Cars and the Great Recession

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NBER Summer Institute - July 2016
Introduction

Questions:

1. What were the sources of the Great Recession?
2. Why certain variables moved in certain ways?
3. Lessons for policy?
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1. What were the sources of the Great Recession?
2. Why certain variables moved in certain ways?
3. Lessons for policy?

- Consumption dropped dramatically during the Great Recession.
- The drop was particularly severe for durables.
- The recovery of consumption was sluggish.
• We look at individual consumption behaviour to uncover plausible sources of variations.
Introduction

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- The cross sectional analysis of consumption can be indicative of individual perceptions and circumstances.
- Heterogeneity can be informative about causes.
• We look at individual consumption behaviour to uncover plausible sources of variations.
• The cross sectional analysis of consumption can be indicative of individual perceptions and circumstances.
• Heterogeneity can be informative about causes.
• Cars might be particularly useful because might convey information about long-run expectations
  - Which shocks are more likely to explain consumption responses?
  - What did consumers think and experience about the impact of the recession on them?
NIPA Data: durable and non durable real growth

Attanasio & al. (UCL & IFS)  Consumption and the Great Recession  NBER SI 2016 4 / 84
NIPA Data: durables and automobiles

Year on Year Growth Rates

- Total durables
- Automobiles
We study Consumer Expenditure Survey (CEX) data

- Household spending on non-durable consumption goods
- Household spending on cars
- Build synthetic panel (birth year of household head)
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- Household spending on non-durable consumption goods
- Household spending on cars
- Build synthetic panel (birth year of household head)
- How good/bad are CEX data?
CEX and NIPA car Data

Source: Meyer and Sullivan, 2014
Car Data

- The information on cars is very detailed and very reliable.
- For each car we know:
  - Make, model, year
  - When it was bought (new or used)
  - What was paid for it.
  - How it was financed.
Car Data

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- For each car we know:
  - Make, model, year
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  - What was paid for it.
  - How it was financed.

- These data can be used to build good estimates of:
  - value of stock of cars (see Attanasio, 2000; Padula (2004))
  - car transactions
Average real consumption of nondurables, annualized

- 80–89
- 70–79
- 60–69
- 50–59
- 40–49
- 30–39
- 20–29
- 10–19
- 00–09

Attanasio & al. (UCL & IFS)
Life Cycle Profiles

Number of cars

- 80–89
- 70–79
- 60–69
- 50–59
- 40–49
- 30–39
- 20–29
- 10–19
- 00–09
Life Cycle Profiles

Percentage of households without car

- 80–89
- 70–79
- 60–69
- 50–59
- 40–49
- 30–39
- 20–29
- 10–19
- 00–09
Life Cycle Profiles

Average real value of stock of cars

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Consumption and the Great Recession

Attanasio & al. (UCL & IFS)

Institute for Fiscal Studies

NBER SI 2016
There are important life-cycle determinants of consumption - but also important *business cycle components*
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- Car purchases, in particular, are very cyclical
Life-Cycle vs Business Cycle

There are important life-cycle determinants of consumption - but also important **business cycle components**

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- Alan Greenspan paid a lot of attention to new car purchases
  - Greenspan and Cohen (ReStat, 1999) "Motor Vehicle Stocks, Scrappage, and Sales"
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  - Last recession was different though
Life Cycle and Business Cycle Patterns

Mean ratio of value of stock of cars to nondurables

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Bar-Ilan Blinder redux

Percentage of households buying car in each quarter

- Original
- Seasonally adjusted
- Recession Quarter dummies

Quarterly data from 1985q1 to 2010q1.
Bar-Ilan Blinder redux

Average real value of cars purchased

Dollars

Recession

1985q1 1990q1 1995q1 2000q1 2005q1 2010q1

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Cohort Income shocks: data

\[ x_{j,t} = \beta_0 + f(\text{age}_{j,t}) + \varepsilon_{j,t} \]

\[ \hat{x}_{j,t} = \beta_0 + f(\text{age}_{j,2006}) + \sum_{i=2007}^{4} x_{j,i} \]

\[ \tilde{x}_{j,t} = \beta_0 + f(\text{age}_{j,2006}) + \sum_{i=2007}^{4} x_{j,i} \]
Cohort Consumption: data
Cohort Car purchases: data
Cars in the Great Recession

