The Evolution of Market Power in the US Auto Industry

Paul L. E. Grieco — Penn State
Charles Murry — Boston College
Ali Yurukoglu — Stanford GSB

Research Questions

How did market power and consumer welfare evolve in the US auto industry from 1980-2018?

How is this related to

- prices and costs,
- concentration,
- innovation,
- product proliferation and differentiation,
- import penetration,
- and demographics?

Approach

1. Estimate rich product-level demand system.
   - Identify heterogeneity using microdata to *measure substitution patterns*.
   - Cost shifter IV to *measure price sensitivity*: real exchange rates.

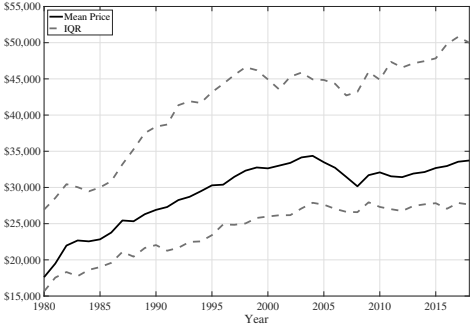
   Outcome: elasticities & consumer welfare.

2. Assume firm conduct to *infer marginal costs*.
   - Static Nash-Bertrand by manufacturers.

   Outcome: marginal costs, markups, total surplus.

Main Findings I

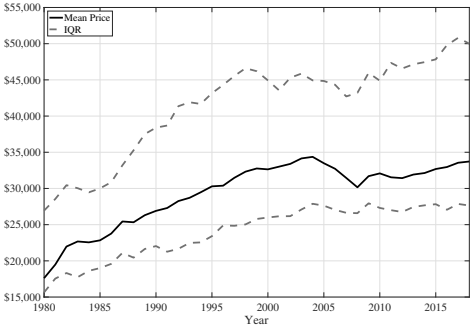
Prices rise. Bad?

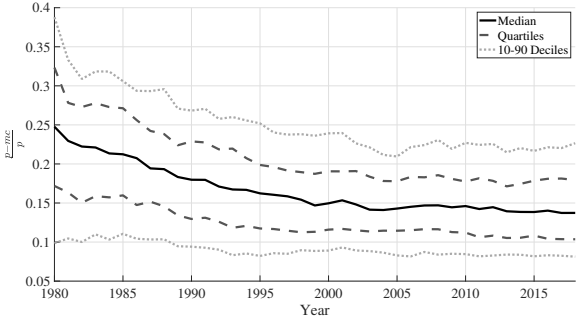


Main Findings I

Prices rise. Bad?

But markups decrease. So, good?





Main Findings II

Why care about long-term trends in markups?

Fixed choice set intuition:

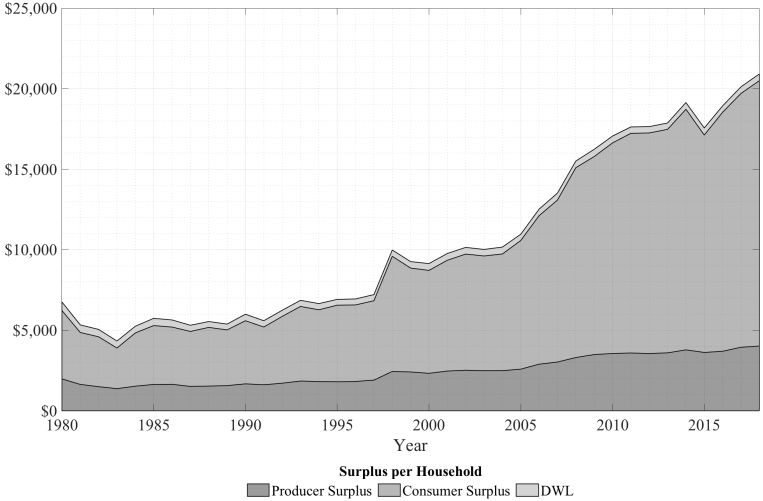
$$\text{markups} \uparrow, \implies \text{consumer welfare} \downarrow.$$

When products are change this no longer holds.

Comparing markups **over time** has similar pitfalls as comparing markups/prices/etc **across industries** [Demsetz, 1973].

Main Findings II

So we look at **Consumer Surplus** directly:



Main Findings III

Why does Consumer Surplus increase?

1. Mostly due to the increase in the **number** and **quality** of products.

2. Other negligible factors:
   - lower costs;
   - less concentrated ownership.

Big Picture

A long-term perspective on market power.

Empirical IO has tended (with exceptions) to focus on cross-sectional data or short panels.

Useful to have a **long-run view of how industries perform** to evaluate antitrust, trade, and regulatory policy.

Using well known tools, we can measure **markups, welfare, and tech. progress** over time.

- We have the tools. The hard part is the data.

