Shock by Bank Funding Shocks: Evidence from 500 Million Consumer Credit Cards

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Motivation

• What explains the sharp decline in consumption after the financial crisis?
  • Also, puzzling slow recovery post-crisis (esp. non-durables, services)?

• Household balance sheet effects (Mian, Rao, and Sufi, 2013):
  • Housing-wealth effect.
  • Debt overhang effect.
  • Borrowing constraints due to reduced collateral values.
Motivation

• What explains the sharp decline in consumption after the financial crisis?
  • Also, puzzling slow recovery post-crisis (esp. non-durables, services)?

• Financial intermediaries’ balance sheet effects: Did bank health affect consumers’ balance sheets?
  • Bank health: Fragile funding structures (reliance on uninsured short-term liabilities).
  • What is the transmission mechanism? Who gets affected? Are the effects short-term or long-term?
  • Effects on Durables vs. Non-durables/services/staples. Consumption financed by Secured (e.g., mortgage, auto) vs. Unsecured debt (e.g., credit cards).
  • This paper: Did bank health affect consumption through credit cards?
Motivation

- Credit card spending accounts for 25% of personal consumption expenditure (PCE) (∼ $10 trillion in 2010, typically ∼ 70% of GDP).

- Most households consume services and non-durable goods such as food, apparel, gasoline, transportation, and healthcare through credit cards.

- Important source of marginal borrowing:
  - Can you cover an emergency $400 expense?
  - Answer is NO for 40% of U.S. households.

Figure 12. Other ways that individuals would cover a $400 emergency expense

Note: Among those who would not pay the expense in full using cash or its equivalent. Respondents can select multiple answers.
• Banks’ balancesheets affect agg. consumption through the credit card channel.

• *Negative bank funding shock* → Dry-up of wholesale funding market.

• CC Balance-Limit Elasticities due to shock: **0.32**

• Banks transmit shocks *unequally* across consumers → *greater transmission* to consumers who have *lower ability to cope* with the transmitted shocks.

• Effects of transmitted shocks are *persistent* for some consumers.
Identification challenges

• **Main challenge:** Isolate the changes in credit supply from the changes in credit demand.

• **Implementation:** *Within-individual comparison* (ala Khwaja & Mian, 2008)
  - Same individual exposed to high-shock and low-shock credit cards.
  - The *within* individual comparison controls for changes in *individual-specific demand factors* (e.g., income changes).
  - Leave-out mean credit limit to mitigate *individual-bank specific demand*.

• **Unique data advantages:**
  - Observe *CC limits* separately from *CC balances*.
  - Observe data on *ALL* credit cards for a given individual *(advantage over previous papers)*.
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- **Unique data advantages:**
  - Observe *CC limits* separately from *CC balances*.
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- **Identify shock’s effect on consumption:**
  
  \[
  \frac{\partial CB}{\partial S} = \frac{\partial CL}{\partial S} \times \frac{\partial CB}{\partial CL}
  \]

  - Isolate \(\Delta\) (Credit Limits) due to the sudden bank liquidity shock.
  - Next, examine \(\Delta\) (Balances) resulting from \(\Delta\) (Credit Limits) induced by the bank liquidity shock.
Transmission of bank shocks through credit cards

- **Hedged consumers?**: Ex-ante, the bank lending channel through credit cards is not obvious.

- Consumers have multiple credit cards and unutilized credit.
  - 59.8% of the households held two or more credit cards in 2007 (source: 2007 SCF).
  - Average utilization ratio is about 27%.

- **Substitutes**: Households have access to other sources of financing (personal loans, home equity lines of credit)

- Thus, frictions that constrain consumers in the credit market are necessary for a real impact of bank shocks transmitted through the credit card channel.
  - We highlight which credit market frictions are binding.
Data

• Data from one of the three major credit bureaus in the United States – observe credit limits and balances on all credit cards of an individual (∼ 500 million CCs.)

• Sample: 18 BHCs with non-zero wholesale funding dependence that are CC issuers; account for 65% of market; cover 7 of top 10 CC issuers which account for 50% of market share.
  • Dropped 4 foreign issuers, 1 specializing in retail store cards, 1 targeting a particular segment of U.S. population (veterans), 1 with insufficient data.

• Omit cards closed in the post-shock period → so that we don’t pick up changes in credit limits and balances due to personal bankruptcies or CC cancellations.

• Two main samples: Within-individual sample (158 million CCs, 54 million individuals), Aggregate sample (500 million CCs, 134 million individuals).

• Bank data from BHC Y-9C filings.
Bank liquidity shock

- Bank exposure to liquidity shock: ratio of bank’s short-term wholesale funding to deposits.

- **Exposure measure**: bank’s runnable funding (short-term wholesale funding) as a proportion of its stable funding (deposits).