**Summary:**

- Something different about Great Recession
- Large drop in car purchases
- Action on the intensive margin

**Why:**

- Larger shocks?
- More persistent shocks?
- Finance?
- Wealth shocks (housing)?
- Long-run risk?
- Petrol prices?
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Why:

- Larger shocks?
- More persistent shocks?
- Finance?
- Wealth shocks (housing)?
- Long-run risk?
- Petrol prices?

We construct a model to check what of these possibilities is more plausible.
Model

Key features:

- Partial equilibrium
Model

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- Life-cycle household choice model
- Exogenous income process (no labour supply)
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- Borrowing constraints
  - allow for collateralized car loans

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Model

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- Heterogeneity in age, income, assets (cars, debt, savings)
**Model**

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- Exogenous income process (no labour supply)
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  - non-durables
  - durables which are subject to non-convex adjustment costs
- Borrowing constraints
  - allow for collateralized car loans
- Heterogeneity in age, income, assets (cars, debt, savings)
- Variety of idiosyncratic and aggregate shocks
Literature

PIH and Consumer Durables

- Bernanke (1984, QJE, 1985, JME), Bar-Ilan and Blinder (1992, JMCB)

Heterogeneous agents infinite horizon models with durables

- Bertola and Caballero (1990, NBER Macro), Berger and Vavra (2015, Econometrica),

Life-cycle models of consumer choice


(S,s) decision rules and automobile expenditures


**Demographics:**

- A continuum of households of measure 1 born every period
- Households indexed by age \((a)\) and identity \((j)\)
- Face stochastic mortality shocks: Survive from age \(a\) to age \(a + 1\) with probability \(\pi(a) \in [0, 1]\)
- Retire at age \(T_r\), die for sure at age \(a^{\text{max}}\)
- Face stochastic income stream
- Aggregate and idiosyncratic income shocks
- Shocks to credit conditions
- Wealth shocks
Household choice problem

**Instantaneous utility function:**

\[
u_{a,t} = \frac{\gamma_a \left[ \alpha \left( \frac{c_{a,t}}{\gamma_a} \right)^{1-1/\mu} + (1 - \alpha) \left( \frac{\xi_d^j a_{t+1}}{\gamma_a} \right)^{1-1/\mu} \right]^{(1-\varphi)/(1-1/\mu)}}{1 - \varphi} - 1
\]

- \( \mu \geq 0 \) measures elasticity of substitution between non-durables and durables service flow
- \( 1/\varphi \) measures intertemporal elasticity of substitution
- \( \gamma_a \) measures typical household size at age \( a \)
Household choice problem

Law of motion for stock of cars:

\[ d_{a,t+1}^j = (1 - \delta) d_{a-1,t}^j + i_{a,t}^j \]

- Linear depreciation
Household choice problem

**Law of motion for stock of cars:**

\[ d_{a,t+1}^j = (1 - \delta) d_{a-1,t}^j + i_{a,t}^j \]

- Linear depreciation
- We have also experimented with:

\[ d_{a,t+1}^j = \begin{cases} (1 - \delta^L) d_{a-1,t}^j + i_{a,t}^j & \text{with probability } p \\ (1 - \delta^H) d_{a-1,t}^j + i_{a,t}^j & \text{with probability } 1 - p \end{cases} \]
Household choice problem

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- Car “death” shocks
Model

The Household Problem

Household choice problem

Car adjustment cost function:

\[ Y(d_{a-1,t}^j) = \begin{cases} 0 & \text{if } d_{a,t+1}^j = (1 - \delta (1 - \varsigma)) d_{a-1,t}^j \\ \psi d_{a-1,t}^j & \text{otherwise} \end{cases} \]

