Credit Shocks and Equilibrium Dynamics in Consumer Durable Goods Markets

Alessandro Gavazza
LSE

Andrea Lanteri
Duke University

NYU Macro Lunch
November 2019

Motivation

- Understanding the dynamics of durable purchases is an important question in macro, because of their high volatility over the cycle.
- Recent focus on household heterogeneity and durables *illiquidity* (fixed costs) to understand the response of consumption to shocks/policy (e.g. Berger and Vavra, 2015; Kaplan and Violante, 2014).
- What is the role of equilibrium dynamics in secondary markets for the response of consumer durables to macro shocks?
- We focus on car markets around the Great Recession (figure).

This paper

- Empirical evidence: Aggregate data, micro data on car prices (NADA) and on consumer expenditures (CEX) around the Great Recession
  - decrease in scrappage, replacement of used cars, purchases of new cars
  - increase in replacement cost, driven by fall in used prices
- Model: Quantitative incomplete-markets framework
  - durable good with a quality ladder
  - equilibrium in secondary markets and endogenous scrappage
  - effects of macroeconomic shocks (credit tightening) and targeted fiscal stimulus

The market for used cars

Why does it matter for aggregates?

- Large: in the U.S. there are three transactions for each new car sale. Replacement accounts for over half of new sales.
- Equilibrium effects on new sales: many agents are on both sides of markets.
- Replacement decisions are key to understand the effects of targeted stimulus policies ("Cash for clunkers").

Mechanism

Wealthier households tend to own newer cars. When their cars depreciate, they sell them as used and buy newer ones.

Poorer households tend to own older cars. When their cars depreciate, they scrap them and replace them.

Tighter borrowing limit $\Rightarrow$ borrowers postpone scrappage $\Rightarrow$ fall in demand for used cars $\Rightarrow$ used-car prices $\downarrow$ $\Rightarrow$ wealthy agents postpone replacement $\Rightarrow$ new purchases $\downarrow$

Related literature

- Macro models of durables with heterogeneous agents: Berger and Vavra (2015), Guerrieri and Lorenzoni (2017), Favilukis et al. (2017), Garriga and Hedlund (2017), Huo and Ríos-Rull (2016), Kaplan and Violante (2014), Leahy and Zeira (2005).
- Durable/machine replacement: Adda and Cooper (2000), Cooper and Haltiwanger (1993), Cooper et al. (1999), Gavazza et al. (2014), Rust (1985), Stolyarov (2002).

Outline

- Data and empirical patterns
- Model
- Calibration
- Quantitative analysis
  - Credit shock and endogenous illiquidity
  - Aggregate income shock
  - Cars as collateral
  - Policy: replacement subsidy

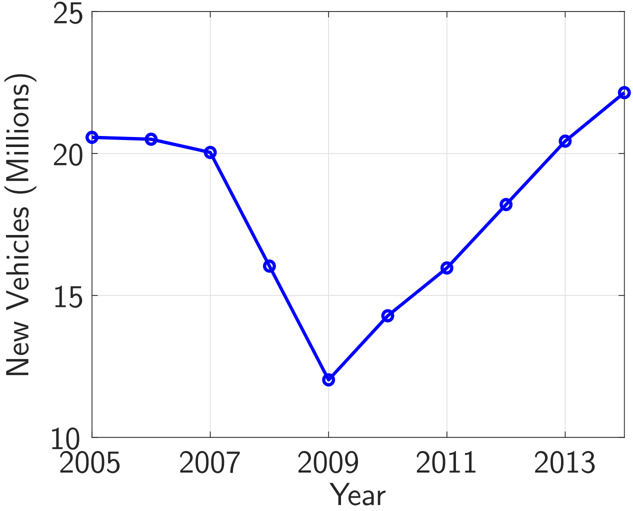
Section 1

Data

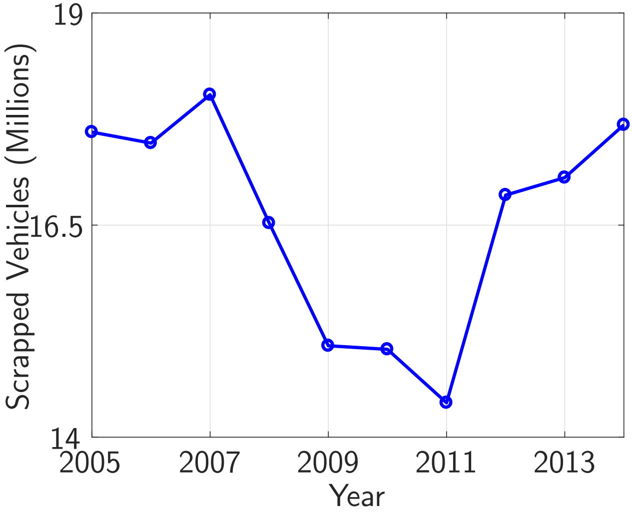
Data and summary of key facts

- Aggregate data: large drop in sales of new vehicles and in scrappage of old vehicles
- NADA (National Automobile Dealers Association) data on prices of new and used vehicles: large drop in used prices
- CEX (Consumer Expenditure Survey): fall in replacement activity

