

Battery-Powered Bargains? Assessing Electric Vehicle Resale Value in the United States

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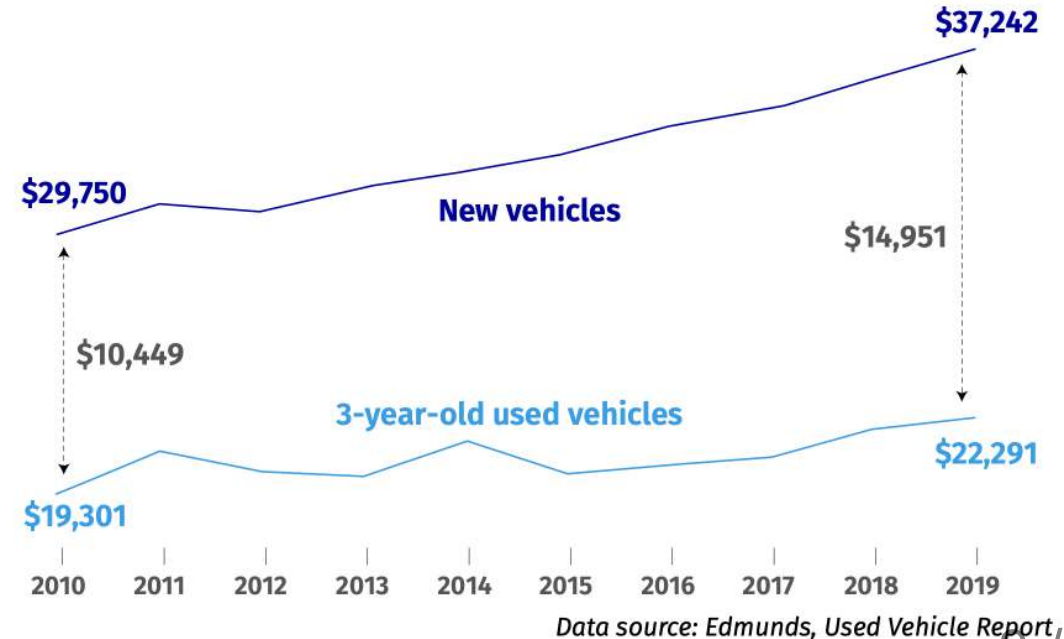
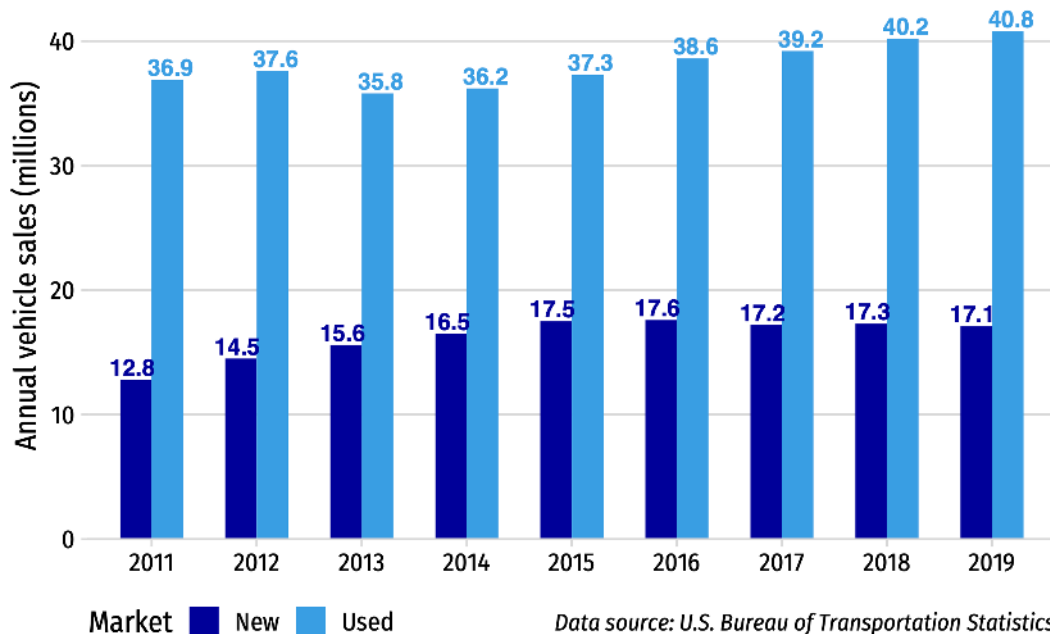
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The vehicle resale market is critically important

