The Evolution of Market Power in the US Auto Industry

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Research Questions

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

How is this related to changes in

- market structure,
- import penetration,
- product proliferation and differentiation,
- characteristics and marginal costs?

Motivation

Now famous result: economy-wide markups are rising. [DLEU (2020)]

Generated a lot of follow-on research on concentration and competition policy.

Lots of criticism about empirical methods.

Our Contrubution
Provide detailed industry study of market power and industry efficiency using cannonical IO methods.

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.

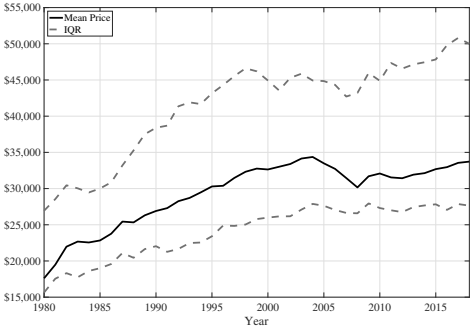
   Outcome: elasticities & consumer welfare.

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

   Outcome: marginal costs, markups, total surplus.

Main Findings I

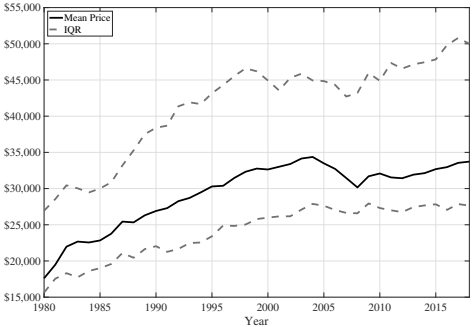
1. Prices rise. Bad?

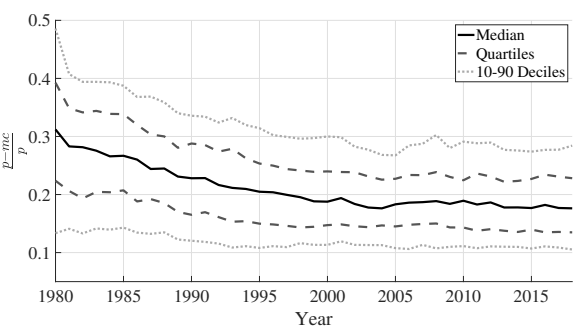


Main Findings I

1. Prices rise. Bad?

2. But markups decrease. Good?





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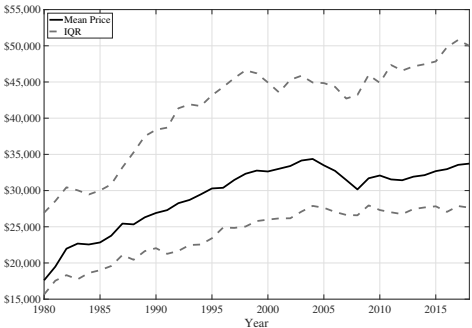
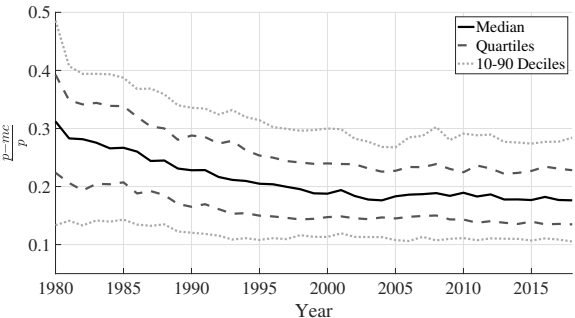
1. Prices rise. Bad?