New car sales around the Great Recession



Scrappage


19
16.5
14
2005
2007
2009
2011
2013
Year
Scrapped Vehicles (Millions)

NADA data

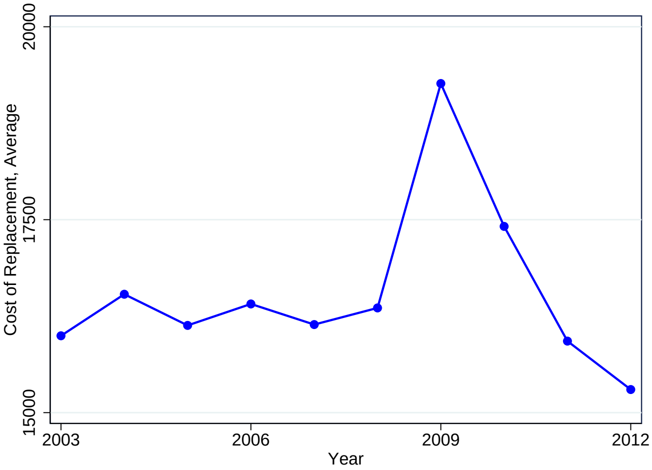
We use NADA (National Automobile Dealers Association) data on car prices, based on transaction records at dealership. Monthly frequency, 2003-2012, 10 US macro-regions. We use July of each year.

For each car model j, age s and year of observation t, we observe

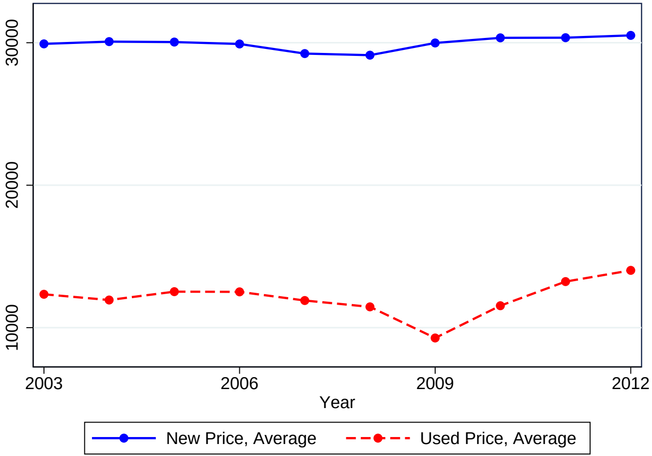
- the typical trade-in price $p_{jst}^{trade-in}$
- the typical retail price p_{jst}^{retail}

We construct the cost of replacement of a S-year old car: $p_{j0t}^{retail} - p_{jSt}^{trade-in}$. Example: 4-year old Toyota Camry (highly traded model).

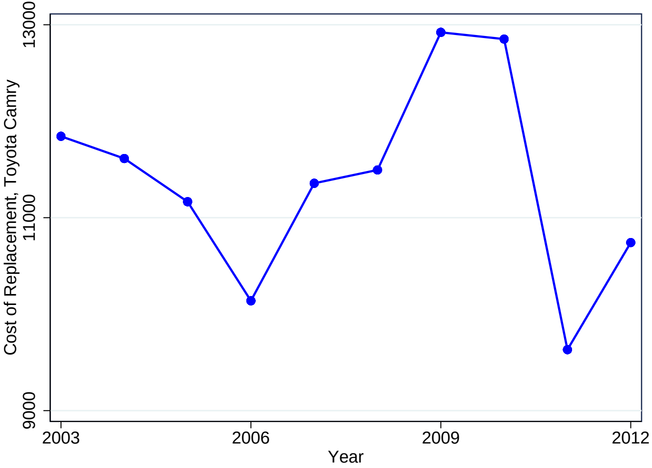
Replacement cost (average car)