Alternative approaches

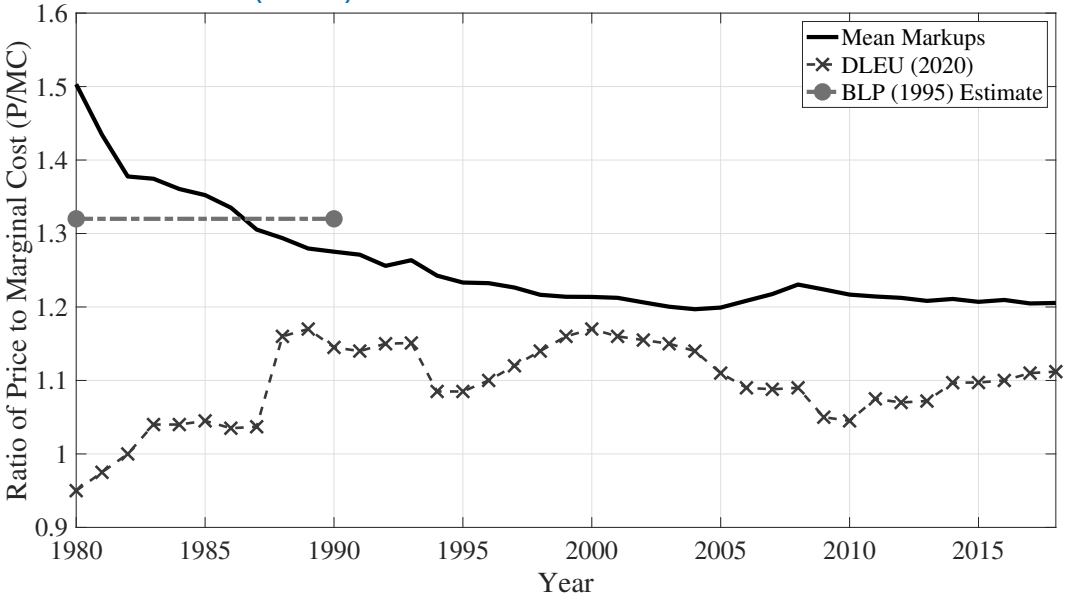
Recent focus on long run trajectory of **markups** and concentration.

De Loecker, Eeckhout and Unger (2020) estimate a long panel of markups using "production function approach".

- No conduct assumption.
- No consumer welfare.
- Firm level, not product level

Both methods have different data requirement and make different, potentially strong, assumptions.

Contrast to DLEU (2020)



Why US Automobiles?

Important industry...

Oligopoly with large fixed costs – prime suspect for worrying about market power.

Major durable goods industry: $\approx 3.5\%$ of consumer expenditure.

Well studied in IO: BLP95, Goldberg95, BLP99, Petrin02, BLP05, etc.

Why US Automobiles?

...with lots of changes over time

Iconic shift from "What is good our country is good for General Motors." to "Government Motors."

Developments in last 40 years:

- import penetration from Japan and Korea;
- outsourcing to Canada and Mexico enabled by NAFTA;
- significant technological progress;
- decline of sedan, rise and fall of minivan, rise of SUV.
- EVs...

Data and Industry Trends

Data Construction (1/2)

Market: Entire USA, yearly for 1980-2018.

Source 1. "Macrodata" from Wards Auto Yearbooks.

- Model-level sales, MSRP and characteristics.

Source 2. "Microdata:" Demographics
CEX (500 cars/yr, 1983-2004) and GfK MRI Survey (2000 cars/yr, 1994-2017)

- Survey respondents report car make/model purchased, price, and demographics.

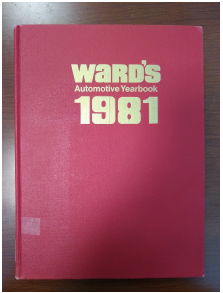
Source 3. "Microdata:" Second-choices
MaritzCX (1991, 1999, 2005, 2015) survey.

- Survey respondents report alternative cars considered.

Additional Sources
Production location, model redesigns, EV characteristics, misc missing information.

Data Construction (2/2)

We aggregate “trims” to “models” by taking the median characteristics of each model across trims.



Issues to consider

- Sales year v. model year issues.
- Within year entry and exit of models.