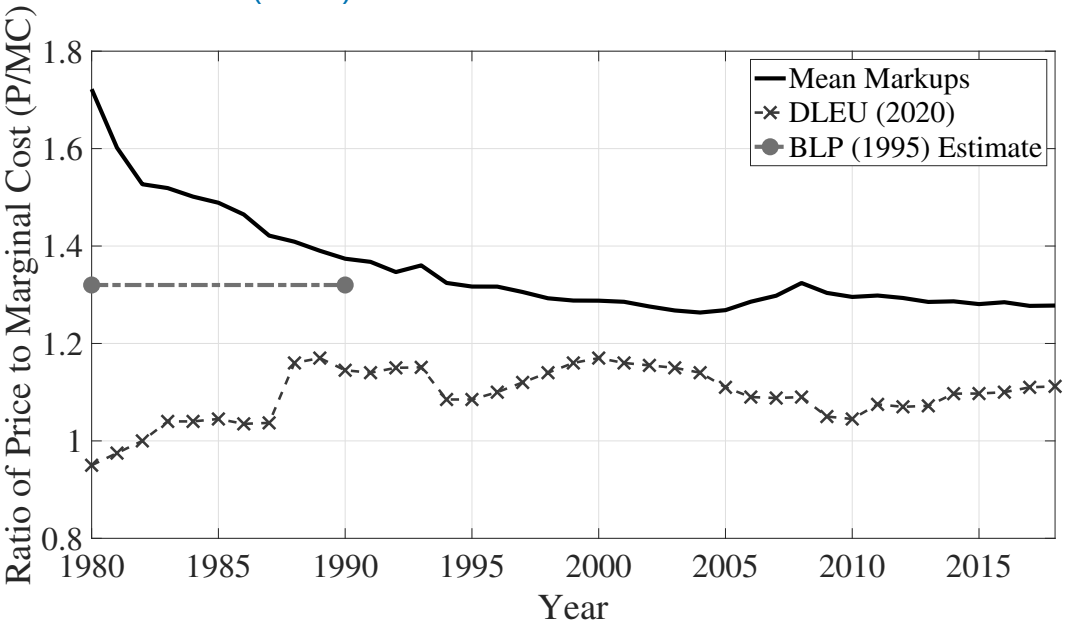
2. But markups decrease. Good?

1 + 2 → Cost rising faster than prices. Bad?





Contrast to DLEU (2020)



Why do we care about long-term trends in markups?

Fixed choice set intuition:

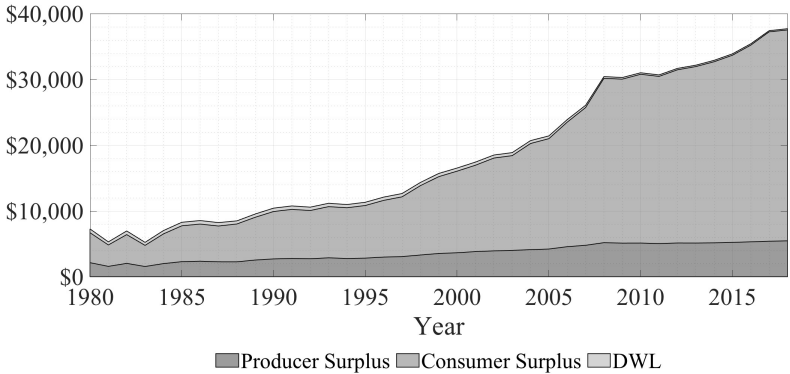
$$\text{markups} \uparrow, \implies \text{consumer welfare} \downarrow.$$

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?

Major factors:

- Product quality (e.g., design, air conditioning, electronics,...).
- Production improvements that lower marginal cost.

Moderate factors:

- Number of products.
- Introduction of SUVs.

Negligible factors:

- Less concentrated market structure (rise of imports);
- Trends in size, weight, horsepower, mpg.

Data and Industry Trends

Markets and Products

Market
Entire USA, yearly for 1980-2018.

Product
Vehicle make/model "owned" by a manufacturer.
Ex: Audi A5 in 2016 from Volkswagen AG.

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

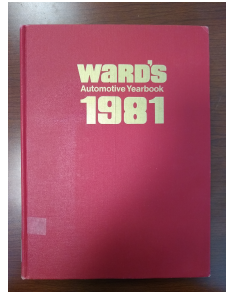
Production location, model redesigns, EV characteristics, misc missing information.