70% of sales are used vehicles

Used vehicles are more affordable (pre-covid)



We really need to understand PEV resale value

- Depreciation is a key component in "Total Cost of Ownership" (TCO) models, e.g. [ANL's TCO Study](#)
- "Resale anxiety" a potential obstacle to electric vehicle adoption [Brückmann et al. \(2021\)](#)
- BEV buyers nervous about depreciation tend to lease rather than buy [Dua et al. \(2019\)](#)

Prior research suggests PEVs depreciate faster than CVs

Study	Model Years	MSRP Data	Resale Value Data	Resolution	Sample Size	Main Results PEVs vs. ICEs
This study	2012-2018	EPA; carsheet.io	marketcheck	Daily listings	9,015,324	BEVs and PHEVs depreciate quicker than CV/HEV but is improving with more recent model years and higher ranges.
Rush et al. (2022)	2012-2019	Edmunds	Edmunds TMV	Monthly time series	582,000*	CVs and HEVs consistent 3-yr retention; PHEVs and BEVs initially lower but increasing in retained value
Burnham et al. (2021)	2013-2019	EPA	Edmunds TMV	1 TMV snapshot (July 2020)	686*	BEVs and PHEVs depreciate more quickly than HEVs and CVs
Hamza et al. (2020)	2014-2019	KBB	KBB	Snapshot (2019)	72*	PHEVs and CVs hold value similarly; BEVs 11% lower retention over 5 years
Guo et al. (2019)	2010-2016	Wards	Edmunds TMV	Snapshot (Q4 2016)	1,400*	PEV retention lower than gasolines equivalents. Tesla major exception with highest retained value over time.
Schoettl et al. (2018)	2011-2015	EPA	KBB	Snapshot (Jan. 2018)	200*	PHEVs retained resale value equally as well as CVs (i.e., 0% average difference), and BEVs improved to an average of -5.7% difference in resale value compared to CVs
Tal et al. (2017)	2011-2015	New car <u>buyers</u> survey / OEM website	Self-reported used car buyers survey	Snapshot (2016)	160*	PEVs models held 34% (2011 Nissan Leaf) to 80% (2014 Toyota Prius plug-in) of value in 2015 compared to MSRP.
Zhou et al. (2016)	Unknown	NADA guides	NADA guides	Unknown	Unknown	Comparing the adjusted retention rates of PHEVs and BEVs with those of CVs indicates <u>2-3 year</u> retention rate is lower for PEVs.

Abbreviations:
EPA = Environmental Protection Agency (fuelconomy.gov)
TMV = True Market Value (private party data)
KBB = Kelly Blue Book (private party data)
NADA = National Automobile Dealers Association

**Sample sizes estimated based on descriptions of data in papers.*

Data: ~9M used vehicle listings from 60k dealerships (2016 - 2020)

Key sample stats	Conventional <i>N</i> = 8395 000	Hybrid <i>N</i> = 464 560	PHEV <i>N</i> = 58 915	BEV Tesla <i>N</i> = 22 518	BEV other <i>N</i> = 74 331
Age (years)					
Mean	3.40	3.70	3.86	3.82	3.66
Median	3.28	3.58	3.65	3.80	3.61
SD	1.49	1.51	1.40	1.28	1.13
Listing price (Used \$USD)					
Mean	16 192	16 954	16 684	51 314	14 109
Median	14 957	16 429	16 364	49 006	12 428
SD	6188	5040	4347	13 111	6068
MSRP (New \$USD)					
Mean	28 104	30 193	37 765	88 157	36 606
Median	27 308	28 923	36 645	89 320	34 409
SD	7819	4806	3284	8825	5134
Electric Range (miles)					
Mean	—	—	35	238	87
Median	—	—	38	246	82
SD	—	—	14	47	27
Minimum	—	—	11	139	58
Maximum	—	—	53	335	238

Two Studies, One Dataset

Measuring Electric Vehicle **Mileage** in the United States

Zhao, L., Ottinger, E., Yip, A., & Helveston, J.P. (2023) "[Quantifying electric vehicle mileage in the United States](#)" *Joule*. 7, 1–15.