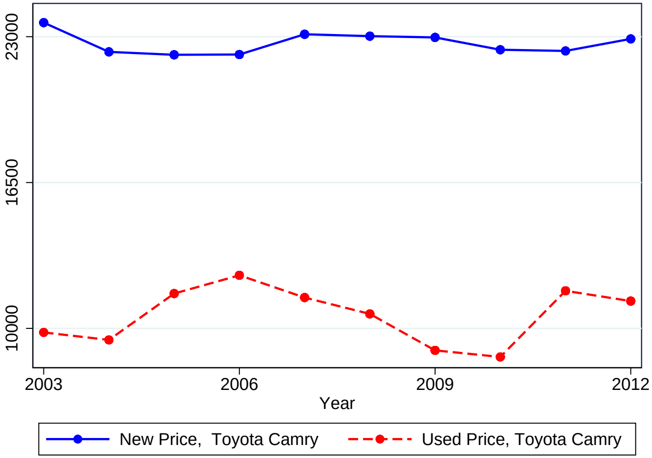
New vs used (average car)



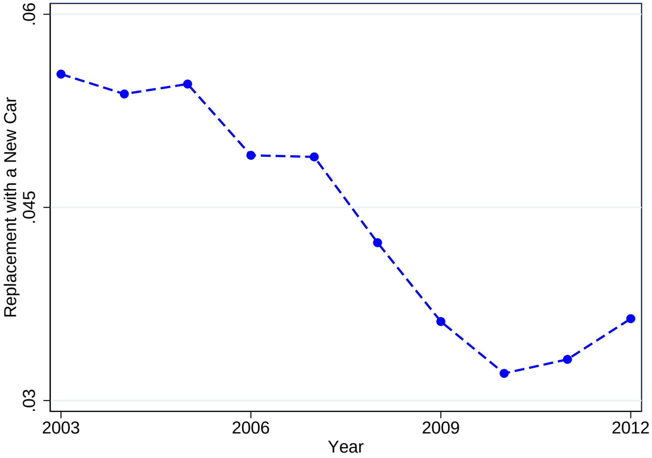
Replacement cost (Toyota Camry)



New vs used (Toyota Camry)



Used replacement in CEX



Section 2

Model

Model ingredients

- Uninsurable income risk generates heterogeneity in wealth $\Rightarrow$ gains from trade
- Durable good with quality ladder (depreciation in utility)
- Traded at equilibrium prices
- Endogenously scrapped

Preferences and car quality

Utility

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(c_{it}^{\alpha} d_{it}^{1-\alpha}\right)^{1-\gamma}}{1-\gamma}$$

with $\alpha, \beta \in (0,1)$ and $\gamma > 0$.

There is a finite number N of car qualities $q_1 > q_2 > .. > q_N$.

Households own one or no car. Utility from car equals car quality or no-car utility type: $d_{it} \in \{q_1, q_2, ..., q_N, \theta_i\}$

Technology

- Stochastic income w_{it} denominated in non-durable good (idiosyncratic shocks).
- New cars are of quality q_1 and are produced using non-durable with linear technology. Price of new cars equals marginal cost p_1.
- Stochastic depreciation: a car of quality q_n becomes of quality q_{n+1} with probability π_n
- All cars can be scrapped to get p_N units of non-durable. Cars of quality q_N must be scrapped.

Markets

- Cars are traded at equilibrium prices p_n, subject to transaction costs $\lambda(p_n)$.
- Households trade non-contingent bonds at price p_b, subject to borrowing constraint $b_{it} \geq \phi$, with debt limit $\phi < 0$.

Government

The government issues a constant level of debt and issues lump-sum taxes to finance it.

$$b_G(1 - p_b) = \tau$$

We also consider a car replacement stimulus policy, similar to "Cash for clunkers".

Dynamic program

Household problem in stationary equilibrium

$$V(b,w,n;\theta)=\max_{c,b',\tilde{n}}\left\{u(c,d(\tilde{n};\theta))+\beta\mathrm{E}\left[V(b',w',n';\theta)|\tilde{n},w\right]\right\}$$

subject to

- $c+p_{\tilde{n}}+p_b b'+\tau=w+p_n-\lambda(p_n)\mathcal{I}(\tilde{n}\neq n)+b$
- $b'\geq\phi$
- stochastic transitions $F_w(w,w')$ and $F_n(\tilde{n},n')$

Policy functions $b'=g_b(b,w,n;\theta)$ and $\tilde{n}=g_n(b,w,n;\theta)$

Market clearing

Distribution of households over states $m(b, w, n; \theta)$.

- Cars of quality q_1:

$$\int \mathcal{I}(g_n(b, w, n; \theta) = 1) dm(b, w, n; \theta) = \int dm(b, w, 1; \theta) + x$$

  where x is production of new cars.

- Cars of quality $q_{\bar{n}}$, for $\bar{n} = 2, .., N - 1$:

$$\int \mathcal{I}(g_n(b, w, n; \theta) = \bar{n}) dm(b, w, n; \theta) \leq \int dm(b, w, \bar{n}; \theta).$$

  with $=$ sign, or $p_{\bar{n}} = p_N$

- Bonds: $\int g_b(b, w, n; \theta) dm(b, w, n; \theta) = b_G$.