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,

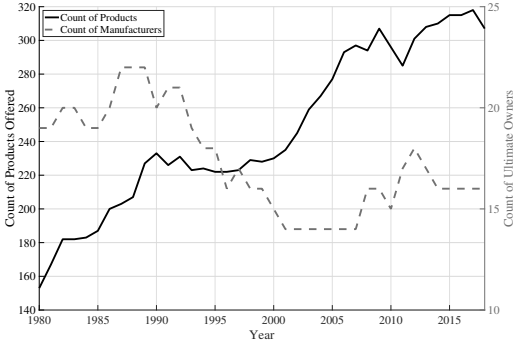
MAKES AND SERIES	SEDANS 2-door	SEDANS 4-door	HARDTOPS 2-door	HATCHBACKS 2-door	HATCHBACKS 4-door	CONV. 2-door	WAGON	SELECTED OPTIONS A/Trans.	SELECTED OPTIONS *Air	SELECTED OPTIONS 4/Trans.	SELECTED OPTIONS TRT - P/Defog
CHEVROLET DIV.											
Chevette CS 4	—	—	—	$5,935	$6,249	—	—	$425	$645	—	$115 $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	7,686	7,868	—	—	—	—	8,027	465	645	175	115 135
Cavalier CS 4	—	7,720	—	7,743	—	—	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	—	—	—	—	9,496	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	—	—	12,680	—	—	—	—	STD	750	175	115 145
Caprice 6	—	—	10,718	—	—	—	—	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	—	—	—	—	11,966	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