Measuring Electric Vehicle **Resale Value** in the United States

Roberson, Laura A., Pantha, S., & Helveston, J.P. (2024) "[Battery-Powered Bargains? Assessing Electric Vehicle Resale Value in the United States](#)" *Environmental Research Letters*.

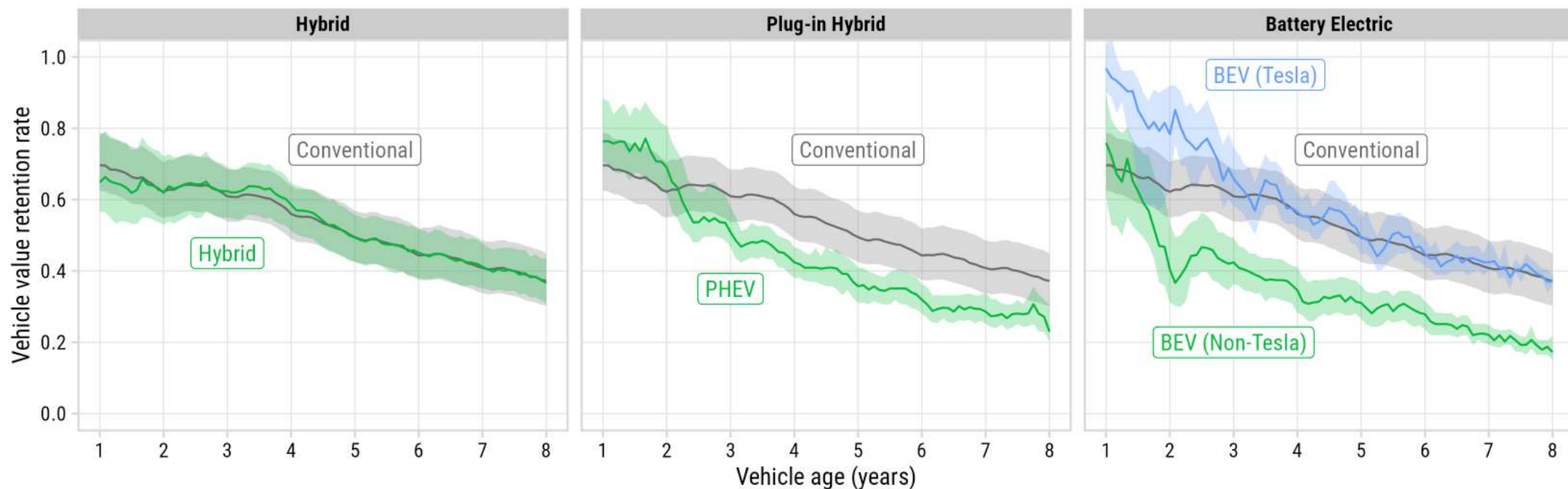


Value Retention Rate:

$$r = \frac{\textit{ListingPrice}}{\textit{MSRP}}$$

BEVs & PHEVs are depreciating worse than CVs and HEVs

(Except Tesla)



Data: All listings between 2016 - 2019 (inclusive)