- \( \varsigma \in [0, 1] \): car maintenance
- \( \varsigma = 1 \): All depreciation is maintenance
- \( \varsigma = 0 \): Depreciation is like ageing (irreversible)
- \( \psi d_{a-1,t}^j \): Fixed cost of car adjustment
- Time costs, instantaneous depreciation upon purchase, contractual costs etc.
Household choice problem

**Car finance:**

\[ k_{a,t+1}^j \leq \eta_t p_t d_{a,t+1}^j \]

- \( p_t \): Price of cars
- \( \eta_t \in [0, 1] \): Collateral parameter
- Household has to have at least \((1 - \eta_t) p_t d_{a,t+1}^j\) in savings for the downpayment
- Young households may be constrained until they can afford downpayment
- Households towards end of life-cycle may use cars as collateral for obtaining credit
Household choice problem

Car credit account:

\[ k_{a,t+1}^j = (1 + r_t^k) k_{a-1,t}^j + p_t \varphi_{a,t}^j - \zeta (k_{a-1,t}^j) \]

- \( r_t^k \): Interest on car loans
- \( p_t \varphi_{a,t}^j \): New car loan issued in period \( t \)
- \( \zeta (k_{a-1,t}^j) \): Repayments on car loan - we let this be flexible
- \( r_t^k \geq r_t \) (savings rate)
Household choice problem

**Borrowing constraint**

\[ b_{a,t+1}^j \geq 0 \]

- Households can save in risk free asset but car loans is the only option to go into debt
- We assume that \( r_t^k \geq r_t \) so that there is a premium on car loans
Household choice problem

**Borrowing constraint**

\[ b^j_{a,t+1} \geq 0 \]

- Households can save in risk free asset but car loans is the only option to go into debt
- We assume that \( r^k_t \geq r_t \) so that there is a premium on car loans
- So we allow for costly collateralized debt
  - Tighter than Berger and Vavra (Econometrica, 2015): Collateralized debt at the risk free rate
  - Less strict than Kaplan and Violante (Econometrica, 2014): Do not allow for any debt
Household choice problem

Borrowing constraint

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- We assume that \( r_t^k \geq r_t \) so that there is a premium on car loans
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  - Tighter than Berger and Vavra (Econometrica, 2015): Collateralized debt at the risk free rate
  - Less strict than Kaplan and Violante (Econometrica, 2014): Do not allow for any debt
- Because of the car loan premium, households do not want to save and have car loan debt at the same time
- Indebted households will typically be young or close to retirement
Household choice problem

**Stochastic income stream while working:**

\[
\log y_{a,t}^j = p_{a,t}^j + u_t^j,
\]

\[
p_{a,t}^j = p_{a-1,t-1}^j + g_a + e_t^j,
\]

\[
e_t^j = \nu_t + \varepsilon_t^j,
\]

\[
u_t^j \sim N (0, \sigma_u^2)
\]

\[
\varepsilon_t^j \sim N (0, \sigma_\varepsilon^2),
\]

\[
\nu_t \sim N (0, \sigma_v^2)
\]

\[
\exp(y_{25}^j) \sim \log N \left( -\frac{1}{2} \sigma_Y^{25}, \sigma_Y^{25} \right)
\]

- \(u_t^j\): transitory idiosyncratic income shock.
- \(\varepsilon_t^j\): permanent idiosyncratic income shock.
- \(\nu_t\): permanent aggregate income shock.
Household choice problem

Budget constraints:

- While working \((a < T_r)\):

\[
\begin{align*}
    c_{a,t}^j + p_t (i_{a,t}^j - \vartheta_{a,t}^j) + \Upsilon (d_{a-1,t}^j) + b_{a,t+1}^j + \zeta (k_{a-1,t}^j) \\
    \leq y_{a,t}^j + (1 + r_t) b_{a-1,t}^j
\end{align*}
\]
Household choice problem

