyncratic shock)
Everyone may delay, a clear instance of *illiquidity*

The delay is an endogenous, best-reply, response to others’ behavior.
Fedwire Settlement Delay - September 2008

Bech and Garratt (2012)
High Reserves
For several years leading up to the crisis, key factors affecting the funding of payments in Fedwire Funds were relatively constant.

- Reserves held by banks in Federal Reserve accounts were flat at around $10 bn and the interest charged to banks for overdrafts remained fixed at an annualized rate of 36 basis points.

In 2008, the Federal Reserve changed its Interest on Required and Excess Reserves (IOR) policy to promote efficiency in the banking system and to support financial stability while implementing monetary policy.
Increases in Reserves and Fedwire Timing

The large increase in reserves hastened payments significantly.

Funding of Payments

- There are three sources of funding for payments made by banks through Fedwire Funds.
  - own account balances, incoming payments, overdrafts.
- The distinction between the first two categories can be a bit blurry.
  - bank starts the day with an opening account balance which is equal to their reserve holdings.
  - throughout the day, money flows in and out of a bank’s account as it receives and makes payments.
- So how do we tell when a payment is made by own account balances and when it is made by recycled liquidity from incoming payments?
Hierarchical rule

- All liquidity received within a minute is used to fund outgoing payments within the same minute.
- Outgoing payments in excess of incoming payments are funded out of additional account balances if available.
- Any outgoing payments in excess of existing account balances are funded using overdrafts.
- Note:
  - An overdraft is an intraday loan from the Federal Reserve to the bank and interest is assessed on a minute-to-minute basis.
  - Overdrafts are granted automatically provided their total value does not exceed a cap imposed on the bank by the Federal Reserve.
Percentage of total transactions sent via Fedwire attributable to each funding category.
Collateralized Overdraft Policy

• On March 24, 2011, the Federal Reserve implemented a new two-tier system for intraday credit which set a zero fee for collateralized daylight overdrafts and a 50 basis point charge (computed on an annual basis) for uncollateralized daylight overdrafts.

• Under this policy banks can avoid overdraft fees if they have sufficient collateral posted at the Discount Window.

• The implementation of collateralized overdrafts was not accompanied by a significant change in aggregate daylight overdrafts.
Implication 1: Reduced Credit Risk

- Percentages of collateralized overdrafts (includes Funds and Securities) based on end-of-minute calculations used to compute fees. Source: Board of Governors of the Federal Reserve System
### Accounting for Overdrafts

- Because overdrafts represent what is essentially a common liquidity pool they economize on aggregate liquidity usage.

<table>
<thead>
<tr>
<th>N</th>
<th>Transfer</th>
<th>Account Balances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A pays B</td>
<td>B pays A</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
<td>-75</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>150</td>
<td>175</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
<td>50</td>
</tr>
</tbody>
</table>

- The total liquidity provided by each bank is 50 and hence the total liquidity provided to make the payments is 175. Since the total value of payments is 500 this means the turnover is 2.86, i.e., each $1 of liquidity provided funded $2.86 worth of payments.
Now imagine banks held higher reserves, i.e., each bank has opening account balance that is just sufficient to complete their day’s payments (in the same order) without overdrafts.

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<tbody>
<tr>
<td></td>
<td>A pays B</td>
<td>A pays B</td>
<td>B pays A</td>
<td>B pays A</td>
</tr>
<tr>
<td>0</td>
<td>125</td>
<td>125</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>75</td>
<td>175</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
<td>0</td>
<td>250</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>100</td>
<td>150</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>150</td>
<td>250</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
<td>125</td>
<td>125</td>
<td>0</td>
</tr>
</tbody>
</table>

The total liquidity provided to make the payments is now 250: 125 from each bank and 0 from the Federal Reserve. The turnover rate has now fallen to 2.

Point is, when banks use overdrafts the total amount of liquidity required to complete the day’s payments falls; the gains come from the use of a common liquidity pool.
Implication 2: Reduced Turnover

- Actual turnover is calculated as the total value of transfers sent via Fedwire Funds divided by the sum of liquidity provided by banks and system liquidity provided by the Federal Reserve. The counterfactual is the total value of transfers sent via Fedwire Funds divided by the hypothetical liquidity that would have to be provided by banks if daylight overdrafts were not allowed.
FR Payment System Improvement Initiative

• 10 year plan, Public consultation paper released in September 2013

1. To articulate the FRB’s perspective on:
   – Key gaps and opportunities in the current payment environment
   – Desired outcomes that close these gaps and capture these opportunities

2. To solicit broad industry input on:
   – The Federal Reserve Banks’ perspectives on gaps, opportunities, and desired outcomes articulated in this paper
   – Potential strategies and tactics to shape the future of the U.S. payment system
   – The Federal Reserve Bank’s role in implementing these strategies and tactics.

• Strategies for Improving the U.S. Payment System paper released on January 26, 2015.
Desired Outcomes

1. **Speed**: A ubiquitous, safe, faster electronic solution(s) for making a broad variety of business and personal payments, supported by a flexible and cost-effective means for payment clearing and settlement groups to settle their positions rapidly and with finality.

2. **Security**: U.S. payment system security that remains very strong, with public confidence that remains high, and protections and incident response that keeps pace with the rapidly evolving and expanding threat environment.

3. **Efficiency**: Greater proportion of payments originated and received electronically to reduce the average end-to-end (societal) costs of payment transactions and enable innovative payment services that deliver improved value to consumers and businesses.
Desired Outcomes

4. **International**: Better choices for U.S. consumers and businesses to send and receive convenient, cost-effective and timely cross-border payments.

5. **Collaboration**: Needed payment system improvements are collectively identified and embraced by a broad array of payment participants, with material progress in implementing them.
Strategies

1. Actively engage with stakeholders on Initiatives Designed to Improve the U.S. Payment System
   – Task Force
2. Identify effective approaches for implementing a safe, ubiquitous, faster payments capability in the United States
3. Work to reduce fraud risk and advance the safety, security and resiliency of the payment system
4. Achieve greater end-to-end efficiency for domestic and cross-border payments
5. Enhance Federal Reserve Bank payments, settlement and risk-management services
Broad scope of technologies

- Legacy Networks
  - ACH
  - Check
  - Funds Transfer
  - Credit Card
  - Debit Card
- Emerging/Alternative Methods
  - Mobile Wallets
  - Money Transfer Solutions
  - General Purpose Reloadable Cards
  - Committee engaged a consultant that explored role of VCs along with other technologies and the consultant’s work is factoring into future analysis.