’86 Model U.S. Car Factory List Prices by Makes,

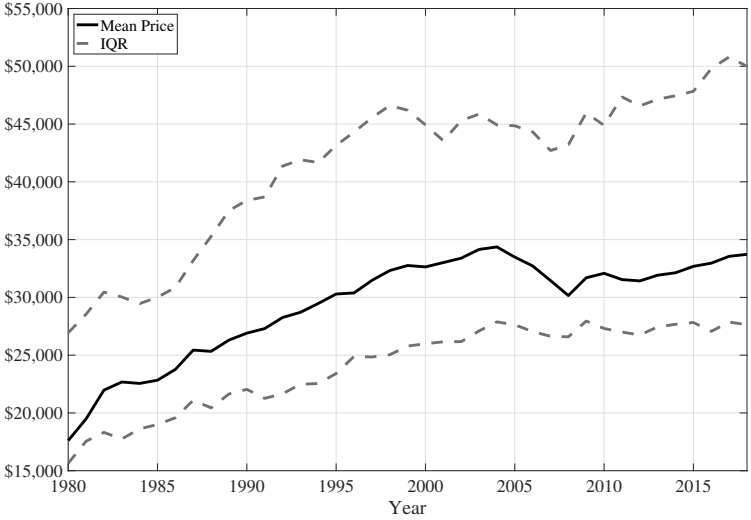
MAKES AND SERIES	SEDANS 2-door	SEDANS 4-door	HARDTOPS 2-door	HATCHBACKS 2-door	HATCHBACKS 4-door	CONV. 2-door	WAGON	SELECTED OPTIONS A/Trans.	A/c	4/Cyl.Eng.	Tilt	Rr.Defog.
CHEVROLET DIV.												
Chevette CS 4	—	—	—	$5,935	$6,249	—	—	$425	$645	—	$115	$135
Chevette CS 4D	—	—	—	6,442	6,777	—	—	—	—	—	115	135
Cavalier 4	$7,076	$7,258	—	—	—	—	$7,417	465	645	$175	115	135
Cavalier 6	7,586	7,868	—	—	—	—	8,027	465	645	175	115	135
Cavalier CS 4	—	7,720	—	7,143	—	—	7,895	465	645	175	115	135
Cavalier CS 6	—	8,330	—	8,353	—	—	8,505	465	645	175	115	135
Cavalier RS 4	8,010	8,181	—	8,200	—	$12,900	8,349	465	645	175	115	135
Cavalier RS 6	8,620	8,791	—	8,810	—	13,510	8,959	465	645	175	115	135
Cavalier Z24 6	9,248	—	—	9,438	—	—	—	465	645	175	115	135
Nova 4	—	7,725	—	—	7,959	—	—	*	*	*	*	*
Camaro Sport Cpe. 4	—	—	—	9,349	—	—	—	465	750	175	115	145
Camaro Sport Cpe. 6	—	—	—	9,699	—	—	—	465	750	175	115	145
Camaro Sport Cpe. 8	—	—	—	10,099	—	—	—	465	750	175	115	145
Camaro Berlinetta 6	—	—	—	12,316	—	—	—	465	750	185	115	145
Camaro Berlinetta 8	—	—	—	12,716	—	—	—	465	750	185	115	145
Camaro Z28 8	—	—	—	12,316	—	—	—	465	750	175	115	145
Celebrity 4	9,149	9,345	—	—	—	—	9,495	490	750	175	115	145
Celebrity 6	9,584	9,780	—	—	—	—	9,930	490	750	175	115	145
Monte Carlo 6	—	—	$10,655	—	—	—	—	STD	750	175	115	145
Monte Carlo 8	—	—	11,045	—	—	—	—	STD	750	175	115	145
Monte Carlo SS 8	—	—	12,880	—	—	—	—	STD	750	175	115	145
Caprice 6	—	—	10,719	—	—	—	—	STD	750	175	115	145
Caprice 8	—	—	11,108	—	—	—	—	STD	750	175	115	145
Caprice Classic 6	11,110	11,270	—	—	—	—	—	STD	750	175	115	145
Caprice Classic 8	11,500	11,660	—	—	—	—	11,986	STD	750	175	115	145
Caprice Classic Brougham 8	—	11,904	—	—	—	—	—	STD	750	175	115	145
Corvette 8	—	—	—	27,502	—	—	—	STD	STD	185	STD	165