Budget constraints:

- While working \((a < T_r)\):

\[
\begin{align*}
c^j_{a,t} + p_t \left( j^j_{a,t} - \vartheta^j_{a,t} \right) + \Upsilon \left( d^j_{a-1,t} \right) + b^j_{a,t+1} + \zeta \left( k^j_{a-1,t} \right) \\
\leq y^j_{a,t} + (1 + r_t) b^j_{a-1,t}
\end{align*}
\]

- When retired \((a \geq T_r)\):

\[
\begin{align*}
c^j_{a,t} + p_t \left( j^j_{a,t} - \vartheta^j_{a,t} \right) + \Upsilon \left( d^j_{a-1,t} \right) + b^j_{a,t+1} + \zeta \left( k^j_{a-1,t} \right) \\
\leq m^j_{a,t} + (1 + r_t) b^j_{a-1,t}
\end{align*}
\]

\[
m^j_{a,t} = F \left( y^j_{T_r-1}, \ldots, y^j_{T_r-n} \right)
\]

- \(m^j_{a,t} \geq 0\) : Retirement benefits
Life cycle

- Birth at date 25
- Initial assets
- Choose consumption, assets, loans
- For sure: Family, career
- Stochastic: Permanent and transitory income risk

- Retire at age 60
- Consume, save

- Death for sure at age 80
- Mortality risk
Household choice problem

**Dynamic Programming Problem:**

\[
V(s) = \max (V^p(s), V^n(s))
\]

\[
s = (b_{a-1}, d_{a-1}, k_{a-1}, w, a, \theta, \eta)
\]

- Value of adjusting:

\[
V^p(s) = \max_{c_a, d'_a, k'_a, b'_a, i_a, \vartheta_a} u(c_a, d'_a) + \beta \pi(a) \mathbb{E}V(s')
\]

subject to:

\[
c_a + p(i_a - \vartheta_a) + \psi d_{a-1} + b'_a + \zeta(k_{a-1}) \\
\leq (1 - \chi(a)) y_a + \chi(a) m + (1 + r) b_{a-1}
\]

\[
d'_a = (1 - \delta) d_{a-1} + i_a^d
\]

\[
k'_a \leq \eta p d'_a
\]

\[
k'_a = (1 + r^k) k_{a-1} + p \vartheta_a - \zeta(k_{a-1})
\]
Household choice problem

- Value of not adjusting:

\[ V^n(s) = \max_{c_a, d'_a, k'_a, b'_a} u(c_a, d'_a) + \beta \pi(a) \mathbb{E} V(s') \]

subject to:

\[ c_a + b'_a + p(\zeta d_{a-1} - \vartheta_a) + \xi(k_{a-1}) \leq (1 - \chi(a)) y_a + \chi(a) m + (1 + r) b_{a-1} \]

\[ d'_a = (1 - \delta(1 - \zeta)) d_{a-1} \]

\[ k'_a \leq \eta p d'_a \]

\[ k'_a = \left(1 + r^k\right) k_{a-1} + p\vartheta_a - \xi(k_{a-1}) \]
We calibrate to the pre-Great Recession period

1. A subset of parameters are preselected.
2. Another subset of parameters are calibrated by indirect inference.
3. Check performance of model on moments not targeted in 2.
## Calibration: Preselected Parameters

