DISCUSSION OF “THE REAL EFFECTS OF LIQUIDITY DURING THE FINANCIAL CRISIS: EVIDENCE FROM AUTOMOBILES”

Gabriel Chodorow-Reich  
Harvard University and NBER

NERB Corporate Finance Meeting  
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OVERVIEW

1. Big picture and BMR story.

2. Most convincing result.

3. Puzzling result.

4. Quantitative importance.
Big picture and BMR story

- Collapse in new auto sales in 2008-09.
LIGHT WEIGHT VEHICLE SALES

Millions of units, SAAR

**Big picture and BMR story**

- Collapse in new auto sales in 2008-09.

- Existing literature finds strong cross-sectional relationship between decline in auto sales and 2006 debt to income, house price decline, etc. (Mian, Rao and Sufi QJE 2013).
Decline of auto purchases and debt to income

Unbinned unweighted $R^2$: 0.12
Unbinned weighted $R^2$: 0.39
Big picture and BMR story

- Collapse in new auto sales in 2008-09.

- Existing literature finds strong cross-sectional relationship between decline in auto sales and 2006 debt to income, house price decline, etc. (Mian, Rao and Sufi QJE 2013).

- BMR introduce cross-sectional variation in auto financing.
BMR Story

Money market fund liability runs

MMF demand for ABCP ↓

Captive auto finance company borrowing costs ↑

Consumer auto financing costs ↑

Auto sales ↓
A PRIORI PLAUSIBLE?

- Auto finance companies heavy users of Federal Reserve CPFF.
- But CPFF already available in Jan-09, and TALF begins lending against new auto ABS in Mar-09.
- Capital losses could also explain lending contraction.
  - GMAC had substantial exposure to subprime real estate.
- Relative interest rate of captives spikes briefly in late 2008.
  - Not adjusted for borrower quality, LTV, etc.
  - Retail interest rate, not floorplan finance rate.
- Paper contains nice narrative evidence that financing shock mattered.
### A prior Plausible? Financing of ABCCP from CPFF, January 1, 2009

<table>
<thead>
<tr>
<th>Rank</th>
<th>Firm</th>
<th>Billions outstanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Liberty Hampshire Company</td>
<td>16.358</td>
</tr>
<tr>
<td>2</td>
<td>BSN Holdings</td>
<td>14.645</td>
</tr>
<tr>
<td>3</td>
<td>Hudson Castle</td>
<td>13.032</td>
</tr>
<tr>
<td>4</td>
<td>Fortis Bank SA/NV</td>
<td>12.025</td>
</tr>
<tr>
<td>5</td>
<td>American International Group</td>
<td>7.828</td>
</tr>
<tr>
<td>6</td>
<td>GMAC LLC</td>
<td>7.480</td>
</tr>
<tr>
<td>7</td>
<td>Ford Credit</td>
<td>6.938</td>
</tr>
<tr>
<td>8</td>
<td>State Street Bank &amp; Trust</td>
<td>5.653</td>
</tr>
<tr>
<td>9</td>
<td>Royal Bank of Scotland Group</td>
<td>5.097</td>
</tr>
<tr>
<td>10</td>
<td>Citigroup</td>
<td>3.427</td>
</tr>
<tr>
<td>18</td>
<td>Chrysler Financial Services</td>
<td>1.495</td>
</tr>
</tbody>
</table>
A PRIORI PLAUSIBLE? AUTO FINANCE INTEREST RATES

Percent

Commercial bank 48 mo.  Sep–08

Captive avg. maturity

2005 2006 2007 2008 2009 2010 2011
**Most Convincing Result**

- **Specification:**

\[
\ln Q^f_{imst} = \alpha_{is} + \alpha_m + \beta_1 \ln Q^f_{imst-1} + \beta_2 s^{}_{imst-1} + \epsilon^f_{imst}.
\]

- \(Q^f_{imst}\): New cars purchased in county \(i\), of make \(m\) in segment \(s\), financed by type \(f \in \{\text{captive, non-captive}\}\), at time \(t\).
- \(s^{}_{imst-1}\): captive finance share for segment \(s\) and make \(m\) in county \(i\) at time \(t-1\).