Aggregate Trends

1. Rising prices.
2. Decreasing concentration.
3. Increasing car quality.

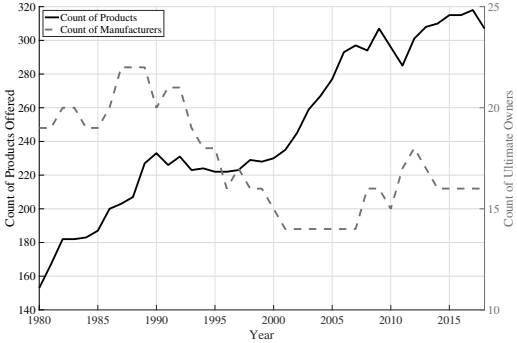
Prices Rising

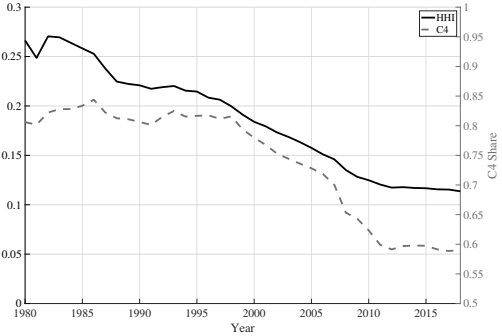
Real 2015 US$



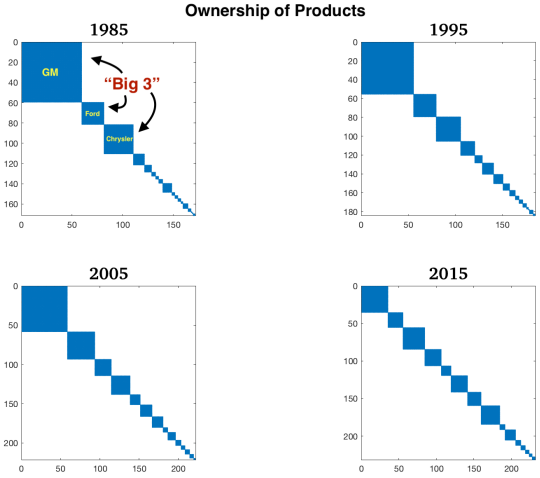
Concentration

Fewer firms, but lower HHI,

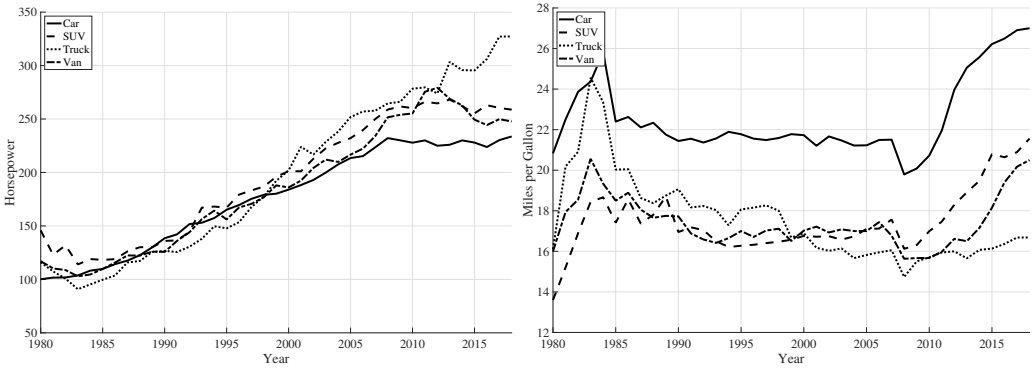




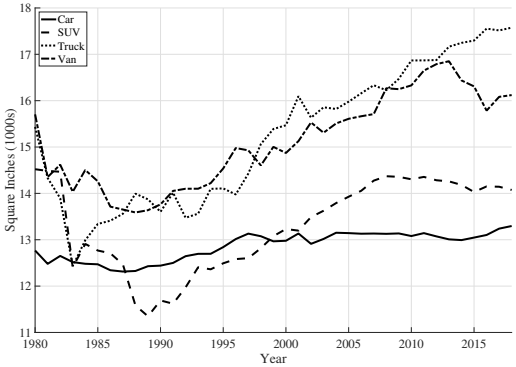
Product Portfolios of Manufacturers

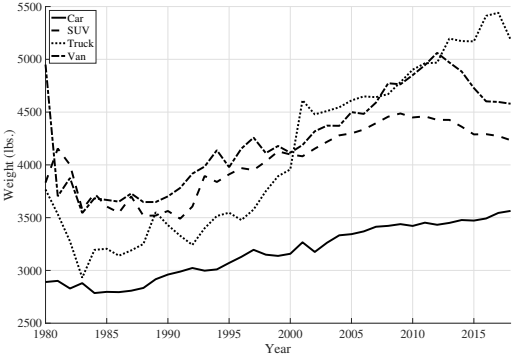


Power ↑ with same fuel efficiency, Knittel (2011).

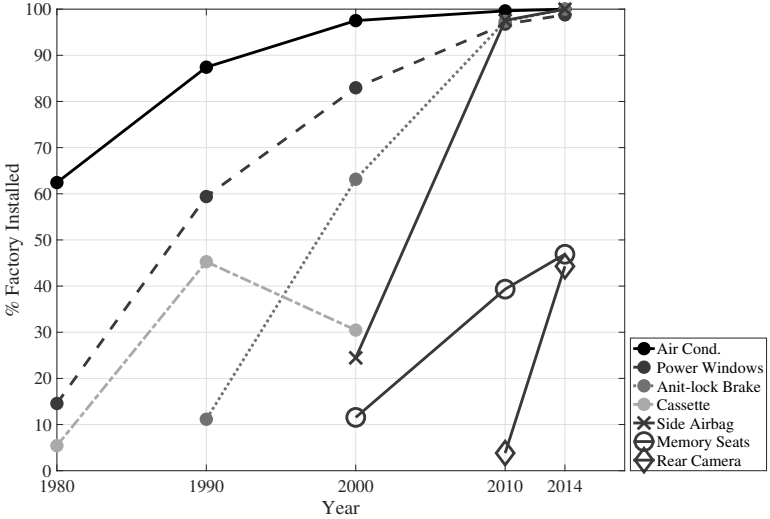


Vehicles are getting bigger and heavier...