### Table 2: Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_{\text{max}}$</td>
<td>max. lifespan (life starts at 25)</td>
<td>55 years</td>
</tr>
<tr>
<td>$T_r$</td>
<td>Retirement age</td>
<td>35 years</td>
</tr>
<tr>
<td>$\pi_a$</td>
<td>Survival probabilities</td>
<td>Match Life Table, 2009</td>
</tr>
<tr>
<td>$\beta$</td>
<td>subjective discount factor</td>
<td>0.96</td>
</tr>
<tr>
<td>$1/\varphi$</td>
<td>intertemporal elasticity of substitution</td>
<td>2/3</td>
</tr>
<tr>
<td>$r$</td>
<td>annual real return on savings</td>
<td>4 percent</td>
</tr>
<tr>
<td>$r^k$</td>
<td>annual car loan interest rate</td>
<td>5.78 percent</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>Pension replacement rate</td>
<td>60 percent</td>
</tr>
<tr>
<td>$\sigma_u^2$</td>
<td>Variance of transitory income shocks</td>
<td>0.246^2</td>
</tr>
<tr>
<td>$g_a$</td>
<td>Life-cycle income growth</td>
<td>matched to CEX data</td>
</tr>
<tr>
<td>$\gamma_a$</td>
<td>$f(\text{average household size})$</td>
<td>matched to CEX data</td>
</tr>
</tbody>
</table>
# A. Targets Used for Calibration

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of households purchasing a car</td>
<td>25.4 percent</td>
<td>24.8 percent</td>
</tr>
<tr>
<td>Mean of ratio of car to non-durables spending</td>
<td>18.9 percent</td>
<td>16.0 percent</td>
</tr>
<tr>
<td>Mean of ratio of value of car stock to non-durables spending</td>
<td>66.7 percent</td>
<td>76.8 percent</td>
</tr>
<tr>
<td>Cross sectional standard deviation of non-durables consumption expenditures</td>
<td>61.4 percent</td>
<td>66.9 percent</td>
</tr>
<tr>
<td>Growth from age 25 to peak of log non-durables consumption spending</td>
<td>34.8 percent</td>
<td>55.1 percent</td>
</tr>
<tr>
<td>Correlation of aggregate non-durables consumption and aggregate durables purchases</td>
<td>72.1 percent</td>
<td>66.1 percent</td>
</tr>
<tr>
<td>Standard deviation of aggregate non-durables consumption expenditure</td>
<td>0.77 percent</td>
<td>0.85 percent</td>
</tr>
<tr>
<td>Standard deviation of aggregate durables purchases</td>
<td>5.91 percent</td>
<td>5.70 percent</td>
</tr>
</tbody>
</table>
### B. Other Moments Not Targeted in Calibration

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at peak of non-durables spending</td>
<td>45 years</td>
<td>46 years</td>
</tr>
<tr>
<td>Age at peak of car stock</td>
<td>53 years</td>
<td>48 years</td>
</tr>
<tr>
<td>Growth to peak in car stock</td>
<td>58.0 percent</td>
<td>68.6 percent</td>
</tr>
<tr>
<td>Cross sectional standard deviation of value of car stock</td>
<td>96.5 percent</td>
<td>75.0 percent</td>
</tr>
</tbody>
</table>
Calibration: Parameter Estimates from Indirect Inference

2. Estimated parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>weight on non-durables in utility function</td>
<td>0.814</td>
</tr>
<tr>
<td>$\mu$</td>
<td>elasticity of substitution</td>
<td>1.276</td>
</tr>
<tr>
<td>$\psi$</td>
<td>car adjustment cost parameter</td>
<td>0.0644</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>car maintenance cost parameter</td>
<td>0.1097</td>
</tr>
<tr>
<td>$\xi$</td>
<td>Durable flow parameter</td>
<td>0.6428</td>
</tr>
<tr>
<td>$\delta$</td>
<td>car depreciation rate</td>
<td>0.215</td>
</tr>
<tr>
<td>$\sigma_u^2$</td>
<td>variance of initial income</td>
<td>0.658$^2$</td>
</tr>
<tr>
<td>$\sigma_e^2$</td>
<td>variance of idiosyncratic permanent income shock</td>
<td>0.0106$^2$</td>
</tr>
<tr>
<td>$\sigma_v^2$</td>
<td>variance of aggregate permanent income shock</td>
<td>0.0207$^2$</td>
</tr>
</tbody>
</table>
Policy Functions: Consumption vs. Cash on Hand