- **Example:** [decline in GM sales in mid-size cars in county \(i\) relative to national decline in GM sales] *relative to* [decline in Ford sales in mid-size cars in county \(i\) relative to national decline in Ford sales] as function of [captive share of GM mid-size cars in county \(i\) relative to average GM captive share] *relative to* [captive share of Ford mid-size cars in county \(i\) relative to average Ford captive share].
This table reports the results of estimating Eq. (3). The makes are Ford, GM, Honda, and Toyota. The dependent variable in Column (1) is the log number of cars financed by the automaker's captive arm in 2009 within a county, and Column (1) controls for the log number of cars financed by the automaker's captive arm in 2008 within the county. The dependent variable in Column (2) is the log number of cars not financed by the automakers' captive arms, and Column (2) controls for the log number of cars not financed by the automaker's captive arm in 2008. Column (3) is the log number of all sales inside the county in 2009, and Column (3) controls for the log number of all sales in 2008. The dependent variable in Column (4) is the log number of all sales by a make in each of eight segment (small cars; mid-sized cars; large cars; luxury cars; small utility vehicles; mid-sized utility vehicles; large utility vehicles; and luxury utility vehicles; for details on the segments, see Appendix B) within a county in 2009; the log number of sales in 2008 are included as a control variable.

Market share is the fraction of cars sold by the make in 2008:Q1 in the county. Column (4) measures market share as the fraction of cars sold by the make within the segment in the county.

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) captive transactions</th>
<th>(2) substitution: non-captive transactions</th>
<th>(3) all transactions</th>
<th>(4) all transactions segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Captive Dependence</td>
<td>-0.306***</td>
<td>0.0357</td>
<td>-0.0189*</td>
<td>-0.0165**</td>
</tr>
<tr>
<td></td>
<td>(0.0323)</td>
<td>(0.0325)</td>
<td>(0.0101)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Log Number of Cars Financed in 2008</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Market Share</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Make Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>County Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>County-Segment Fixed Effect</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>11,526</td>
<td>11,546</td>
<td>11,624</td>
<td>33,844</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.363</td>
<td>0.486</td>
<td>0.408</td>
<td>0.94</td>
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Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.
PUZZLING RESULT

- Their baseline specification:

\[
\ln Q_{it}^c = \beta_0^c + \beta_1^c \ln Q_{it-1}^c + \beta_2^c s_{it-1} + X_{it}' \beta_3^c + \epsilon_{it}^c.
\]

- Dependent variable is log cars financed by captives, not total cars sold.

- \( \beta_2^c < 0 \).
- Log additive decomposition into county demand shock and financier supply shock predicts zero relationship between initial share and log change in purchases financed by captive financiers:

\[
\Delta \ln Q_{f}^i = \alpha_i + \alpha_f + \epsilon_{if} \implies \beta_2 < 0, \beta_2^c = 0.
\]

- Pricing model predicts smaller decline in captive-financed auto sales in counties with larger initial share, i.e. \( \beta_2^c > 0 \).
- Intuition is general: same % decline generates larger general equilibrium disruption in places where initial market share is higher.
Table 13. Make-County Panel Regressions  
This table reports the results of estimating Eq. (3). The makes are Ford, GM, Honda, and Toyota. The dependent variable in Column (1) is the log number of cars financed by the automaker's captive arm in 2009 within a county, and Column (1) controls for the log number of cars financed by the automaker's captive arm in 2008 within the county. The dependent variable in Column (2) is the log number of cars not financed by the automakers' captive arms, and Column (2) controls for the log number of cars not financed by the automaker's captive arm in 2008. Column (3) is the log number of all sales inside the county in 2009, and Column (3) controls for the log number of all sales in 2008. The dependent variable in Column (4) is the log number of all sales by a make in each of eight segments (small cars; mid-sized cars; large cars; luxury cars; small utility vehicles; mid-sized utility vehicles; large utility vehicles; and luxury utility vehicles; for details on the segments, see Appendix B) within a county in 2009; the log number of sales in 2008 are included as a control variable. Market share is the fraction of cars sold by the make in 2008:Q1 in the county. Column (4) measures market share as the fraction of cars sold by the make within the segment in the county. 