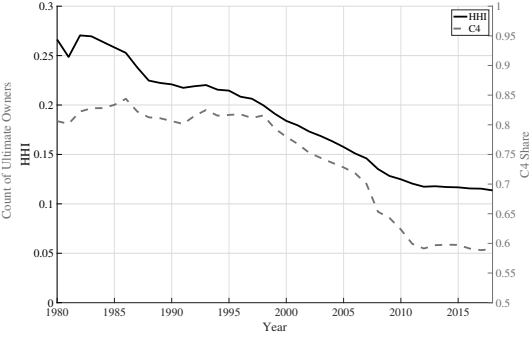
Aggregate Trends

1. Rising prices (as noted earlier).
2. Decreasing concentration.
3. Increasing car quality in many dimensions.

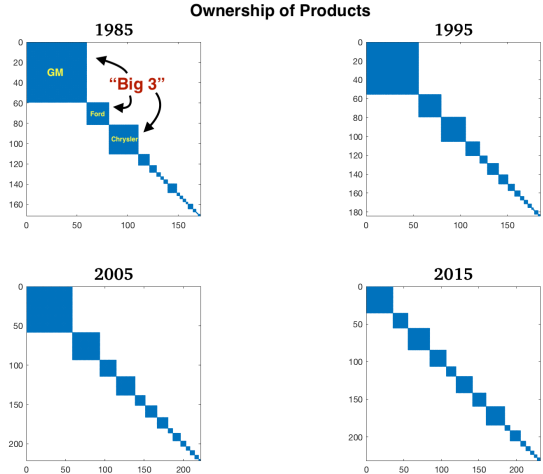
Concentration

Fewer firms, but lower HHI,

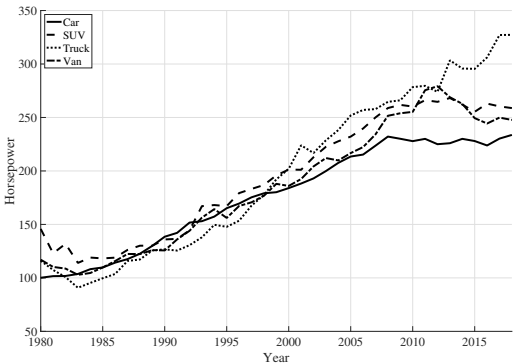


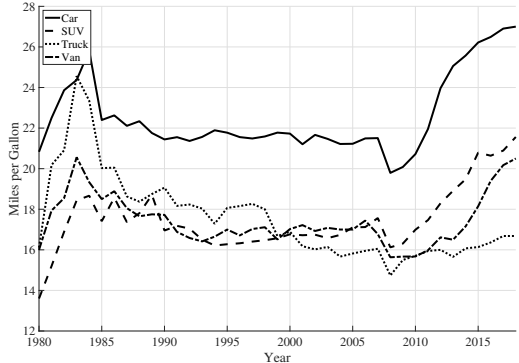


Product Portfolios of Manufacturers

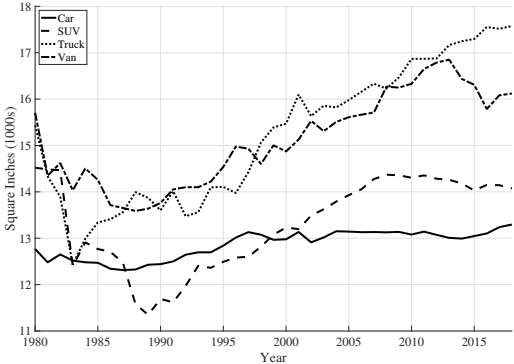


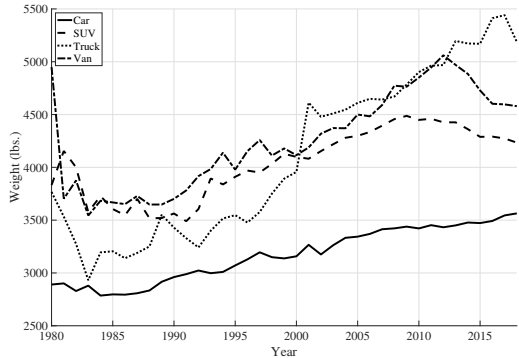
Power ↑ with same fuel efficiency, Knittel (2011).



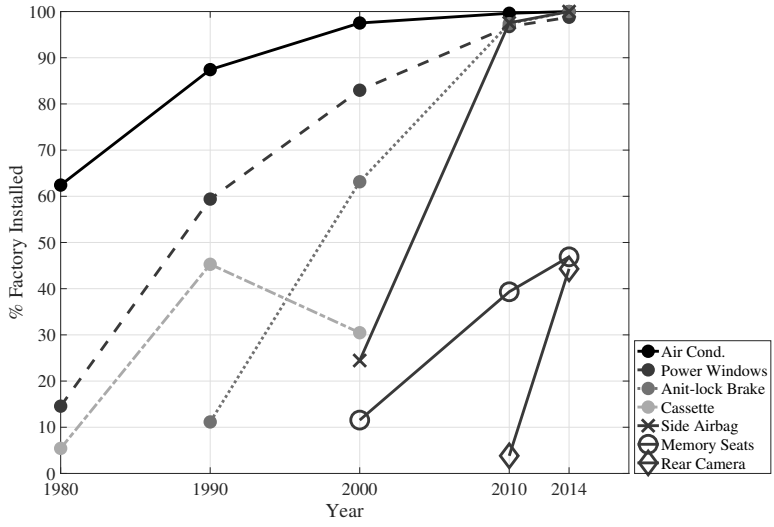


Vehicles are getting bigger and heavier...





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 (very brief)

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.

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

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.

▸ Outside Good

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

			Logit Demand	
	First Stage	Reduced Form	OLS	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

Results

Utility Estimates

			Demographic Interactions						
	β	σ	Income	Inc.^{2}	Age	Rural	FS 2	FS 3-4	FS 5+
Price	-3.200	–	0.094	-0.464	2.068	–	–	–	–
	(0.081)		(0.008)	(0.092)	(0.102)				
Van	-7.292	5.348	–	–	–	–	1.668	3.563	5.653
	(0.234)	(0.099)					(0.148)	(0.157)	(0.189)
SUV	-0.083	3.646	–	–	–	–	–	–	–
	(0.049)	(0.05)							
Truck	-7.533	6.309	–	–	–	3.009	–	–	–
	(0.286)	(0.19)				(0.308)			
Footprint	0.517	1.884	–	–	–	–	0.483	0.463	0.645
	(0.372)	(0.043)					(0.077)	(0.072)	(0.091)
Horsepower	1.094	1.249	–	–	–	–	–	–	–
	(0.45)	(0.086)							
Miles/Gal.	-0.945	1.636	–	–	–	–	–	–	–
	(0.112)	(0.074)							
Luxury	–	2.627	–	–	–	–	–	–	–
		(0.026)							
Sport	-3.066	2.62	–	–	–	–	–	–	–
	(0.067)	(0.056)							
Electric	-5.342	3.835	–	–	–	–	–	–	–
	(0.128)	(0.084)							
EuroBrand	–	1.923	–	–	–	–	–	–	–
		(0.029)							
USBrand	–	2.14	–	–	–	–	–	–	–
		(0.032)							
Constant	-3.164	–	0.362	–	–	–	–	–	–
	(4.311)		(0.031)						

Other linear parameters: Brand dummies, Year dummies, years since redesign.