- Attanasio & al. (UCL & IFS)
- Consumption and the Great Recession
- NBER SI 2016
Policy Functions- Durables: \((S,s)\) Type Policy

![Policy Functions Graph]

- **Adjust**
- **No Adj.**
- **Optimal**

**Attanasio & al. (UCL & IFS)**

Consumption and the Great Recession

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Policy Functions: Durables

Model fit

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Life-Cycle Profiles: Consumption

![Graph showing life-cycle profiles for consumption]

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Life-Cycle Profile: Car Investment

Car investment

Model
Model fit

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Life-Cycle Profile: Assets

Model

Model fit

30 40 50 60 70 80
2
4
6
8
C
30 40 50 60 70 80
0
5
10
15
20
25
K
30 40 50 60 70 ... 40 50 60 70 80
2
4
6
8
10
12
14
Wage

M.O. Ravn (U(C,L))

Consumption and the Great Recession

May 2016 45 / 78

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Consumption and the Great Recession

NBER SI 2016 46 / 84
Simulation experiments

What Did Consumers Think Happened in Great Recession?

We use the model to investigate counterfactual paths of aggregate consumption.

1. We estimate aggregate shocks to various ‘exogenous’ drivers
2. We feed them into the model sequentially
3. We check what shocks are able to generate observed aggregate (and cross sectional) patterns.

Relevant Literature

- Attanasio, Leicester and Wakefield (2011)
- Alan, Crossley and Low (2014)
- Berger, Guerrieri and Lorenzoni (2015)
- Ravn and Sterk (2012, 2015)
We use the model to ask for counterfactual paths of aggregate consumption and other variables in response to:

- **Common income shock during Great Recession** - shock much larger than usual
- **Financial market shock 1** - increase in premium on car loans
- **Financial market shock 2** - decline in leverage
- **Common life-cycle profile shock during Great Recession** - a moment of long-run risk
- **Wealth shock** (housing)
- **Durables user cost shock**
The Great Recession

**Step 1:** Simulate model starting from stationary distribution

- Use sequence of aggregate shocks \((v_t)_{t=1970}^{2006}\) fitted to NIPA data on wages (sum of compensation of employees and proprietors income)
- Draw other idiosyncratic shocks from their respective distributions.

**Step 2:** Simulate model from 2007 onwards under alternative assumptions about source of aggregate shock and therefore about household expectations.

- In all cases, aggregate income fitted to NIPA
- Draw other idiosyncratic shocks from their respective distributions.
Income Shocks

Simulation experiments

Income shocks

Attanasio & al. (UCL & IFS)
Consumption and the Great Recession
NBER SI 2016

Income Shocks

aggregate wage shocks

income (aggregate stochastic wage)
Permanent Income Shocks

Attanasio & al. (UCL & IFS)

Consumption and the Great Recession

NBER SI 2016
Permanent Income Shocks

Simulation experiments

Income shocks

Attanasio & al. (UCL & IFS)
Consumption and the Great Recession
NBER SI 2016
Permanent Income Shocks

Simulation experiments

Income shocks

Attanasio & al. (UCL & IFS)
Consumption and the Great Recession
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The Great Recession

- Permanent income shock can account for non-durables consumption drop
  - But NOT for pre-recession boom
- Permanent income shock cannot account for car investment drop
- Fails to account for intensive - extensive margin
Credit conditions tightened considerably during the Great Recession:

- Spread on car loans went up
- Leverage declined
- How important are these? (here only spread)
Simulation experiments

Financial Shocks

Interest Rate Premium

![Graph showing interest rate premium over time](image)