Stationary equilibrium

Stationary equilibrium:

- value function V and decision rules g_b, g_n for bonds and cars,
- distribution of agents m,
- prices p_b, p_n for $n = 2, .., N - 1$,

such that

- individual optimality,
- bond market and car markets clear,
- m perpetuates itself given decision rules, income shocks and depreciation transitions.

Section 3

Quantitative Analysis

Calibration strategy

Four sets of parameters.

- Preferences: a period is a year and we match vehicles expenditure share.
- Income shocks: we match income persistence and volatility in PSID.
- Bonds and borrowing limit: we let $\phi =$ average yearly income and match liquid wealth/GDP from Flow of Funds.
- Cars:
  - Qualities and depreciation. We set $N = 4$ for computational feasibility and then match empirical price depreciation schedule and scrappage frequencies.
  - Transaction costs. We parametrize $\lambda(p_n) = \lambda_0 + \lambda_1 p_n$ and use the difference between retail and trade-in prices to estimate λ_0, λ_1.

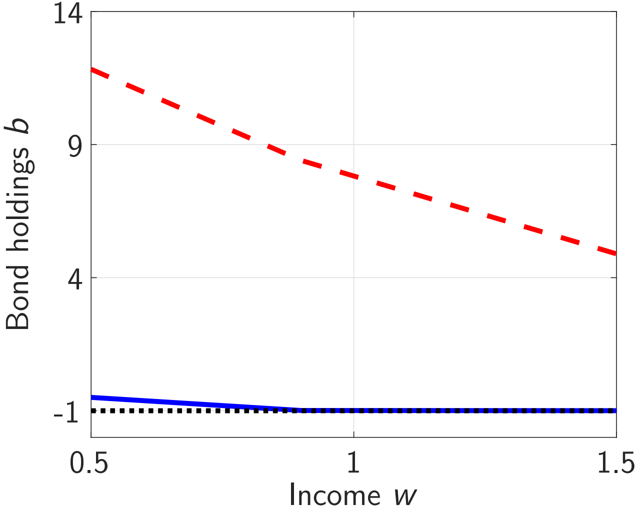
Parameter values

Parameter	Value	Parameter	Value
α	.95	π_3	$1/2$
β	.945	q_1	1
γ	2	q_2	.3
ρ	.9	q_3	.1
σ	.2	θ	$\in \{0, 1\}$
ϕ	-1	p_1	.45
b_G	1.5	p_4	.036
π_1	$1/3$	λ_0	.03
π_2	$1/10$	λ_1	.15

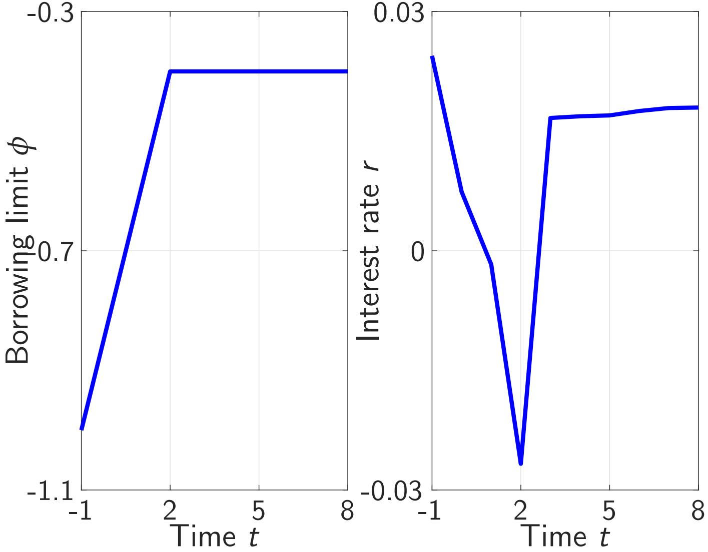
Solution method

- Stationary Equilibrium: standard
- Aggregate shocks: we consider unexpected ("MIT") shocks and compute the transitional dynamics iterating between sequences of decision rules and sequences of market-clearing prices
- Key challenge: market clearing in presence of discrete choices and heterogeneous agents. Excess demand is a step function.
- Contribution: We propose a smoothing method that involves shifting masses of agents close to the thresholds for the discrete choice in order to achieve exact market clearing. Widely applicable, e.g. incomplete-markets models with labor participation.

