The Capitalization of Consumer Financing into Durable Goods Prices

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MIT and NBER

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BYU

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Credit $\leftrightarrow$ Asset prices

- Credit-asset prices nexus key area of post-crisis finance
- Affecting affordability through credit common policy objective
Credit ↔ Asset prices

- Credit-asset prices nexus key area of post-crisis finance
- Affecting affordability through credit common policy objective
- Existing credit-prices evidence focuses on collateral constraints
Credit ⇔ Asset prices

- Credit-asset prices nexus key area of post-crisis finance
- Affecting affordability through credit common policy objective
- Existing credit-prices evidence focuses on collateral constraints
- Payment size itself important dimension of credit, esp. for households
Capitalization of supply shocks in the cross-section

- This paper: use disaggregated data on car loans and sales to identify mechanics of credit-supply shock capitalization and incidence.
Capitalization of supply shocks in the cross-section

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- Question: How do individual transaction prices impound individual credit terms?
Capitalization of supply shocks in the cross-section

- This paper: use disaggregated data on car loans and sales to identify mechanics of credit-supply shock *capitalization* and *incidence*

- Question: How do *individual* transaction prices impound *individual* credit terms?

  1. Identify borrower-specific exogenous changes in maturity (payment size)
  2. Marry individual maturity shocks to individual prices paid for equivalent cars
  3. Suggestive evidence that credit shocks affect bargaining intensity
Capitalization of supply shocks in the cross-section

- This paper: use disaggregated data on car loans and sales to identify mechanics of credit-supply shock **capitalization** and **incidence**

- Question: How do *individual* transaction prices impound *individual* credit terms?

  1. Identify borrower-specific exogenous changes in maturity (payment size)
  2. Marry individual maturity shocks to individual prices paid for equivalent cars
  3. Suggestive evidence that credit shocks affect bargaining intensity

- **Spoiler:** Significant capitalization effects of individualized credit supply shocks. Price adjustment offsets ~20% of monthly payment increase.
Isolating credit channel

Deregulation → Credit Supply

Shock →

- Lending standards down
- Interest rates down
- Local firms credit access improves
- Expectations improve
- Local aggregate demand increases
- Affordability improves
- Capital flows in

... → Prices increase
Focus on different dimension of credit supply

• Typical dimensions of credit supply:
  ○ interest rates (e.g. Bernanke and Gertler 1995)
  ○ credit limits (e.g. Gross and Souleles 2002)
  ○ lending standards (e.g. Keys et al. 2010)

• Maturity important for many credit contracts
  ○ corporate loans, car loans, equipment, personal loans, furniture, student loans, mortgages

• Maturity has large effects on installment-payment size

→ This paper: maturity policies important dimension of credit supply
Tie-in to debt + bargaining literature

• Highlights the usefulness of debt in the bargaining process

• Related corporate finance lit on debt and bargaining in
  ◦ market for corporate control (Israel 1991, Muller and Panunzi 2004)
  ◦ between firms and their suppliers (Hennessey and Livdan 2009)
  ◦ firms and organized labor (Matsa 2010)
  ◦ between hospitals and insurers (Towner 2018)

→ We show similar dynamic: limited financial flexibility influences the bargaining process

• **Relevance**: most secured debt involves bargained-over collateral
Outline

1. Motivation and contribution
2. *Auto loans setting and data*
3. Discontinuous maturity policies
4. Capitalization effects
5. Mechanism
6. Conclusion
Auto loans are ubiquitous, important

- $1.2 trillion outstanding (NY Fed, 2016)
- Fastest growing consumer debt category, 3rd largest
- 100m outstanding loans ≈ 0.8 per U.S. household
- Vehicles 50%+ of low-wealth HHs total assets (Campbell, 2006)
Data source

- Data from a private software services company
- Originated by 372 lending institutions in all 50 states
- ~1 million used auto loans from 2005-2017
- Most are used-car loans originated by credit unions
  - CU market share of used car loans ~30%
- Observe price, make, model, model year, trim, origination date
- Drop loans intermediated by seller (indirect loans)
Loan summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std Dev</th>
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<tbody>
<tr>
<td>Interest Rate</td>
<td>0.041</td>
<td>0.024</td>
</tr>
<tr>
<td>Maturity (months)</td>
<td>61.3</td>
<td>12.8</td>
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<tr>
<td>Purchase Price ($)</td>
<td>20,341</td>
<td>9,432</td>
</tr>
<tr>
<td>Car Age (years)</td>
<td>3.88</td>
<td>2.95</td>
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<tr>
<td>FICO Score</td>
<td>714.1</td>
<td>69.0</td>
</tr>
<tr>
<td>Loan-to-Value Ratio</td>
<td>0.91</td>
<td>0.22</td>
</tr>
<tr>
<td>Observations</td>
<td>972,621</td>
<td></td>
</tr>
</tbody>
</table>
Outline