- **Interest Rate Spread Shocks**
  - 1990
  - 1995
  - 2000
  - 2005
  - 2010

- **Interest Rate Spread**
  - 0.01
  - 0.015
  - 0.02
  - 0.025

- **Both**
- **Wage**
- **Spread**

- Attanasio & al. (UCL & IFS)
- Consumption and the Great Recession
- NBER SI 2016 56 / 84
Simulation experiments

Financial Shocks

Interest Rate Premium

![Graph showing log. consumption and log. car investment over time](image)

- **Log. Consumption**
  - Data: both, wage, spread
  - 1990: 0.14
  - 1995: 0.16
  - 2000: 0.18
  - 2005: 0.2
  - 2010: 0.22

- **Log. Car Investment**
  - Data: both, wage, spread
  - 1990: −1.8
  - 1995: −1.7
  - 2000: −1.6
  - 2005: −1.5
  - 2010: −1.5

Attanasio & al. (UCL & IFS)

Consumption and the Great Recession

NBER SI 2016
Simulation experiments
Financial Shocks

Interest Rate Premium

% purchasing new car

log. value of new car purchase

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Simulation experiments

Financial Shocks

Interest Rate Premium

![Graph showing log. car loans and log. savings over time]

- Log. car loans
- Log. savings

Both: blue line
Wage spread: red and green lines


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Simulation experiments

Financial Shocks

Seem not matter much

1. Only few households are indebted - car loans very expensive
2. Those households who have car loans really don’t matter much for aggregate consumption

This could supposedly be very different for other types of debt
Tightening of financial constraints seem not to matter much

• But, housing crisis may have mattered: potentially large wealth shocks.
• Reallocation of wealth between households
• "Expensive" to model this fully, but we introduce a "wealth shock"
Wealth Shocks

Write budget constraint as:

\[ c^j_{a,t} + d^j_{a,t} + \Omega^j_{a,t} + \Upsilon \left( d^j_{a-1,t-1} \right) \leq y^j_{a,t} + (1 - \delta) d^j_{a-1,t-1} + \left( 1 + r^\Omega_t \right) \Omega^j_{a-1,t-1} \]

- \( \Omega^j_{a,t} \): net financial assets
- Now allow for wealth shocks if net assets are positive:

\[ c^j_{a,t} + d^j_{a,t} + \Omega^j_{a,t} \left( 1 + p^1_{\Omega>0} \right) + \Upsilon \left( d^j_{a-1,t-1} \right) \leq y^j_{a,t} + (1 - \delta) d^j_{a-1,t-1} + \left( 1 + r^\Omega_t \right) \left( 1 + p^1_{\Omega>0} \right) \Omega^j_{a-1,t-1} \]

- where

\[ \log p' = \log p + \varepsilon_p, \quad \varepsilon_p \sim \mathcal{N}(0, \sigma^2_p) \]

- \( \sigma^2_p \) calibrated to match variance of change of house price (FHFA HPI deflated by CPI)
Wealth Shocks

Simulation experiments

Wealth shocks

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Wealth Shocks

Simulation experiments

Wealth shocks

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Wealth Shocks

Simulation experiments

Wealth shocks

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NBER SI 2016
Wealth Shocks

Simulation experiments
Wealth shocks

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Life-cycle income profile

Simulation experiments
Long term growth shocks

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Life-cycle income profile shocks

Recall income process:

\[ y_{a,t} = p_{a,t} + u_t, \quad u_t \sim N\left(0, \sigma_u^2\right) \]

\[ p_{a,t} = p_{a-1,t-1} + g_a + e_t \]

We now allow \( g_a \) to be stochastic

\[ g_a = (g_{\text{low}}, g_{\text{high}}) \]

\[ q_{ij} = \Pr(g_{a,t} = g_i | g_{a,t-1} = g_j) \]

- long run risk: \( q_{\text{high}, \text{high}} \) and \( q_{\text{low}, \text{low}} \) close to 1
- Assume that everyone starts with \( g_{\text{high}} \)
- then hit by \( g_{\text{low}} \)
- We also modify pensions (MA of final years’ salary)
Life-cycle income profile shocks
Life-cycle income profile shocks