Elasticities and Substitution

Price Elasticities by Income over Time

	Income Quintile				
Year	1	2	3	4	5
1980	-5.96	-5.78	-5.49	-5.13	-4.30
2000	-8.24	-7.83	-7.40	-6.88	-6.21
2018	-9.37	-8.56	-7.69	-6.90	-6.46

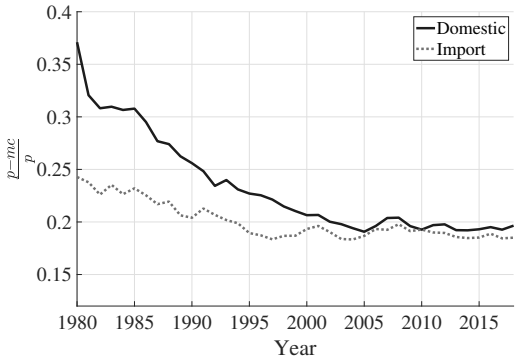
Correlation b/w 1st & 2nd Choice, 2015

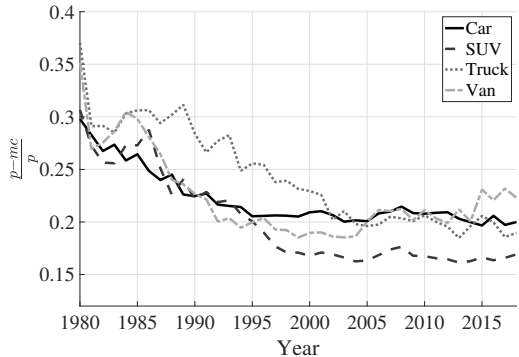
Name	Data	Model Predicted
Van	0.71	0.71
SUV	0.64	0.64
Truck	0.84	0.80
Footprint	0.71	0.69
Horsepower	0.60	0.59
MPG	0.65	0.65
Luxury	0.48	0.49
Sport	0.28	0.28
Electric	0.37	0.19
Euro. Brand	0.34	0.34
US Brand	0.48	0.47

▸ Second Choice Predictions

Markups Over Time

(Price - Marg. Cost) / Price





Why do Markups fall?

Single product Bertrand pricing:

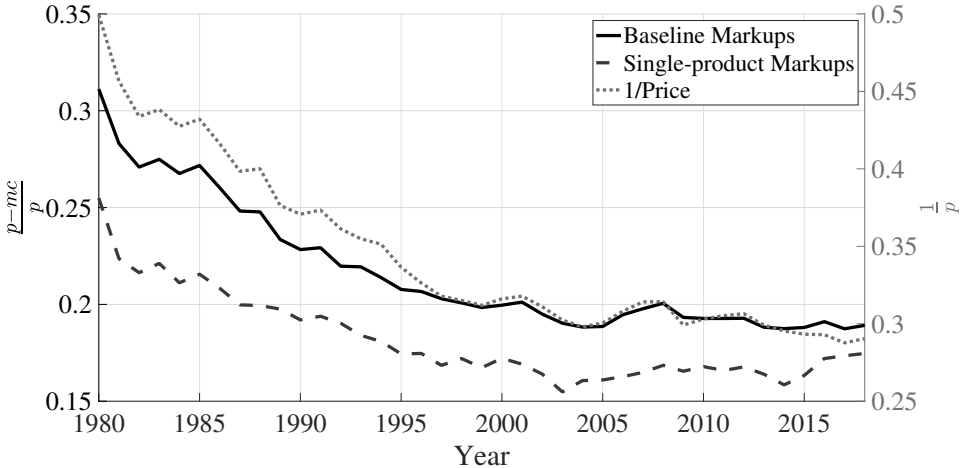
$$\text{Markups} = \frac{1}{\text{elas}} = \frac{s}{p} \times \frac{1}{\frac{ds}{dp}}$$

$\frac{ds}{dp}$: Relatively stable over time.

shares: Stable.