1. Motivation and contribution
2. Auto loans setting and data
3. Discontinuous maturity policies
4. Capitalization effects
5. Mechanism
6. Conclusion
Identification challenge

- **Goal**: Test for capitalization effects of financing terms in cross-section
- Can’t regress price on maturity
  - Better cars have higher prices and can support longer maturity
- Estimate lender-specific *maximum allowable maturity policies*

→ Isolate natural experiment in *offered* maturity affecting ~5% of sample
Average maturities decline with car age

- Collateral depreciates $\Rightarrow \text{max offered maturity} = f(\text{car age})$
- Overall, smooth relationship between maturity and car age
- Fairly similar patterns for all car types
Average maturities decline with car age

- Collateral depreciates $\Rightarrow$ max offered maturity $= f(\text{car age})$
- Overall, smooth relationship between maturity and car age
- Fairly similar patterns for all car types
Main idea: cars all age on Jan 1 (car age \( \equiv \) calendar year - model year)

Policies that limit max offered maturity based on car age cutoff will lead to January 1 discontinuities

Important: Policies vary across lenders, search costly
Lender-specific maturity policies

- Key insight: cars all age on Jan 1 (car age $\equiv$ calendar year - model year)
- Policies that limit max offered maturity based on car age cutoff will lead to January 1 discontinuities
- Important: Policies vary across lenders, search costly

![Graph showing expected car life and max allowable loan maturity over car age.](image)
Detecting exogenous maturity shocks

1. For each lender × car age, identify lender max maturity policy
   - E.g., lender offers max maturity of 72 months for cars 0-3 years old
   - Same lender offers max maturity of 60 months for cars 4-7 years old
   - Max offered maturity \( \equiv p_{80} \) within lender × car age × month
   - Maturity policy \( \equiv \) stable max offered maturity for more than one year

2. Follow cars as they age
   - Maturity shock \( \iff \) max maturity policy for a *given* vehicle changes from one month to the next
Sample lender maturity policy for 3-year-old cars
Example maturity shocks

- 2006 Honda Civic LX (treatment)
- 2012 Honda Civic LX (control)

Maturity policies:
- 2006m1
- 2008m1
- 2010m1
- 2012m1
- 2014m1
- 2016m1
- 2018m1

3 year old cars
- 2006 Honda Civic LX

4 year old cars
- 2012 Honda Civic LX
Natural experiment

• Summary: isolated plausibly exogenous ~5% of transactions that should be affected by maturity shock

• Treatment: max offered maturity changes on Jan 1 (for given lender × model year)

• Control: lender’s max offered maturity does not change Jan 1

• Post: January through June

• Pre: July through December

• Rich controls: Same lender, same car in both treatment/control
First-stage specification

- Measure relevance for loan $i$, commuting zone $g$, lender $l$, month $t$

$$Maturity_{iglt} = \beta_1 Post_t + \beta_2 Treat_i + \beta_3 Treat_i \cdot Post_t + X'_{it} \gamma + \phi_g + \psi_l + \epsilon_{iglt}$$

- $\beta_3$ reports how maturity changed for treated cars post-Jan
- Identifying assumption: treatment and control loans would have had similar maturity trends but for age-based policies
- Crucial controls: Year-Make-Model-Trim $\times$ Month FEs $\delta_{YMMT(i),t}$
- Double cluster by commuting zone and month
Maturity parallel trends

Average Maturities Around New Year

Month

-2 -1 0 1

Maturity (months)