Other quality improvements...



Empirical Strategy

Model Overview

Demand: Differentiated product discrete choice.

- Observed and unobserved taste heterogeneity $\rightarrow$ flexible product substitution.
- Price variation from real exchange rate of assembly country. (Cost shifter IV.)

Supply: Multiproduct Nash-Bertrand equilibrium

- "Back out" implied marginal costs.
- Conduct assumption not imposed during demand estimation (incl. cost, not competition-based IV).

Model Specification (1/2)

Demand

Each year (t), households (i) make a discrete choice over the available vehicle models (j) and outside option.

$$u_{ij} = \beta_i x_{jt} + \alpha_i p_{jt} + \xi_{jt} + \epsilon_{ijt}.$$

Supply

Each year: static, simultaneous, Nash Eq. in prices.

$$\text{Price FOC:} \quad q_j + \sum_{k \in \mathcal{J}_t^m} (p_j - c_j) \frac{\partial q_j}{\partial p_k} = 0$$

Model Specification (2/2)

Car Characteristics

Horsepower, miles per $, weight, width, height, style ("car," truck, SUV, van), new/refresh design (refresh), make dummy.

Observed Heterogeneity

- Price: income, age.
- Footprint (length $\times$ width): family size dummies.
- SUV, Truck: family size, rural.
- Outside option: income.

Unobserved Heterogeneity

- SUV, van, truck
- luxury, sport, US brand, European brand
- horsepower, miles per $, footprint, electric motor

Identification Overview

1. Price elasticity: real exchange rate IV.

2. Observed heterogeneity: CPS/MRI microdata moments, e.g.,

$$E[\text{footprint}_{j(i)} | \text{family size}_i]$$

3. Unobserved heterogeneity: Marritz second choice moments, e.g,

$$Corr[\text{footprint}^1_{j(i,1)}, \text{footprint}^2_{j(i,2)}]$$

where $\text{footprint}_{j(i,c)}$ is the characteristic of consumer i's cth choice product.

IV for Price: Real Exchange Rate

$$RXR_{jt} = \frac{PPP_{jt}}{e_{jt}} = \frac{\text{ratio of price levels}}{\text{nominal exchange rate}}$$

lagged *pl_con* from the Penn World Table.

RXR_{jt} varies when

- PPP changes (eg local labor costs),
- nomial exchange rates change (used in Goldberg and Verboven, 2001)
- BLP (1999) uses e and and measure of local wages.

Examples

- If wages rise in Japan then cost in yen goes up, RXR goes up, and Toyota should raise prices in the US.
- If yen depreciates relative to dollar (e goes up) so one dollar buys more yen, then RXR goes down, and Toyota should lower prices in the US.
- After NAFTA, Ford starts outsourcing Ford Ranger/F-150 production to Mexico.

Positive relationship between RXR and consumer prices in US.

IV Logit Results / First Stage

	First Stage	Reduced Form	Logit Demand OLS	Logit Demand IV
Real XR*	4.867 (0.991)	-0.993 (0.285)		
Price			-0.042 (0.005)	-0.204 (0.059)
Characteristics	yes	yes	yes	yes
Make Dummies	yes	yes	yes	yes
Year Dummies	yes	yes	yes	yes
N	9611	9611	9611	9611
Mean Own Price Elas.	–	–	-1.50	-7.34
*Implied XR Pass-through	0.146	–	–	–
First Stage F-Stat: 24.13				

Note: Standard errors clustered by make.

Micromoments

Observed Heterogeneity

Price X Income

$E[p_{ij*} \mid Inc_i^{Qx}] - E[p_{ij*} \mid Inc_i^{Q1}]$

Price X Age

$E[p_{ij*} \mid Age_i^{60+}] - E[p_{ij*} \mid Age_i^{<30}]$

Car Size X Family Size

$E[CarSize_{ij*} \mid FS_i^{5+}] - E[CarSize_{ij*} \mid FS_i^{1}]$

$E[CarSize_{ij*} \mid FS_i^{3-4}] - E[CarSize_{ij*} \mid FS_i^{1}]$

Unobserved Heterogeneity

$Corr(x_{j(i,1)}, x_{j(i,2)})$

for $x =$ Van, Truck, SUV, HP, Footprint, MP$, Luxury, Sport, EV, USBrand, EuroBrand

Substitution to the Outside Good

Ideally, we would measure substitution to the outside good with second choice moment, but this is not available.

We do allow strength of outside good to vary with income, based on purchase probabilities by income.

Our Strategy

Vary market size definition.

- Option 1: Number of Households
- Option 2: Number of Households scaled by average duration of a new car ownership.
- Include time fixed effects so outside option is year-specific.