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**Simple Model**

- Captive finance company $c$, non-captive $n$, areas indexed by $i$.
- Upward sloping credit supply:
  \[
  r_{it}^c = \alpha_t^c + \gamma (\ln Q_{it}^c - \ln \bar{Q}_i^c),
  \]
  \[
  r_{it}^n = \alpha_t^n + \gamma (\ln Q_{it}^n - \ln \bar{Q}_i^n).
  \]

  - $\alpha_t^f$: national cost of funds for type $f \in \{c, n\}$.
  - $\bar{Q}_i^f$: area-specific target sales. Interpret as sales infrastructure.
  - $\gamma > 0$: When sales rise above the target, interest rate increases.

- Downward sloping credit demand:
  \[
  \ln Q_{it} = \pi_{it}^0 - \pi_{it}^1 r_{it}.
  \]

- Equilibrium in car market:
  \[
  Q_{it} = Q_{it}^c + Q_{it}^n \quad \forall i.
  \]
**Model solution**

- Bertrand competition over interest rates:

\[ Q_{it}^n = \kappa_t \left[ \frac{Q_i^c}{Q_i^n} \right] Q_{it}^c, \quad \kappa_t \equiv \exp \left[ \frac{\alpha_t^c - \alpha_t^n}{\gamma} \right]. \]

- Market share \( s_{it} \):

\[ s_{it} \equiv \frac{Q_{it}^c}{Q_{it}} = \frac{Q_i^c}{Q_i^c + \kappa_t Q_i^n}. \]

- Solution for quantities:

\[ \ln Q_{it}^c = \left[ 1 + \pi^1 \gamma \right]^{-1} \left[ \pi_{it}^0 - \pi^1 (\alpha_t^c - \gamma \ln \bar{Q}_i^c) + \ln s_{it} \right], \]

\[ \ln Q_{it} = \left[ 1 + \pi^1 \gamma \right]^{-1} \left[ \pi_{it}^0 - \pi^1 (\alpha_t^c - \gamma \ln \bar{Q}_i^c) \right] - \pi^1 \gamma \left[ 1 + \pi^1 \gamma \right]^{-1} \ln s_{it}, \]

\[ \ln Q_{it}^n = \ln Q_{it} + \ln(1 - s_{it}). \]
Regression equation, all autos

\[
\Delta \ln Q_{it} = \left[1 + \pi^1 \gamma \right]^{-1} \left[ \Delta \pi_{it}^0 - \pi^1 \Delta \alpha^c_t + \Delta \ln s_{it} \right] - \Delta \ln s_{it}
\]

\[
\approx \left[1 + \pi^1 \gamma \right]^{-1} \left[ \Delta \pi_{it}^0 - \pi^1 \Delta \alpha^c_t \right] - \frac{\pi^1 \gamma}{1 + \pi^1 \gamma} \left[s_{it-1} - 1\right] \left[\kappa_t - 1\right]
\]

\[
= \beta_0 + \beta_2 s_{it-1} + \varepsilon_i,
\]

where:

- \( \beta_0 \equiv -\pi^1 \left[1 + \pi^1 \gamma \right]^{-1} \left[\Delta \alpha^c_t - \gamma (\kappa_t - 1)\right] \): national shock to captive finance cost of credit;
- \( \beta_2 \equiv -\frac{\pi^1 \gamma}{1 + \pi^1 \gamma} \left[\kappa_t - 1\right] < 0 \);
- \( \varepsilon^c_i \equiv \left[1 + \pi^1 \gamma \right]^{-1} \Delta \pi_{it}^0 \): county-specific demand shock;
- \( \Delta \ln s_{it} \approx \left[s_{it-1} - 1\right] \left[\kappa_t - 1\right] \): first order approximation around \( \kappa_t = 1 \);
- \( \alpha^c_{t-1} = \alpha^n_{t-1} \): assumed for simplicity.
Regression equation, captive-financed autos