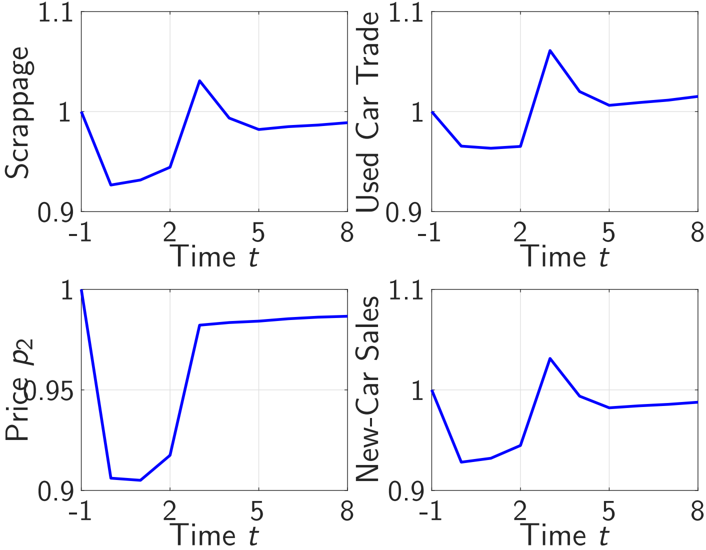
Replacement thresholds



Credit shock and interest rate



Credit shock and car markets



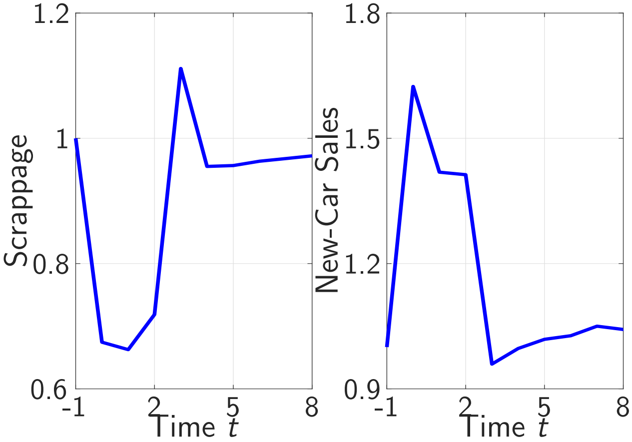
Endogenous illiquidity: two counterfactuals

We leverage our framework with an equilibrium notion of durables "illiquidity" to address two questions:

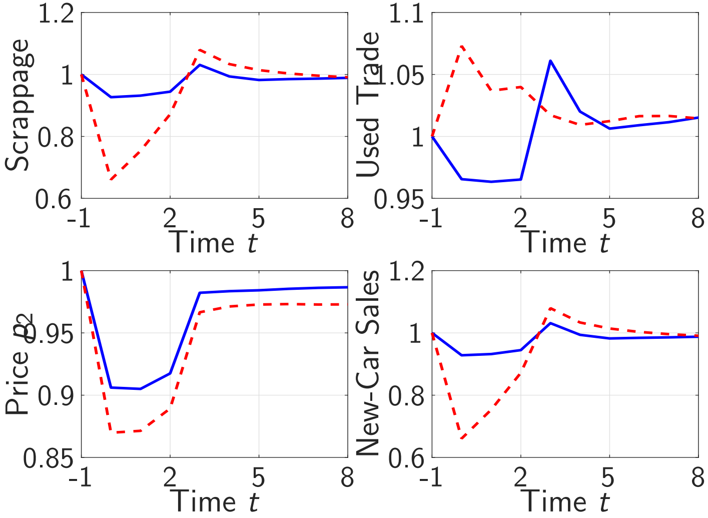
- What would have happened in absence of secondary-market clearing?
- What would have happened in absence of trading costs?

The role of equilibrium in secondary markets

In absence of used-car market clearing, positive durable investment response and strong negative comovement of new production and scrappage.



The role of trading costs

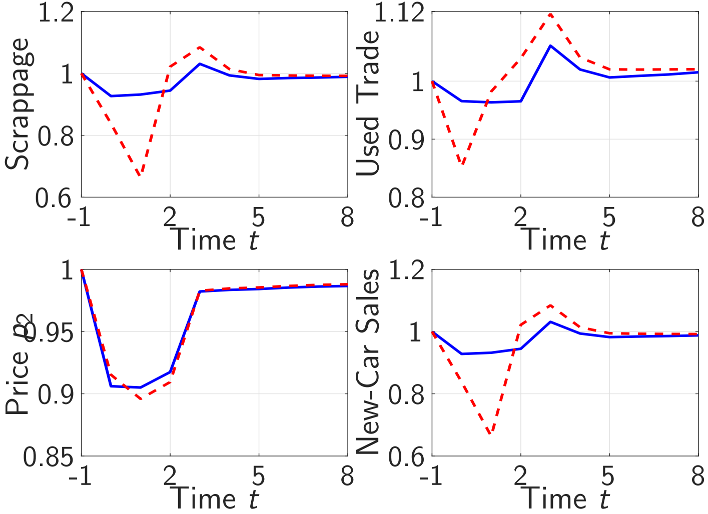


Solid line: baseline; dashed line: counterfactual with no trading costs.