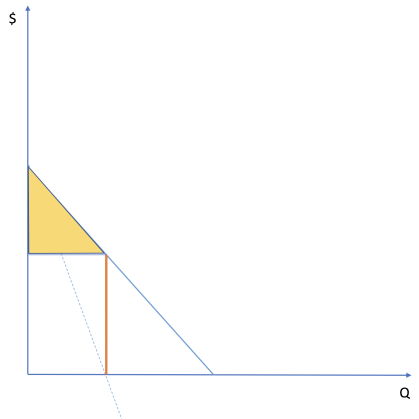
prices: Increasing substantially $\implies$ higher quality.

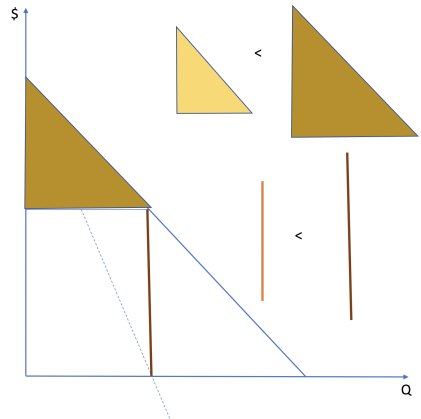
Prices rise $\Longrightarrow$ markups fall



Why care about markups?

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 product quality change over time;
- aggregate fluctuations in desirability of outside good.

We want welfare trends that account for car quality, but not recessions or other changes in "outside good".

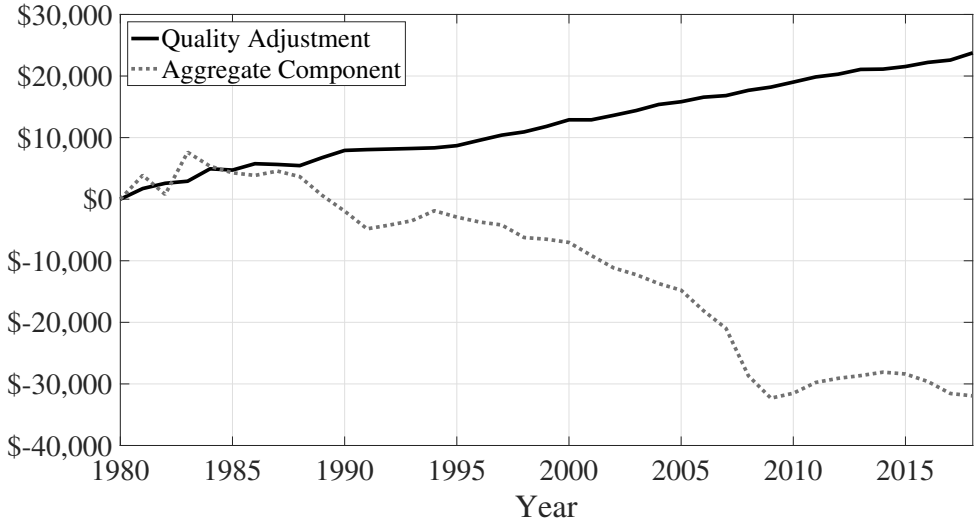
Our strategy: Leverage continuing products

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 aggregate fluctuations in outside good.

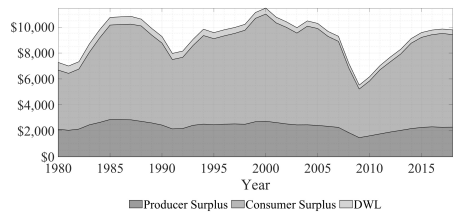
To calculate welfare integrate over aggregate component (calculating counterfactual equilibrium) to remove its impact.