Results

Utility Estimates

			Demographic Interactions						
	β	σ	Income	Inc.^{2}	Age	Rural	FS 2	FS 3-4	FS 5+
Price	-3.744	–	0.09	-0.372	1.998	–	–	–	–
	(0.081)		(0.008)	(0.092)	(0.102)				
Van	-7.615	5.434	–	–	–	–	1.581	3.524	5.532
	(0.234)	(0.099)					(0.148)	(0.157)	(0.189)
SUV	0.064	3.622	–	–	–	–	–	–	–
	(0.049)	(0.05)							
Truck	-8.531	6.378	–	–	–	2.96	–	–	–
	(0.286)	(0.19)				(0.308)			
Footprint	–	1.787	–	–	–	–	0.571	0.393	0.63
		(0.043)					(0.077)	(0.072)	(0.091)
Horsepower	0.276	1.364	–	–	–	–	–	–	–
	(0.112)	(0.086)							
Miles/$	-2.673	1.986	–	–	–	–	–	–	–
	(0.087)	(0.074)							
Luxury	–	2.635	–	–	–	–	–	–	–
		(0.026)							
Sport	-2.527	2.596	–	–	–	–	–	–	–
	(0.067)	(0.056)							
Electric	-2.62	3.155	–	–	–	–	–	–	–
	(0.128)	(0.084)							
EuroBrand	–	1.937	–	–	–	–	–	–	–
		(0.029)							
USBrand	–	2.182	–	–	–	–	–	–	–
		(0.032)							
Constant	-14.754	–	0.422	–	–	–	–	–	–
	(4.311)		(0.031)						

Model Fit[1]

Demographics

Name	Data	Model Predicted
Price ($10k)		
Inc. Q5 minus Inc. Q1	0.645	0.495
Inc. Q4 minus Inc. Q1	0.410	0.248
Inc. Q3 minus Inc. Q1	0.166	0.132
Inc. Q2 minus Inc. Q1	0.064	0.062
Rural Households		
Pr(Truck) Urban minus Rural	-0.102	-0.103
Car Size (log inches, LxW)		
Fam. Size 2 - Fam. Size 1	0.175	0.191
Fam. Size 3/4 - Fam. Size 1	0.174	0.163
Fam. Size 5+ - Fam. Size 1	0.241	0.241

Correlation b/w 1st & 2nd Choice, 2015

Name	Data	Model Predicted
Van	0.69	0.67
SUV	0.65	0.63
Truck	0.87	0.82
logSize	0.77	0.71
Horsepower	0.65	0.63
MP$	0.56	0.66
Luxury	0.55	0.46
Sport	0.34	0.29
EV	0.36	0.36
Euro. Brand	0.41	0.37
US Brand	0.47	0.48

[1] Older Version of Estimates

Model Predicted Substitution[2]

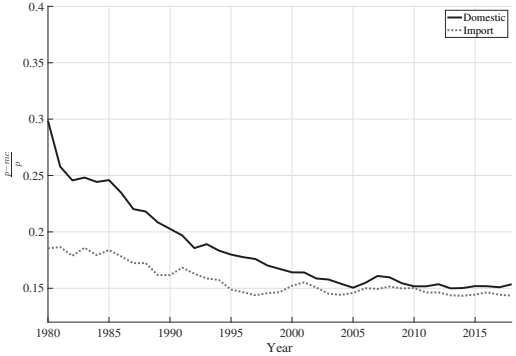
First Choice	First most popular second choice		Second most popular second choice	
Trucks				
ford f series	chevrolet silverado	33.6%	ram pickup	24.3%
nissan frontier	ford f series	20.3%	toyota tacoma	19.3%
SUVs				
nissan rogue	honda cr-v	7.5%	toyota rav4	6.9%
ford explorer	ford escape	6.5%	chevrolet equinox	5.9%
fiat 500x	volkswagen tiguan	5.5%	ford escape	5.4%
porsche macan	bmw x5	4.8%	audi q5	3.8%
Vans				
nissan quest	toyota sienna	17.4%	honda odyssey	16.1%
dodge caravan	chrys. town-country	13.1%	honda odyssey	7.4%
Cars				
ford mustang	chevrolet camaro	8.9%	dodge challenger	7.4%
dodge viper	chevrolet corvette	15.0%	tesla model s	9.6%
honda accord	toyota camry	7.3%	toyota corolla	5.9%
bmw 3 series	mercedes c-lass	9.2%	audi a3	3.7%
lexus es350	acura tlx	6.0%	lexus is250/350	5.4%
vw passat	volkswagen jetta	10.4%	ford fusion	3.8%

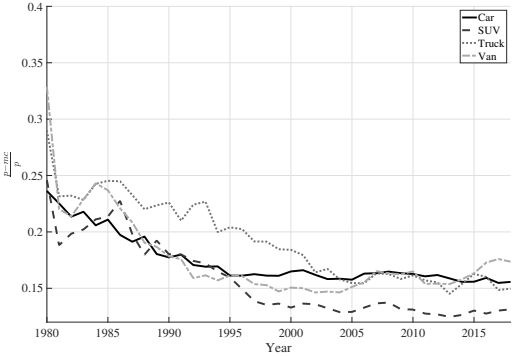
Note: The percent of those consumers switching to an inside good that choose that particular product. For 2015.