Modeling retention rate as exponential decay

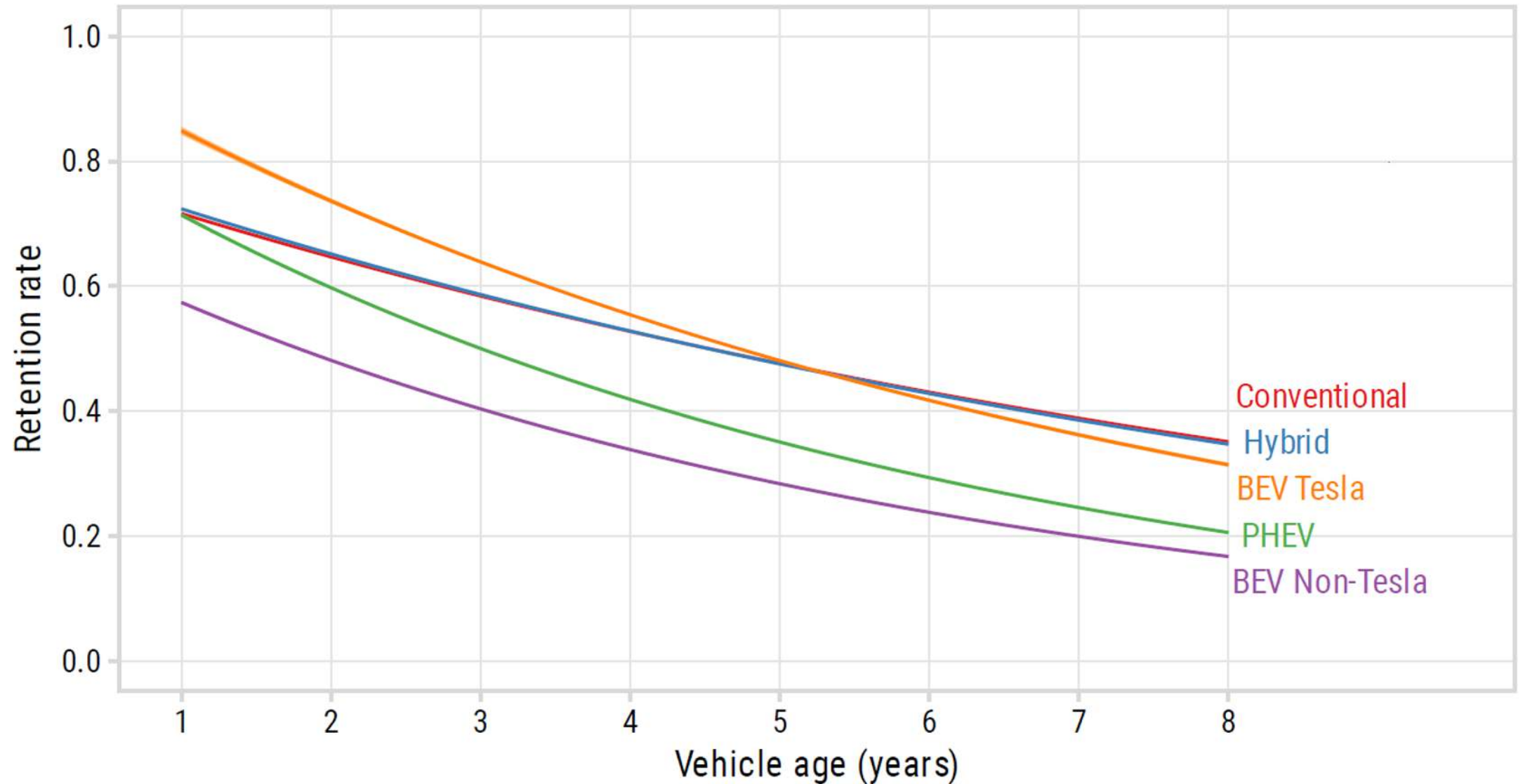
$$r = \alpha \exp(\beta \mathbf{x})$$

$$\log(r) = \alpha + \beta \mathbf{x}$$

Interpretation:

$$\Delta r = \exp(\hat{\beta}) - 1$$

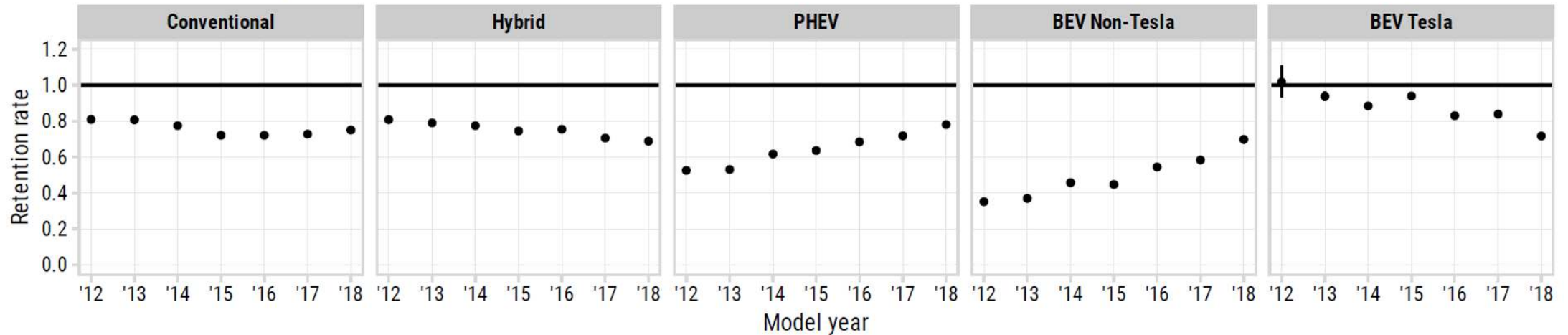
Effect of age on predicted retention rate by powertrain