J  A  S  O  N  D  J  F  M  A  M  J

△ Treated  □ Control
## First stage maturity regressions

<table>
<thead>
<tr>
<th>Maturity</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment × Post</td>
<td>-2.157***</td>
<td>-2.284***</td>
<td>-2.290***</td>
</tr>
<tr>
<td></td>
<td>(0.304)</td>
<td>(0.271)</td>
<td>(0.265)</td>
</tr>
<tr>
<td>Treatment</td>
<td>-0.371</td>
<td>0.561**</td>
<td>0.368</td>
</tr>
<tr>
<td></td>
<td>(0.365)</td>
<td>(0.282)</td>
<td>(0.263)</td>
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<tr>
<td>Borrower Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>YMMT × Month FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CZ FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lender FE</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>972,621</td>
<td>972,621</td>
<td>972,621</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.350</td>
<td>0.407</td>
<td>0.447</td>
</tr>
</tbody>
</table>

→ Chosen maturity decreases by ~2 months for treated borrowers (e.g., 1 in 4 borrowers receives the max, which decreases by 9 months)
Motivation and contribution
Auto loans setting and data
Discontinuous maturity policies
Capitalization effects
Mechanism
Conclusion
Use variation in loan terms to test for capitalization

- Reduced-form specification to look for discrete price changes
- For loan $i$, commuting zone $g$, lender $l$, month $t$ estimate

$$\log Price_{igt} = \beta_1 Post_t + \beta_2 Treat_i + \beta_3 Treat_i \cdot Post_t + X_{it}' \gamma + \varphi_g + \psi_l + \epsilon_{igt}$$

- **Identifying assumption**: parallel price trends for treatment/control
- Requires no differential unobserved changes in composition
  - Support with balance tests
- Double cluster by CZ and month
Unobserved heterogeneity

- Worry: Composition changed with $T \Leftrightarrow$ lower $P$ anyway
- Year-Make-Model-Trim (YMMT) fixed effects go very far
- Timing supportive: not a one-month shock but move to new stable $\bar{T}$
- Still important unobservables: mileage, accident history, sophistication, etc.
Unobserved heterogeneity

- Worry: Composition changed with $T \iff$ lower $P$ anyway
- Year-Make-Model-Trim (YMMT) fixed effects go very far
- Timing supportive: not a one-month shock but move to new stable $\bar{T}$
- Still important unobservables: mileage, accident history, sophistication, etc.

1. Borrower characteristics balance checks
2. No detectable effect on vehicle mileage
3. Repeat-sales test
4. Maturity effects constant with car age
5. Oster (2017) unobserved selection test
Borrower composition balance: FICO
Borrower composition balance: DTI

![Graph showing DTI balance by month for Treatment and Control groups.]}
Mileage differential stable around Jan 1
Reduced form parallel trends
Capitalization effects

\[
\log Price_{igt} = \beta_1 Post_t + \beta_2 Treat_i + \beta_3 Treat_i \cdot Post_t + \chi'_{it} \gamma + \varphi_g + \psi_l + \epsilon_{igt}
\]

<table>
<thead>
<tr>
<th>log(Price)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment × Post</td>
<td>-0.006**</td>
<td>-0.007***</td>
<td>-0.007***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Treatment</td>
<td>-0.007</td>
<td>0.006</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.005)</td>
<td>(0.005)</td>
</tr>
</tbody>
</table>

Borrower Controls: Yes, Yes, Yes
YMMT × Month FE: Yes, Yes, Yes
CZ FE: Yes, Yes
Lender FE: Yes
Observations: 972,621, 972,621, 972,621
R-squared: 0.909, 0.911, 0.914

→ Average prices drop ~70 bp from average $\Delta T$
Isolating maturity effects from interest-rate effects

- Treatment × Post affects both $T$ and $r$
- Estimate 2SLS system to estimate partial value of maturity
- Instrument set is Lender × Year × Age cell $k$ indicators × Post

$$\log \text{Price}_{igt} = \sum_k \alpha_k I_{k(ilt)} + \eta_{\text{mat}} \text{Maturity}_i + \eta_{\text{rate}} \text{Rate}_i + X'_{iglt} \mu + \varepsilon_{igt}$$
Isolating maturity effects from interest-rate effects