[2] Older Version of Estimates

Markups Over Time

(Price - Marg. Cost) / Price





Prices are rising and markups falling. What is going on?

Why do Markups fall?

Single product Bertrand pricing:

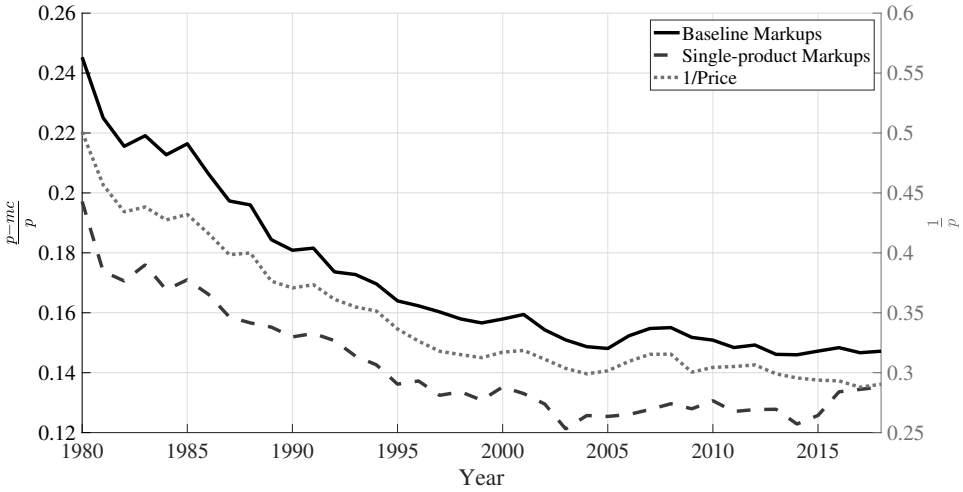
$$\text{Markups} = \frac{1}{\text{elas}} = \frac{s}{p} \times \frac{1}{\frac{ds}{dp}}$$

$\frac{ds}{dp}$: Constant over time.

shares: Constant.

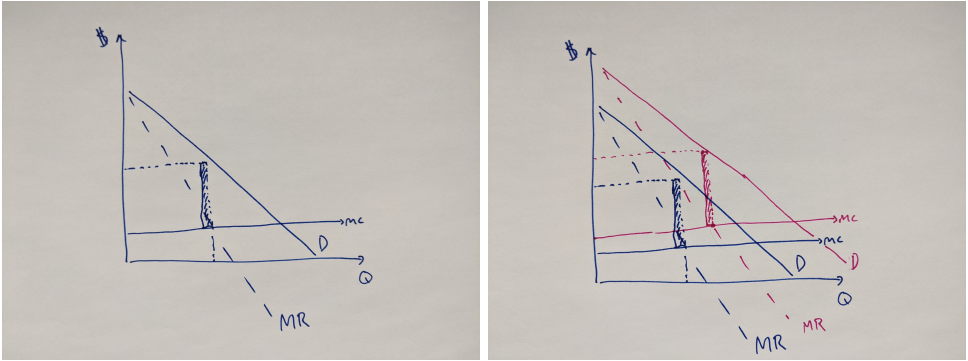
prices: Increasing substantially $\implies$ higher quality.

Why do Markups fall?



Are Markups the Goal?

If products are changing substantially, **markup** is not a conceptually attractive notion of industry efficiency.



Welfare Calculation

Welfare is calculated relative to outside good.

Year dummy captures:

- average quality change over time
- macroeconomic fluctuations

We want welfare trends that account for car quality, but not recessions.

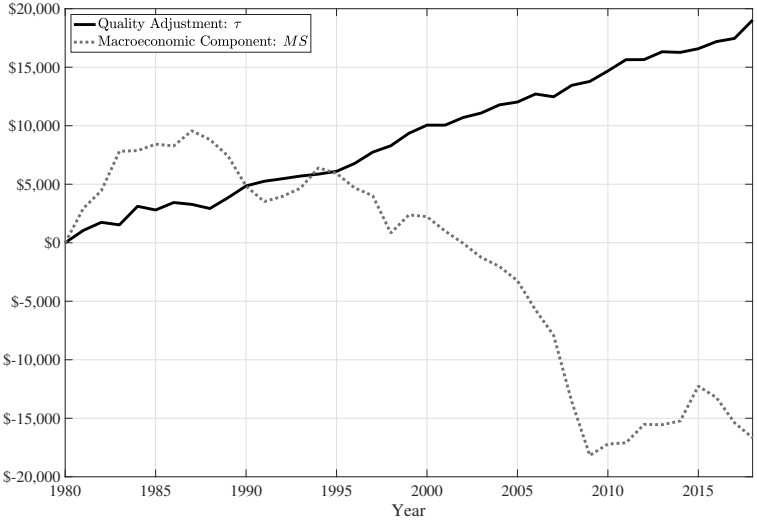
Our strategy: Leverage continuing products

Decompose year effects into mean quality and macro shocks:

- Assume mean utility of continuing projects does not change between t and $t+1$.
- Decline in $E[\xi_t|\text{continuing}]$ represents shift in mean car quality between t and $t+1$.
- Remainder of year effect ascribed to macroeconomic fluctuations.