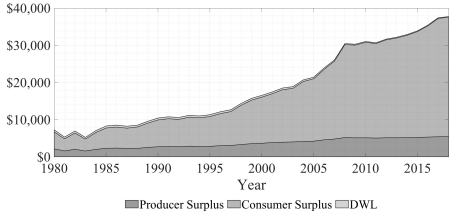
Quality Adjustment



Welfare

Adjustment indicates substantial increase in welfare.





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

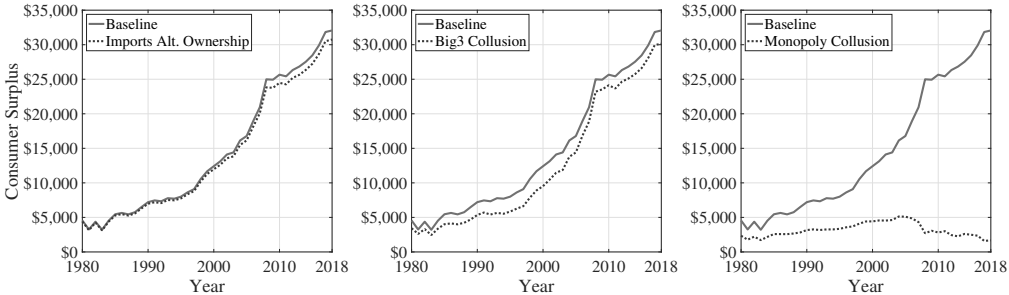
Why is Welfare rising?

Conduct counterfactuals under alternative evolutions of the auto industry.

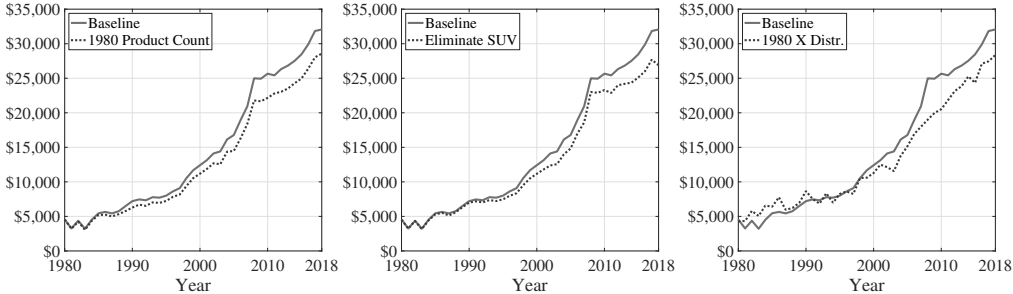
1. Market Structure.
2. Observable product offerings.
3. Product quality and marginal cost improvements.

See which have largest impact on consumer surplus gains...

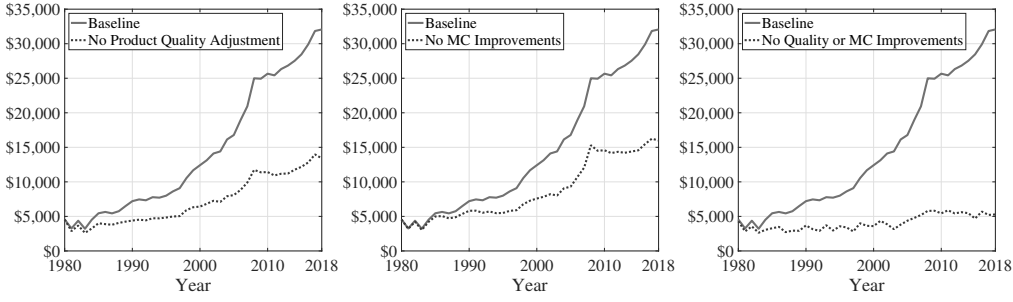
Consumer Surplus varying Market Structure



Consumer Surplus varying Product Set - Observables



Consumer Surplus varying Quality and Cost Trends



Conclusion

We (as a field) have the tools to analyze long term trend in industry evolution.

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

(Old) Lesson: Measuring welfare is more conceptually attractive than markups if products are changing.

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

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.

Back to Identification

Model Predicted Substitution[1]

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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.

[1] Older Version of Estimates