Newer PEVs are holding value better than older PEVs (except Tesla)

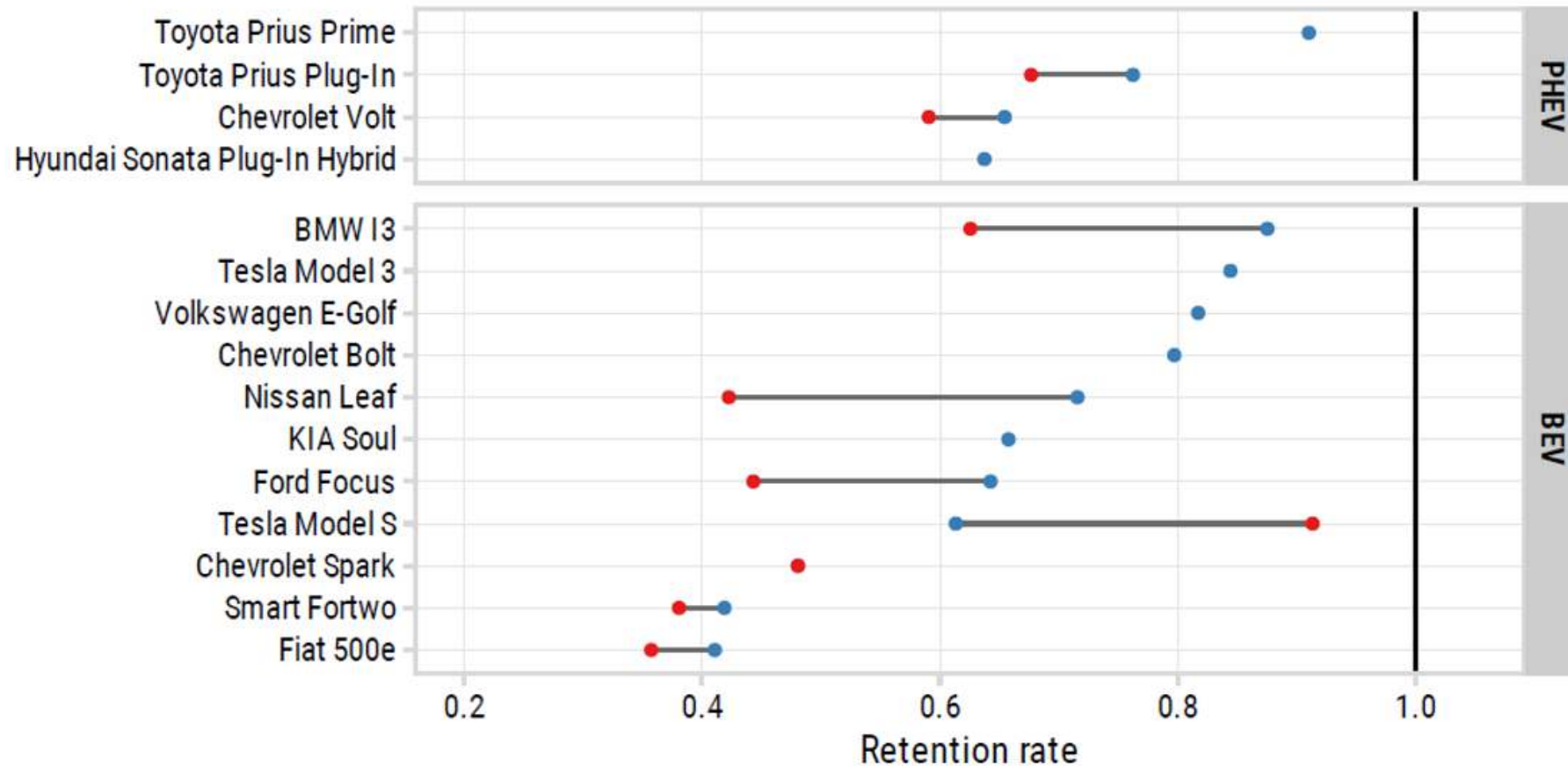
Predicted two-year retention rate by powertrain and model year

Predictions made with zero mileage and mean operating cost across all models.