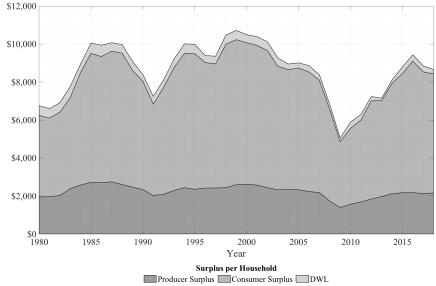
To calculate welfare integrate over macro economic shocks (calculating counterfactual equilibrium) to remove their impact.

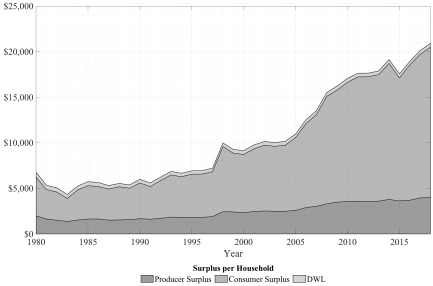
Quality Adjustment



Welfare

Adjustment indicates substantial increase in welfare.





In both cases, bulk of surplus goes to consumers, deadweight loss is small.

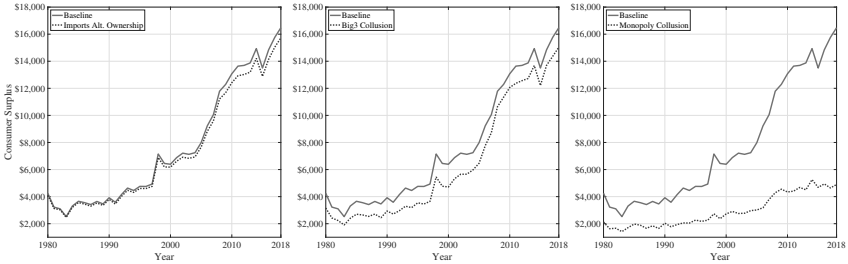
Why is Welfare rising?

What explains the increase in welfare?

1. Manufacturer product ownership.
2. Product offerings [number and quality].
3. Marginal cost efficiencies (in progress).

Thought exercise: what if the trends in these features never happened?

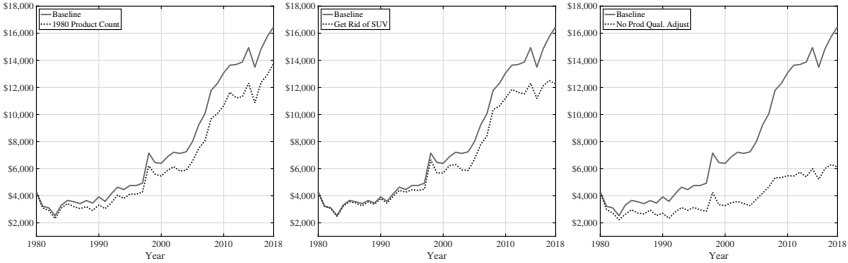
Consumer Surplus varying Market Structure



- Import competition, allowing the big three to collude have limited impact on consumer surplus.

- Full collusion has a large effect.

Consumer Surplus varying Product Set



- Growth in the number of products and SUVs more important than ownership.
- And eliminating product nearly removes the increase.

Conclusion

We (as a field) have the tools to understand rich details about industry evolution.

Measuring welfare is more conceptually attractive than markups if products are changing.

In US automobiles: welfare increases due to more/better products (big) and decreased ownership concentration (small).

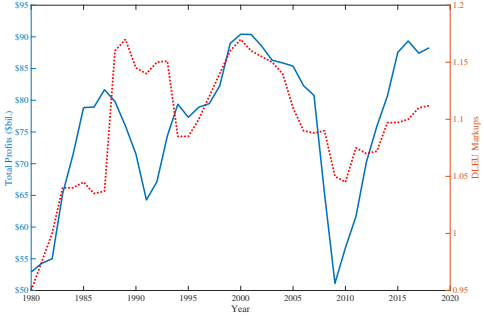
Caveat: We are focusing on price competition, dynamic competitive effects need to be considered.

Comparison to DLEU (2020) [Not in the paper!]

Measurement

- Single markup per firm.
- Changing quality over time?

In the future (speculative)

- Estimate a "single product" model, aggregating our sales/prices.
- Estimate a PF model using our recovered costs.

Our Variable Profits vs DLEU Markups