- Exposure measure: Relatively stable in the pre-crisis period, and declines sharply in the post-crisis period.
Bank liquidity shock

- Banks vary in the extent to which they depend on short-term wholesale funding → liquidity shock should vary across banks.

- **Short-term wholesale funding**: non-deposit financing (e.g., repos, commercial paper, interbank borrowing) with maturity less than one year.
  - Mainly provided by institutional investors such as, money market funds (MMFs) and other banks.

- Advantages: Alternative to deposits when they need to quickly cover any funding gap (supply of deposits is highly inelastic with respect to the interest rates offered (Amel & Hannan, 1999)

- Disadvantages: Expensive and prone to runs when compared to deposit financing

- Ex-ante, less risky/strong banks should have a comparative advantage in accessing the wholesale funding market (Choi & Choi, 2017)
Validity of liquidity shock

<table>
<thead>
<tr>
<th>Depvar:</th>
<th>∆ST Wholesale (1)</th>
<th>∆Wholesale (2)</th>
<th>∆Tot Liabilities (3)</th>
<th>∆Tot Equity (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure</td>
<td>-0.425*** (-4.03)</td>
<td>-0.324*** (-2.95)</td>
<td>-0.272*** (-3.34)</td>
<td>-0.151 (-1.75)</td>
</tr>
<tr>
<td>N</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.469</td>
<td>0.334</td>
<td>0.412</td>
<td>0.181</td>
</tr>
<tr>
<td>Controls</td>
<td>Assets</td>
<td>Assets</td>
<td>Assets</td>
<td>Assets</td>
</tr>
<tr>
<td>Orthog-Exposure $R^2$</td>
<td>0.531</td>
<td>0.412</td>
<td>0.481</td>
<td>0.278</td>
</tr>
</tbody>
</table>

- Banks with high exposure experienced larger decline in short-term wholesale funding
- High exposure banks also experienced declines in total liabilities
- Equities/deposits unaffected
- The exposure measure explains $\sim 53\%$ of the decline in short-term wholesale funding, and $\sim 48\%$ of decline in total liabilities in banks.
Empirical setup: Collapsed cross-sectional analysis

- **Collapse** the time-series credit card account-level data to obtain a **single credit card-level cross-section** separately in the pre-shock and post-shock period by averaging across time.

- **Estimate credit card-level regression:**

  \[
  \Delta CreditLimit_{i,c,b} = \alpha + \beta Exposure_b + f(X_{i,c,b}) + \eta_i + \varepsilon_{i,c,b}
  \]

- **Sample period:**

- Analysis is similar to including **Individual \times Archive FE** which absorbs all time-varying individual-level factors.
Summary stats

- High-exposure banks significantly larger than low-exposure banks

- Insignificant differences in equity capital, liquid assets, business mix, performance between high- and low-exposure banks.

- Greater decline in credit card limits for high-exposure banks:
  - Mean $\Delta CCLimit_{High-exposure} = -3.96\%$
  - Mean $\Delta CCLimit_{Low-exposure} = -0.30\%$

- Greater decline in credit card balances for high-exposure banks:
  - Mean $\Delta CCBalance_{High-exposure} = -49.07\%$
  - Mean $\Delta CCBalance_{Low-exposure} = -19.13\%$

- High-exposure banks lend to relatively higher quality borrowers
  - Better credit scores, higher monthly income, lower delinquency rates, lower subprime share.
  - Consumers of high-exposure banks have higher credit card balance, mortgage balance, differences in debt composition (auto, mortgage, credit card etc.), but similar DTI.
Bank exposure and \( \Delta \) CC limits: Credit card-level analysis

<table>
<thead>
<tr>
<th>Depvar: ( \Delta ) CC Limit</th>
<th>Individual FE</th>
<th>OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Exposure</td>
<td>-3.811***</td>
<td>-5.050***</td>
</tr>
<tr>
<td></td>
<td>(-9.85)</td>
<td>(-13.32)</td>
</tr>
<tr>
<td>Bank characteristics</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Bank quality</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Credit card controls</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>N</td>
<td>158,432,533</td>
<td>158,432,533</td>
</tr>
<tr>
<td>Adj. ( R^2 )</td>
<td>0.072</td>
<td>0.084</td>
</tr>
</tbody>
</table>

- FE estimate implies 1 SD (16%) greater bank exposure leads to a reduction of $434 in credit limit (Avg. pre-shock credit limit $9131.60 \times 4.750\%$).

- FE and OLS estimates are similar \( \rightarrow \) demand factors that drive increases in credit limits seem uncorrelated with liquidity shock exposure in the cross-section.