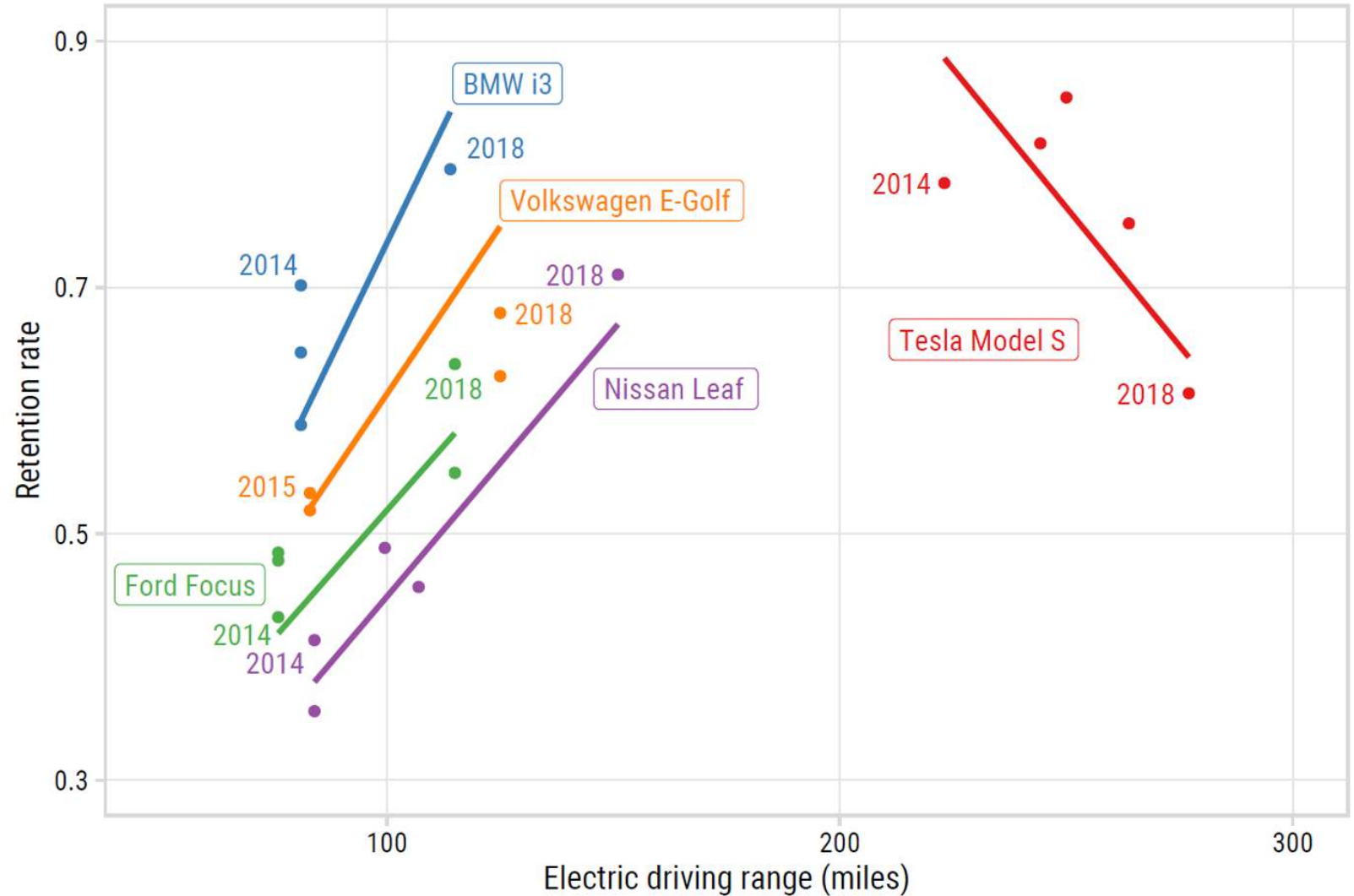
Newer PEVs are holding value better than older PEVs (except Tesla)

Predicted two-year old retention rate for model years 2014 vs. 2018



Longer-range
BEVs hold
value better
(w/diminishing
returns at
200+ miles)

Predicted two-year-old retention rate versus range (select BEVs)