![Graph showing log. consumption and log. car investment over time with different profiles and data points.](image)
Life-cycle income profile shocks

% purchasing new car

log. value of new car purchase

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Life-cycle income profile shocks

- Data seems to indicate that such changes have occurred
- Powerful in the model:
  - larger consumption responses that other income shocks
  - impact on the young and the old simultaneously
  - also important for savings
- Now combine with wealth (housing price) shocks
Life-cycle income profile shocks + wealth shocks

Simulation experiments  Long term growth shocks

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Simulation experiments

Life-cycle income profile shocks + wealth shocks

Life-cycle income profile shocks + wealth shocks

% purchasing new car

log. value of new car purchase

both
wage
price
growth
data

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Consumption and the Great Recession
NBER SI 2016 74 / 84
Cohort profiles

Simulation experiments
Cohort heterogeneity
Cohort declines: changes in growth

Age in 2007

<table>
<thead>
<tr>
<th>Age in 2007</th>
<th>Decline (2010)</th>
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<tbody>
<tr>
<td>25−32</td>
<td>−0.12</td>
</tr>
<tr>
<td>33−42</td>
<td>−0.1</td>
</tr>
<tr>
<td>43−52</td>
<td>−0.08</td>
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<tr>
<td>53−62</td>
<td>−0.06</td>
</tr>
</tbody>
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Val | adjust | Decline (2010) |
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<tr>
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<tbody>
<tr>
<td>25−32</td>
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<tr>
<td>−0.3</td>
<td>−0.25</td>
<td>−0.2</td>
</tr>
<tr>
<td>−0.05</td>
<td>0</td>
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</tr>
</tbody>
</table>
Cohort ‘elasticities’: changes in growth

![Graph showing cohort elasticities over age groups and years](image)
Cohort declines: changes in wealth

Simulation experiments

Cohort heterogeneity

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Cohort ‘elasticities’: changes in wealth

Attanasio & al. (UCL & IFS)  Consumption and the Great Recession  NBER SI 2016
Cohort declines: changes in wealth and growth

Simulation experiments

Cohort heterogeneity

Cohort declines: changes in wealth and growth

25−32
33−42
43−52
53−62

−0.12
−0.1
−0.08
−0.06
−0.04
−0.02
0
Age in 2007

Decline (2010)
data
baseline
growth+wealth

25−32 33−42 43−52 53−62
−0.35
−0.3
−0.25
−0.2
−0.15
−0.1
−0.05
0
Age in 2007

Val | adjust
Decline (2010)

Attanasio & al. (UCL & IFS)
Consumption and the Great Recession

NBER SI 2016
Cohort ‘elasticities’: changes in wealth and growth

Attanasio & al. (UCL & IFS)  Consumption and the Great Recession  NBER SI 2016 81 / 84
Simulation experiments  

Cohort heterogeneity

Cohort declines: changes in spread

\[
\begin{array}{ccccc}
25-32 & 33-42 & 43-52 & 53-62 \\
-0.12 & -0.1 & -0.08 & -0.06 & -0.04 & -0.02 & 0 \\
\end{array}
\]

Age in 2007

C

Decline (2010)

Val | adjust

Data
Baseline
Rate

Attanasio & al. (UCL & IFS)

Consumption and the Great Recession

NBER SI 2016 82 / 84
Cohort ‘elasticities’: changes in spread

![Graph showing cohort elasticities over different age groups in 2007.](image)

*Source: Attanasio & al. (UCL & IFS)*
Conclusions

- Used household consumption choices to gain understanding of the sources of the Great Recession
- Car purchases informative about income expectations due to durability and adjustment costs
- Car purchases informative about financial shocks due to availability of car credit
- Constructed rich life-cycle model with multiple sources of income, wealth, and financial shocks
- Long-run risk and wealth shocks appear most important