- Robust after controlling for bank quality (size, size\(^2\), capital ratio, CC business, ROE, non-perf loans etc.) and credit card controls (CC utilization, CC age, bank-individual relationship).

- Robust to alternate measures of bank exposure (exposure defined w.r.t assets, exposure orthogonalized to bank size) and different levels of clustering (bank-level).
Bank exposure and $\Delta$ CC limits: Parallel trends assumption

- **Within individual trends:** Equivalent to plotting residuals from *Individual $\times$ Archive* FE regression by high- and low-exposure groups.
  - Obtain de-meaned credit limits and exposure variable within each Individual-Archive.
  - Sort and average de-meaned credit limits by high- and low-exposure credit card groups.
Results not driven by any particular bank

- Regressions estimated with 17 BHCs each time after removing 1 BHC one by one.
- Ranking of Bank 1 – Bank 18 in descending order of market share.
Bank exposure and $\Delta$ CC balances

• Why should changes in credit limits affect credit card balances?
  • **Permanent income hypothesis:** $\text{Corr}(\Delta \text{CCLimits}, \Delta \text{CCBalances}) = 0$ if $\Delta(\text{Permanent income}) = 0$.
  
  • **Liquidity constraints:** $\text{Corr}(\Delta \text{CCLimits}, \Delta \text{CCBalances}) > 0$ only if binding liquidity constraints (e.g.: high CC utilization individuals.)
  
  • **Buffer stock models:** $\text{Corr}(\Delta \text{CCLimits}, \Delta \text{CCBalances}) > 0$ if liquidity constraints expected to be binding in future affects currently unconstrained individuals too.
  
• $\text{Corr}(\Delta \text{CCLimits}, \Delta \text{CCBalances}) \neq 0$ because of demand factors.
  • Consumers apply for credit limit increase.
  
  • Lenders can anticipate future demand changes.
  
  • Important to control for Individual FE!
### Bank exposure and $\Delta$ CC balances: Card-level analysis

<table>
<thead>
<tr>
<th></th>
<th>OLS (1)</th>
<th>FE (2)</th>
<th>OLS (3)</th>
<th>FE (4)</th>
<th>2SLS (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depvar: $\Delta$ CC Balance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$ CC limit</td>
<td>0.744***</td>
<td>0.854***</td>
<td>(46.40)</td>
<td>(25.05)</td>
<td></td>
</tr>
<tr>
<td>Exposure</td>
<td>-3.080</td>
<td>-9.805***</td>
<td>(-1.02)</td>
<td>(-4.57)</td>
<td></td>
</tr>
<tr>
<td>$\Delta$ CC limit (instrumented)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.064***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(4.52)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th><strong>Individual FE</strong></th>
<th>✓</th>
<th>✓</th>
<th>✓</th>
<th>✓</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank characteristics</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Bank quality</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Credit card controls</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

| N                   | 158,432,533 | 158,432,533 | 158,432,533 | 158,432,533 | 158,432,533 |
| Adj. $R^2$          | 0.04        | 0.16        | 0.02        | 0.15        | 0.13        |
| F-stat (Excl. Instru)|            |             |             |             | 97.1        |

- OLS and FE estimates suggest that individual demand factors bias against finding results $\rightarrow$ high exposure banks were lending to better borrowers.

- IV estimate captures LATE $\rightarrow$ 2.06% card-level consumption foregone due to 1% reduction in credit limits from short-term wholesale funding shock (Assumption: Shock affects balances only through limits.)

- Results robust to using a “leave-out” mean credit supply measure instead of credit limits $\rightarrow$ mitigates bank-specific individual demand concerns.
For each individual, compute weighted exposure using **All** their credit cards.

**Note:** Individual-level regression (Zip-code FE).

1 SD increase in bank exposure reduces aggregate credit card balances by **1.216%** (effect is $1/8^{th}$ compared to card-level balance results $\rightarrow$ consumers are able to partially hedge away the shock.)

IV estimate captures LATE $\rightarrow$ **0.32%** aggregate CC consumption foregone due to 1% reduction in credit limits from short-term wholesale funding shock.
## Dollar Regressions

<table>
<thead>
<tr>
<th>Depvar: $ Changes:</th>
<th>( \Delta \text{ CC Limit} )</th>
<th>( \Delta \text{ CC Balance} )</th>
<th>( \Delta \text{ Agg. CC Balance} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FE (1)</td>
<td>2SLS (2)</td>
<td>2SLS (3)</td>
</tr>
<tr>
<td>Exposure</td>
<td>-475.35***</td>
<td>0.235***</td>
<td>0.071***</td>
</tr>
<tr>
<td></td>
<td>(-13.31)</td>
<td>(7.30)</td>
<td>(13.03)</td>
</tr>
<tr>
<td>( \Delta \text{ CC limit (instrumented)} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \text{ Agg. CC limit (instrumented)} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>158,432,533</td>
<td>158,432,533</td>
<td>133,501,009</td>
</tr>
<tr>
<td>( F )-stat (excl. instru)</td>
<td>177.15</td>
<td>104.48</td>
<td></td>
</tr>
</tbody>
</table>

- 1 SD increase in bank exposure reduces credit card balance by **$475.35**.