Further analyses

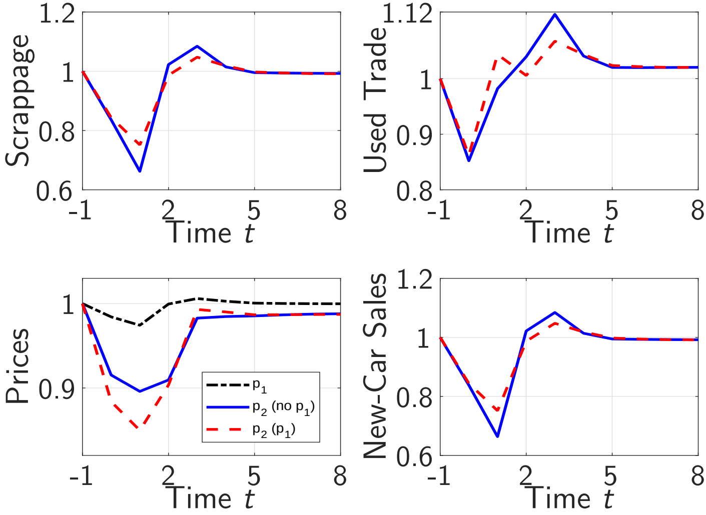
- Aggregate income shock
- Cars as collateral for car loans
- Fiscal stimulus: car replacement subsidies

Credit and income shock



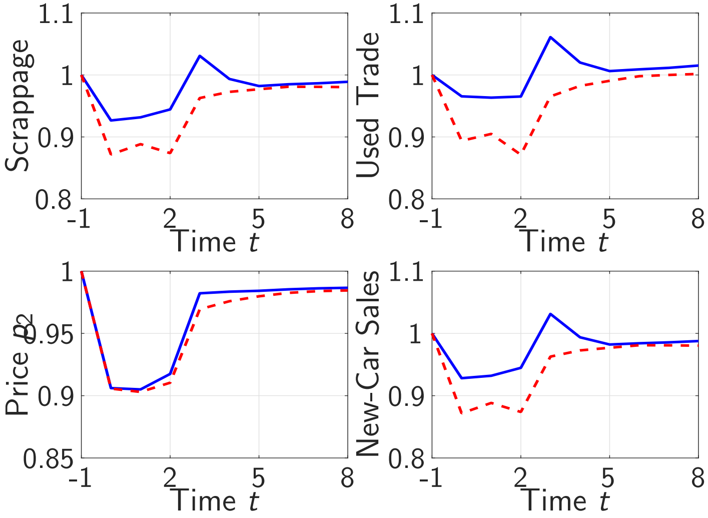
Solid line: baseline; dashed line: aggregate income and credit shock.

Endogenous p_1: $p_{1,t} = c_0 + c_1(x_t - x_{ss})$



Solid line: constant p_1; dashed line: endogenous p_1.

Collateral constraint: $b' \geq \phi\left(\chi_0 + \chi_1 \mathrm{E}_t\left[p_{n'} | \tilde{n}\right]\right)$



Solid line: baseline; dashed line: collateral.

Replacement subsidy

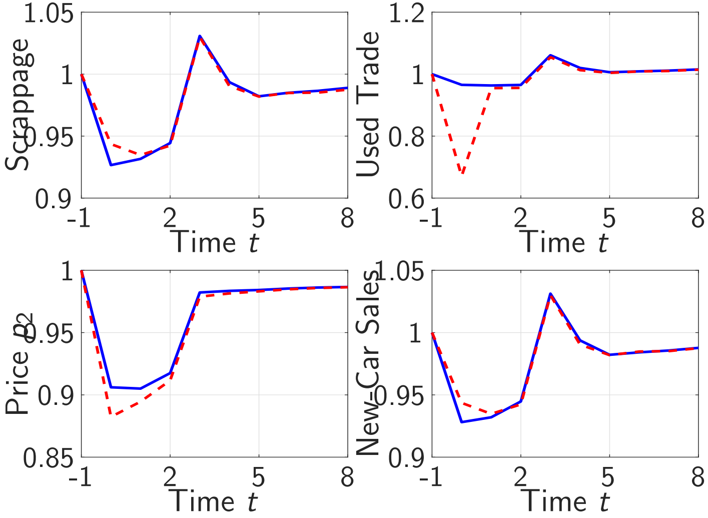
- When the credit shock hits, the government pays s to each household that replaces a car of quality q_3 with a car of quality q_1.
- The stimulus is deficit-financed and the government gradually increases taxes after 10 years to repay the additional debt issued.
- Budget constraints

$$b_{G0} + s \int \mathcal{I}(g_n(b, w, 3; \theta) = 1) dm(b, w, 3; \theta) = \tau_0 + p_{b0} b_{G1}$$

$$b_{Gt} = \tau_t + p_{bt} b_{G,t+1}$$

with $\tau_t = \tau_t^{baseline}$ for $t < 10$ and
$\tau_t = \tau_t^{baseline} + \psi(b_{Gt} - b_{G0})$, $\psi > 0$ for $t \geq 10$.