- Treatment $\times$ Post affects both $T$ and $r$
- Estimate 2SLS system to estimate partial value of maturity
- Instrument set is Lender $\times$ Year $\times$ Age cell $k$ indicators $\times$ Post

$$\log Price_{iglt} = \sum_{k} \alpha_k \Pi_k(ilt) + \eta_{\text{mat}} Maturity_i + \eta_{\text{rate}} Rate_i + X'_{iglt} \mu + \varepsilon_{iglt}$$

$$Maturity_{iglt} = \sum_{k} \pi_{k}^{\text{mat}} \Pi_k(ilt) \cdot Post_t + \sum_{k} \varphi_{k}^{\text{mat}} \Pi_k(ilt) + X'_{iglt} \gamma^{\text{mat}} + v^{\text{mat}}_{iglt}$$

$$Rate_{iglt} = \sum_{k} \pi_{k}^{\text{rate}} \Pi_k(ilt) \cdot Post_t + \sum_{k} \varphi_{k}^{\text{rate}} \Pi_k(ilt) + X'_{iglt} \gamma^{\text{rate}} + v^{\text{rate}}_{iglt}$$
### Isolating maturity effects from interest-rate effects

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maturity</strong></td>
<td>0.0024***</td>
<td>0.0023***</td>
</tr>
<tr>
<td></td>
<td>(0.0004)</td>
<td>(0.0004)</td>
</tr>
<tr>
<td><strong>Rate</strong></td>
<td>-0.863***</td>
<td>-0.905***</td>
</tr>
<tr>
<td></td>
<td>(0.328)</td>
<td>(0.333)</td>
</tr>
<tr>
<td><strong>Borrower Controls</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>YMMT \times Month FE</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>CZ FE</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Lender FE</strong></td>
<td>Yes</td>
<td>Yes</td>
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<td>972,621</td>
<td>972,621</td>
</tr>
</tbody>
</table>

→ Implied elasticity of price w.r.t. payment size of -0.23
Interpreting magnitudes

- 2SLS LATE: value of one year of maturity is $12 \times 0.23\% = 2.8\%$
  - estimated used-car margins \~5–20\% 
    (Gavazza et al. 2014, Huang et al. 2015, Larsen 2018)

- $2.8\% \times \$20k = \$560 \Delta P$ for $\Delta \bar{T} = 12$ months

- One year lower $\Delta \bar{T}$ has IRR of \~8.9\%

- Lower price offsets about 20\% of the higher monthly payment
Outline

1. Motivation and contribution
2. Auto loans setting and data
3. Discontinuous maturity policies
4. Capitalization effects
5. **Mechanism**
6. Conclusion
Typical transaction timing

1. Loan application/Preliminary shopping for car
2. Loan approval
3. Finalize car transaction with financing terms

→ scope for prices to adjust because of search or bargaining
What is the transmission mechanism?

- Welfare interpretation affected by mechanism
- Search frictions most likely explanation for price dispersion, market clearing through bargaining (ANP, 2017)
- If lower prices result of treated borrowers searching more intensively, price effects may be washed out by incurred search costs
- On the other hand, bargaining intensity could have costs, too...
Suggestive evidence on mechanisms

1. **Search intensity**: length of time between application and sale does not change treatment $\times$ post

2. **Bargaining success**: prices fall from app $\rightarrow$ sale for treatment $\times$ post
## Search intensity

<table>
<thead>
<tr>
<th>Treatment × Post</th>
<th>Days Between Application and Origination</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Treatment</td>
</tr>
<tr>
<td></td>
<td>-1.184</td>
</tr>
<tr>
<td></td>
<td>(1.025)</td>
</tr>
<tr>
<td>Post</td>
<td>0.117</td>
</tr>
<tr>
<td></td>
<td>(0.678)</td>
</tr>
<tr>
<td>Treatment</td>
<td>-3.6917**</td>
</tr>
<tr>
<td></td>
<td>(1.728)</td>
</tr>
</tbody>
</table>

- **Borrower Controls**: Yes, Yes, Yes, Yes, Yes, Yes
- **Lender FEs**: Yes, Yes, Yes, Yes, Yes
- **Car Age FEs**: Yes, Yes, Yes, Yes
- **CZ FEs**: Yes
- **Loan Month FEs**: Yes
- **Observations**: 54,929, 54,929, 54,929, 54,929, 54,929
- **R-squared**: 0.005, 0.045, 0.007, 0.046, 0.059
Conclusion: New lessons on credit markets

1. New evidence on the **locality** of credit shocks
   - Previous work: aggregate credit shock affects aggregate prices
   - This paper: Credit varies in the cross-section $\Rightarrow$ prices vary in the cross-section
   - Prices adjust at a more granular level than we might have expected
   - Scope in most durables markets with secured credits
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   - Scope in most durables markets with secured credits