- **Funding-shock induced credit limit cuts:**
  - **Credit card level:** \( \downarrow $1 \text{ Credit Limit} \implies \text{Balance 23.5 cents} \downarrow 
  - **Individual level:** \( \downarrow $1 \text{ Credit Limit} \implies \text{Balance 7.1 cents} \downarrow 

- **Other Studies:**
  - Gross and Souleles (2002): \( \uparrow $1 \text{ Credit Limit} \implies \text{Balance 10 – 14 cents} \uparrow 
  - Mian, Rao, and Sufi (2013): \( \downarrow $1 \text{ House Price} \implies \text{Spending 5 – 7 cents} \downarrow
Heterogeneity: Credit card level analysis

<table>
<thead>
<tr>
<th></th>
<th>Panel A: CC-level Util</th>
<th>Panel B: Ind-level Util</th>
<th>Panel C: Credit Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depvar: ΔCC Limit</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Exposure</td>
<td>-4.052*** (-10.61)</td>
<td>Exposure</td>
<td>-4.038*** (-10.26)</td>
</tr>
<tr>
<td>Exposure × CC util (50–90%)</td>
<td>-4.298*** (-10.61)</td>
<td>Exposure × Agg. util (50–90%)</td>
<td>-4.994*** (-11.68)</td>
</tr>
<tr>
<td>Exposure × CC util (&gt;90%)</td>
<td>-6.587*** (-15.16)</td>
<td>Exposure × Agg. util (&gt;90%)</td>
<td>-8.185*** (-15.37)</td>
</tr>
<tr>
<td>N</td>
<td>158,432,533</td>
<td>151,449,029</td>
<td>158,423,518</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.089</td>
<td>0.089</td>
<td>0.089</td>
</tr>
</tbody>
</table>

• **Banks transmit shocks differentially across consumers!** → Banks cut credit limits more for higher utilization and lower credit score consumers.

• Evidence consistent with greater costs of lending to consumers with greater information frictions (e.g., moral hazard for high utilization ratio consumers).
Heterogeneity: Individual level analysis

<table>
<thead>
<tr>
<th>Change in Credit Card Balances Across All Cards</th>
<th>Utilization</th>
<th>Credit score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-50% (1)</td>
<td>50-90% (2)</td>
</tr>
<tr>
<td>(\Delta) Agg. CC Limit (instru)</td>
<td>0.232 (1.14)</td>
<td>1.078*** (21.11)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change in Total Debt Balances Across All Debt-related Accounts</th>
<th>Utilization</th>
<th>Credit score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-50% (1)</td>
<td>50-90% (2)</td>
</tr>
<tr>
<td>(\Delta) Agg. CC limit (instru)</td>
<td>-0.890*** (-4.91)</td>
<td>-0.001 (-0.03)</td>
</tr>
</tbody>
</table>

- Aggregate consumption elasticity is decreasing in an individual’s ability to hedge.
- Individuals with lower credit score, higher utilization reduce consumption on their credit cards at the aggregate level.
- Elasticities for total debt balances are smaller compared to total credit card balances. → Individuals able to substitute to other credit sources.
- Overall, suggests credit constrained individuals were not able to hedge away the funding shock to their bank at the aggregate level.
Long-run effects of the funding shock

- Total inflation-adjusted real credit extended by banks on credit cards recovered to pre-crisis levels over time.
Long-run effects of the funding shock

- Persistent effects of funding shock for the near-prime and subprime consumers in the long-run.
Conclusion

• **Results:**
  - Funding structure of banks affects aggregate consumption through the credit cards channel.

  • **Heterogeneity in bank response:** Banks transmit shocks more to the credit constrained consumers.

  • **Heterogeneity in consumption elasticities:** Consumption sensitivity to funding shock is higher for credit constrained consumers.

  • Overall, when faced with liquidity shocks, banks pass them on to consumers who are least able to cope with them.

  • *Ours + prior studies shed light on the winners and losers in a credit boom-bust cycle:* Credit constrained consumers enjoy less gains in boom and suffer more costs in bust.

• **Contribution:**
  - Banks’ balance sheets can affect aggregate consumption through the credit card channel with significant distributional consequences over the long-term.

  • *Post-crisis regulatory reform* focused on addressing the vulnerabilities of a bank’s funding structure, especially the reliance on wholesale funding (Tarullo, 2014).