Replacement subsidy



Solid line: baseline; dashed line: replacement subsidy.

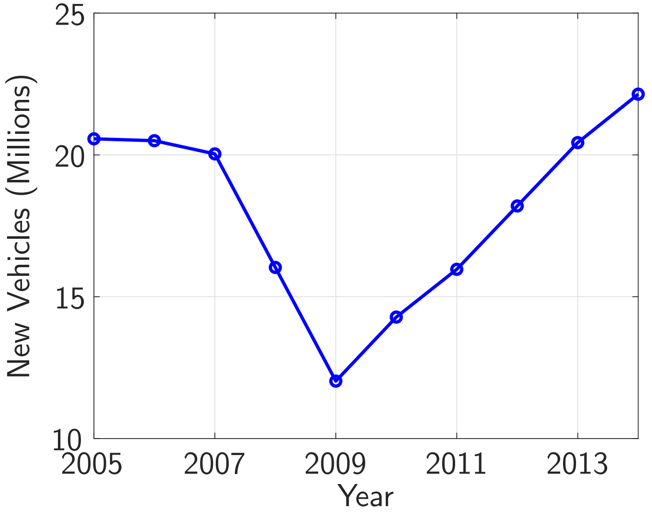
Conclusion

- We use micro data to document dynamics in car markets around the Great Recession
- We build a GE framework with secondary markets that can account for these facts
- Equilibrium in secondary markets is key to understand the aggregate response of new durables to a credit crisis
- Natural framework to analyze stimulus policies such as "Cash for Clunkers": we highlight a new channel, namely substitution away from used market

Section 4

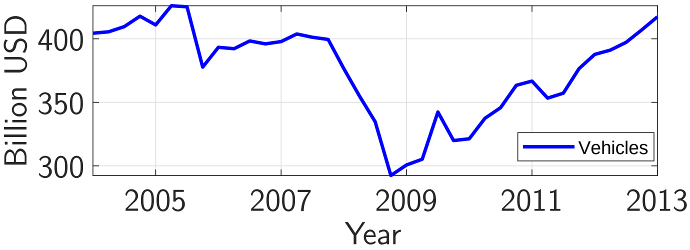
Extra

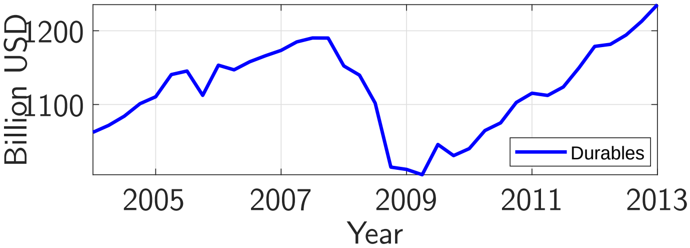
New car sales around the Great Recession



(back)