2. Illustrates new **mechanism of transmission** of credit to asset prices
   - $\Delta$ demand operating through overlooked dimension of credit surface
   - Likely importance of bargaining in transmission
No significant change in price residuals

<table>
<thead>
<tr>
<th>log(Price)</th>
<th>Initial-sale (1)</th>
<th>Second-sale (2)</th>
<th>Difference (1) - (2)</th>
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<tbody>
<tr>
<td>Treatment × Post</td>
<td>-0.012 (0.010)</td>
<td>0.006 (0.007)</td>
<td>0.018* (0.011)</td>
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<tr>
<td>Treatment</td>
<td>0.009 (0.010)</td>
<td>-0.005 (0.004)</td>
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<tr>
<td>YMMT × Month FE</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>CZ FE</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Observations</td>
<td>8,697</td>
<td>8,697</td>
<td></td>
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<tr>
<td>R-squared</td>
<td>0.001</td>
<td>0.001</td>
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</table>
Interest rates change little with max maturity

<table>
<thead>
<tr>
<th>Interest Rate</th>
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<th>(4)</th>
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<tr>
<td>Treatment × Post</td>
<td>0.0006</td>
<td>0.0004</td>
<td>0.0009</td>
<td>0.0012*</td>
<td>0.0016***</td>
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<td>(0.0010)</td>
<td>(0.0011)</td>
<td>(0.0007)</td>
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</tr>
<tr>
<td>Treatment</td>
<td>0.0001</td>
<td>-0.0002</td>
<td>-0.0030***</td>
<td>-0.0009</td>
<td>-0.0005</td>
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<tr>
<td></td>
<td>(0.0014)</td>
<td>(0.0017)</td>
<td>(0.0008)</td>
<td>(0.0005)</td>
<td>(0.0004)</td>
</tr>
<tr>
<td>Post</td>
<td>0.0002</td>
<td>-0.0006</td>
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<td>(0.0007)</td>
<td>(0.0006)</td>
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<td>Borrower Controls</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Car Age FE</td>
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<td></td>
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</tr>
<tr>
<td>YMMT × Month FE</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>CZ FE</td>
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<td>Lender FE</td>
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<td>Observations</td>
<td>972,621</td>
<td>972,621</td>
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<tr>
<td>R-squared</td>
<td>0.426</td>
<td>0.443</td>
<td>0.604</td>
<td>0.640</td>
<td>0.664</td>
</tr>
</tbody>
</table>

→ Interest rates don’t respond much to $\Delta \bar{T}$ policies, but perhaps some
Robust to 50% hold-out training sample

<table>
<thead>
<tr>
<th>log(Price)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
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</thead>
<tbody>
<tr>
<td>Treatment × Post</td>
<td>-0.0003</td>
<td>-0.031**</td>
<td>-0.009*</td>
<td>-0.009**</td>
<td>-0.009***</td>
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<tr>
<td></td>
<td>(0.025)</td>
<td>(0.012)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Treatment</td>
<td>-0.101***</td>
<td>-0.026**</td>
<td>-0.008</td>
<td>0.006**</td>
<td>0.008***</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.012)</td>
<td>(0.009)</td>
<td>(0.003)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Post</td>
<td>-0.062***</td>
<td>0.055***</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.005)</td>
<td></td>
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<tr>
<td>Borrower Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Car Age FE</td>
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<td></td>
</tr>
<tr>
<td>YMMT × Month FE</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Commuting Zone FE</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lender FE</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.070</td>
<td>0.325</td>
<td>0.923</td>
<td>0.925</td>
<td>0.926</td>
</tr>
</tbody>
</table>
## Oster Unobserved Selection Bias

<table>
<thead>
<tr>
<th>log(Price)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Coefficient</td>
<td>-0.026</td>
<td>-0.027</td>
<td>-0.009</td>
<td>-0.006</td>
<td>-0.007</td>
</tr>
<tr>
<td>Omitted Variables</td>
<td>-0.068</td>
<td>-0.071</td>
<td>-0.029</td>
<td>-0.010</td>
<td>-0.009</td>
</tr>
<tr>
<td>Bias-Adjusted</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Includes Zero?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Adjusted Coefficient within Original Confidence Interval?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- Car Age FE
- Age × MMT FE
- YMMT × Month FE
- Commuting Zone FE
- Lender FE