\[
\Delta \ln Q_{it}^c = \left[1 + \pi^1 \gamma \right]^{-1} \left[ \Delta \pi_{it}^0 - \pi^1 \Delta \alpha_t^c + \Delta \ln s_{it} \right] \\
\approx \left[1 + \pi^1 \gamma \right]^{-1} \left[ \Delta \pi_{it}^0 - \pi^1 \Delta \alpha_t^c + [s_{it-1} - 1][\kappa_t - 1] \right] \\
= \beta_0^c + \beta_2^c s_{it-1} + \epsilon_i^c,
\]

where:

- \( \beta_0^c \equiv - \left[1 + \pi^1 \gamma \right]^{-1} \left[ \pi^1 \Delta \alpha_t^c + \kappa_t - 1 \right] < 0 \): national shock to captive finance cost of credit;
- \( \beta_2^c \equiv \left[1 + \pi^1 \gamma \right]^{-1} [\kappa_t - 1] > 0; \)
- \( \epsilon_i^c \equiv \left[1 + \pi^1 \gamma \right]^{-1} \Delta \pi_{it}^0 \): county-specific demand shock;
- \( \Delta \ln s_{it} \approx [s_{it-1} - 1][\kappa_t - 1] \): first order approximation around \( \kappa_t = 1; \)
- \( \alpha_{t-1}^c = \alpha_{t-1}^n \): assumed for simplicity.
Why $\beta_c^2 > 0$?

- Dealer floor plan financing harder to substitute than retail financing, and floor plan financing from captives correlated with retail financing from captives.

- Transitory shocks to captive finance share and mean reversion.

- Residual demand shocks.

- Other?
Quantitative Importance

- Total sales fall 23.5 log points from 2008 to 2009.
- Coefficient in total sales specification: 1 sd increase in captive dependence $\Rightarrow$ 1.5-2.5% fewer total sales.
- Similar magnitude to effect of household balance sheets in 2008-09:

<table>
<thead>
<tr>
<th>Dep.var.: $\Delta \ln[\text{car purchases}]$</th>
<th>06-09</th>
<th>06-09</th>
<th>06-09</th>
<th>06-07</th>
<th>07-08</th>
<th>08-09</th>
</tr>
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<tbody>
<tr>
<td>Housing net worth shock</td>
<td>0.106*</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006 debt to income</td>
<td>-0.119*</td>
<td>-0.084*</td>
<td>-0.024*</td>
<td>-0.040*</td>
<td>-0.020*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.014)</td>
<td>(0.006)</td>
<td>(0.005)</td>
<td>(0.008)</td>
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<td>Yes</td>
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<tr>
<td>$R^2$</td>
<td>0.42</td>
<td>0.45</td>
<td>0.35</td>
<td>0.11</td>
<td>0.27</td>
<td>0.18</td>
</tr>
<tr>
<td>Observations</td>
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<td>919</td>
<td>2180</td>
<td>2180</td>
<td>2180</td>
<td>2180</td>
</tr>
</tbody>
</table>

Displayed right hand side variables normalized to have unit variance.

- Similar magnitude to effect of credit availability on employment in Chodorow-Reich (2014): 1 sd $\Rightarrow$ $\approx$ 2% lower employment.
SMALLER COMMENTS

- Would be useful to better pin down timing. 2008Q2 versus 2009Q2, or seasonally adjust and 2008Q2 versus 2008Q4.

- Making dependent variable log change would help in comparing across specifications and make $R^2$s meaningful.

- Would be useful to see non-parametric binned scatter plots.

- Partial equilibrium adding up exercise would give alternative sense of magnitude.
I buy the bottom line result that they identify an effect of a credit supply shock.

More on the economics would be useful. Why do captive-financed sales fall more in areas with a larger initial captive finance share?

Quantitative magnitude appears similar to related papers, but small relative to the magnitude of the decline in auto sales.