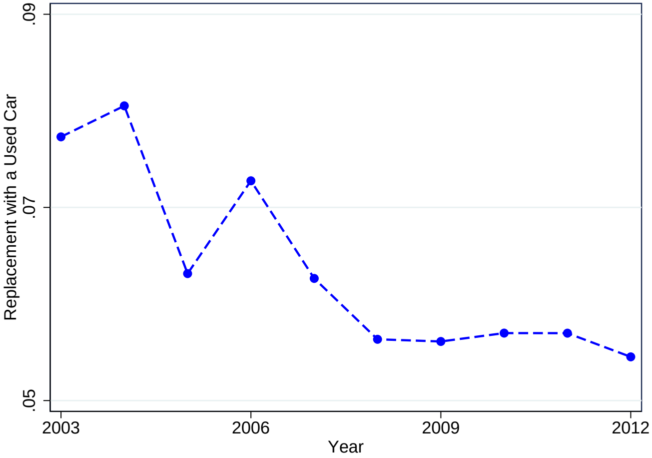
Consumer Expenditures on Durables



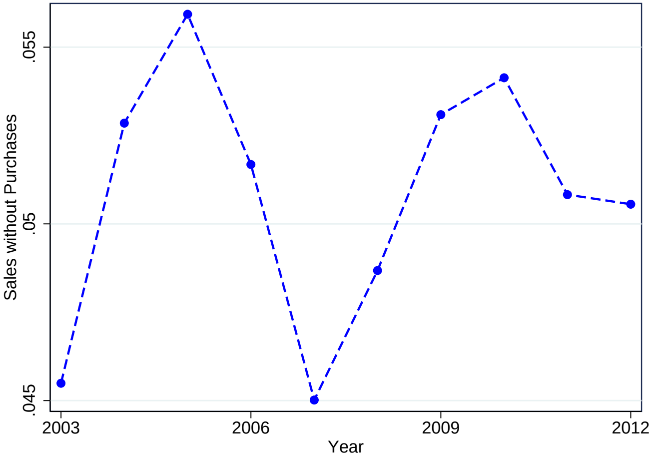


(back)

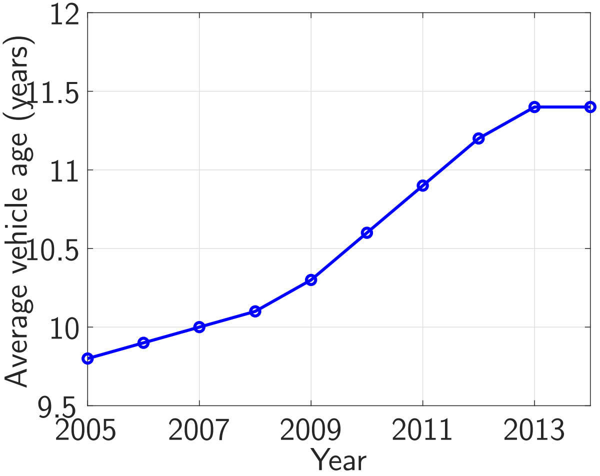
Used-to-used



Used disposal

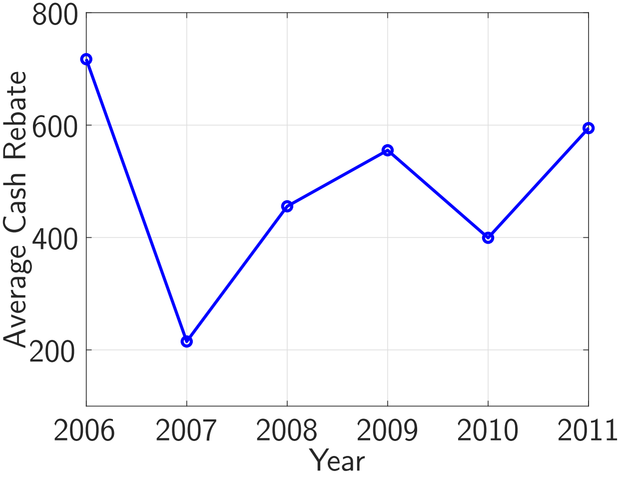


Aging stock

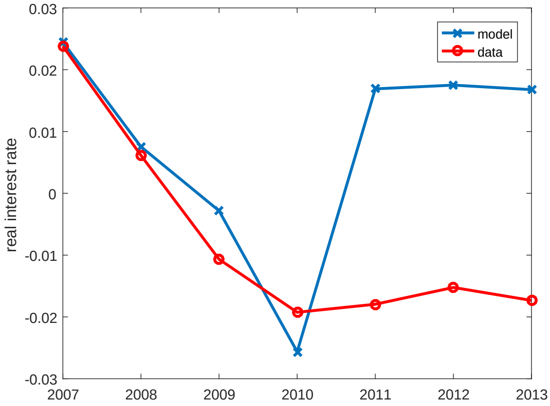


12
11.5
11
10.5
10
9.5
Average vehicle age (years)
2005
2007
2009
2011
2013
Year

WARDS Rebates



Calibrating the credit shock



Aggregate dynamics: solution method

Starting from stationary equilibrium, we consider an unexpected change in ϕ and compute the transitional dynamics that follow.

Assuming convergence to stationary equilibrium at T large, we need to solve for sequences of

- prices $\{p_{bt}, p_{nt}\}_0^T$
- distributions of agents $\{m_t\}_0^T$

We adapt a method described by Ríos-Rull (1998) that iterates to find a fixed point of the mapping from price sequences to sequences of distributions.

User Cost Interpretation

The user cost of an upgrade from q_2 to q_1 is

$$\gamma \equiv p_1 - p_2(1-\lambda) - \frac{1}{1+r}\left[(1-\pi_1)p_1(1-\lambda) + \pi_1 p_2'(1-\lambda) - p_2'\right]$$

To quantify the importance of a decline in used-car prices for the user cost, we can compute the counterfactual increase in r that would give the same increase in γ:

- 1% decline in p_2 and p_2': 37 basis points.
- 1% decline in p_2 only: 212 basis points.