PEV subsidies for new cars should impact used car pricing

New Market

(MSRP - Subsidy = Price)
 $\$30,000 - \$7,500 = \mathbf{\$22,500}$



Used Market

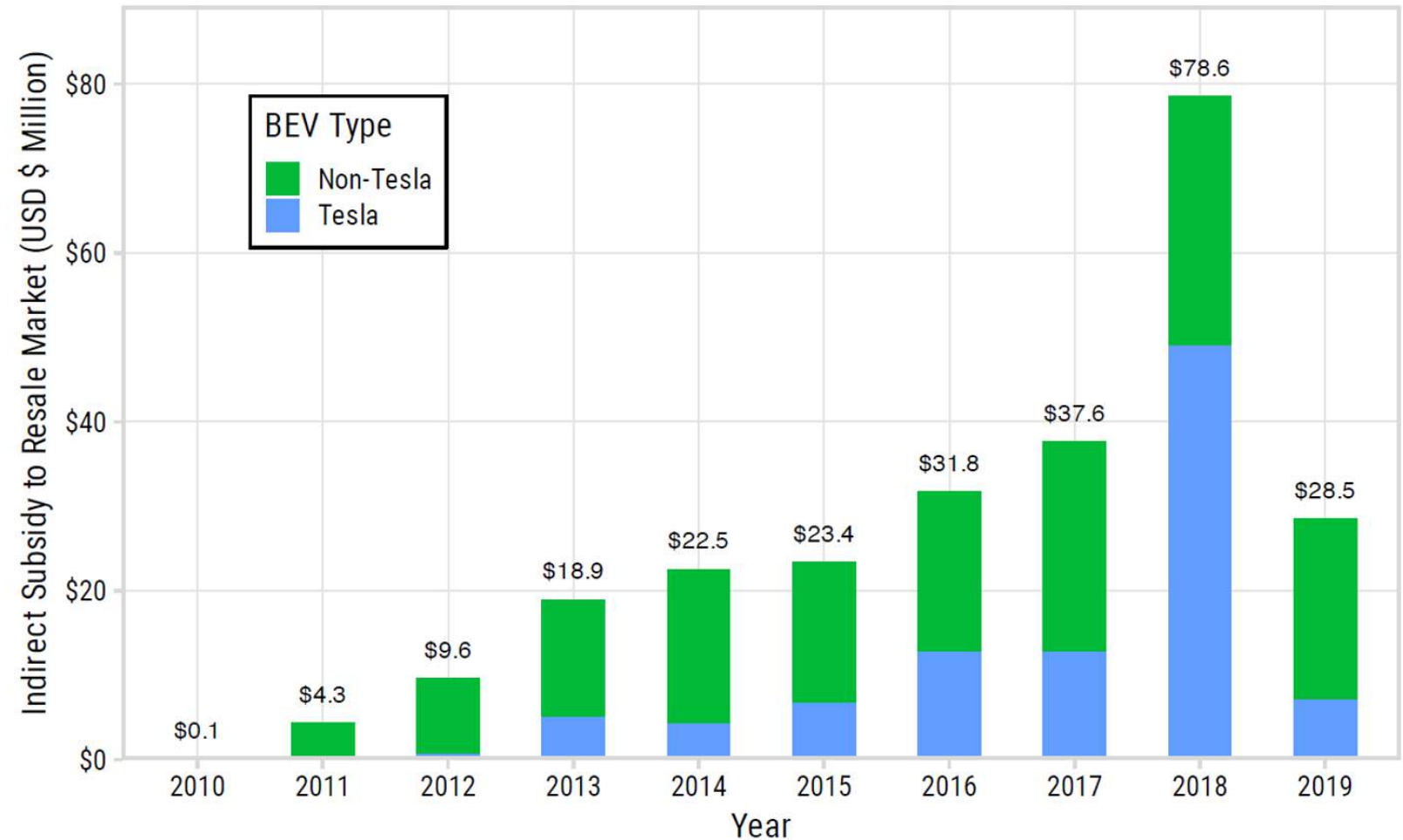
(Assuming adequate supply)
Max Price = **\$22,500**



Used EVs gain additional benefit from new vehicle subsidies with no additional cost to gov't

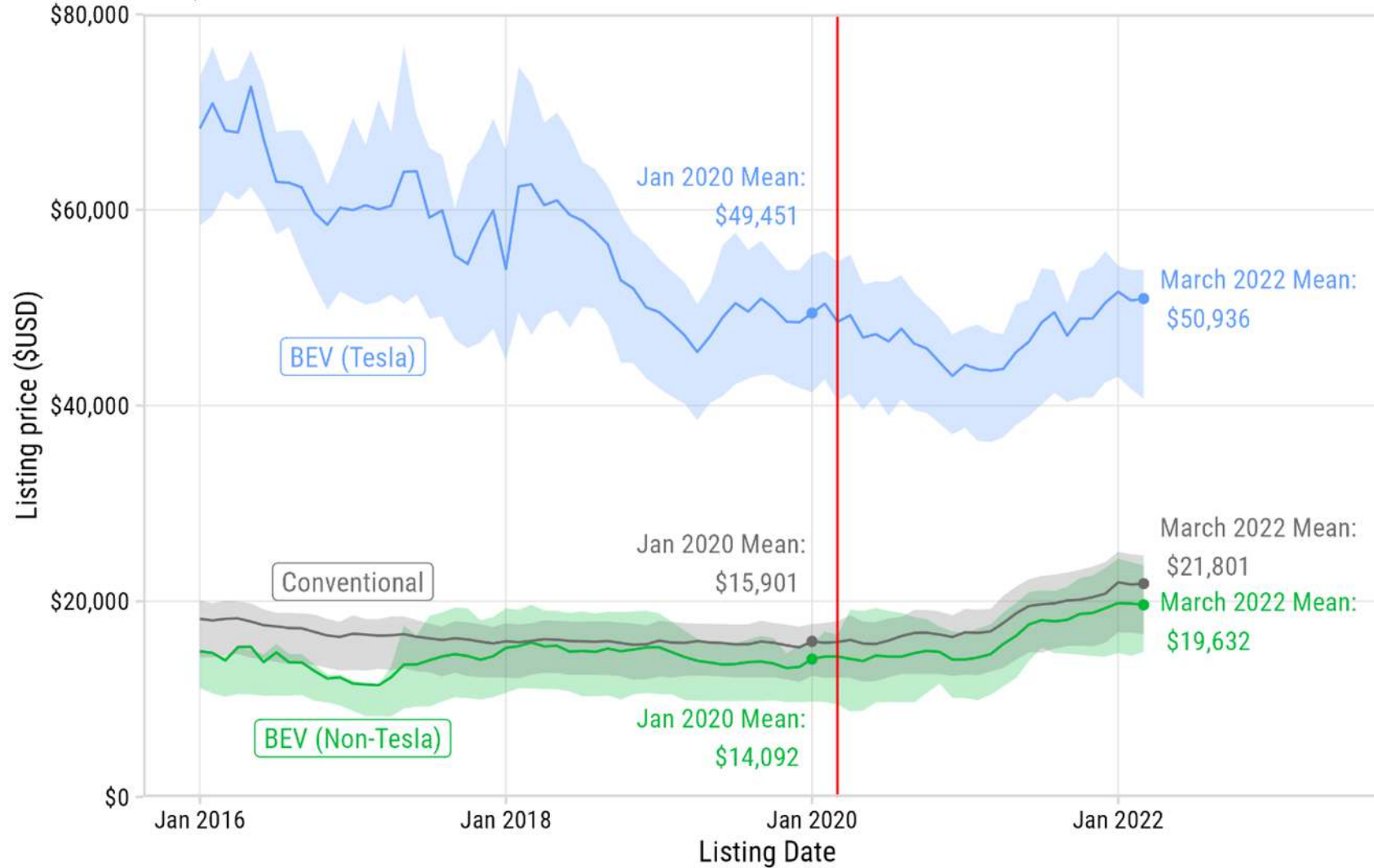
Indirect Subsidies to Resale Market

Between 2010 and 2019, PEV Subsidies in the New Vehicle Market Have Indirectly Provided \$255 Million in Subsidies to the Resale Market Through Reduced Prices.



Used market listing prices are substantially higher post-COVID19

Prices inflation-adjust to constant 2019 \$USD



COVID-19 had substantial impact on used vehicle pricing

Key takeaways

- BEVs have depreciated faster than CVs, but this is changing!
- Newer model BEVs with higher ranges are holding their value more similarly to CVs.
- Subsidies for new BEVs pass ~3% lower prices in used market
- Post COVID19 pandemic used prices are up ~40%

Thanks!

Slides:

<https://slides.jhelvy.com/2024-btr6/>

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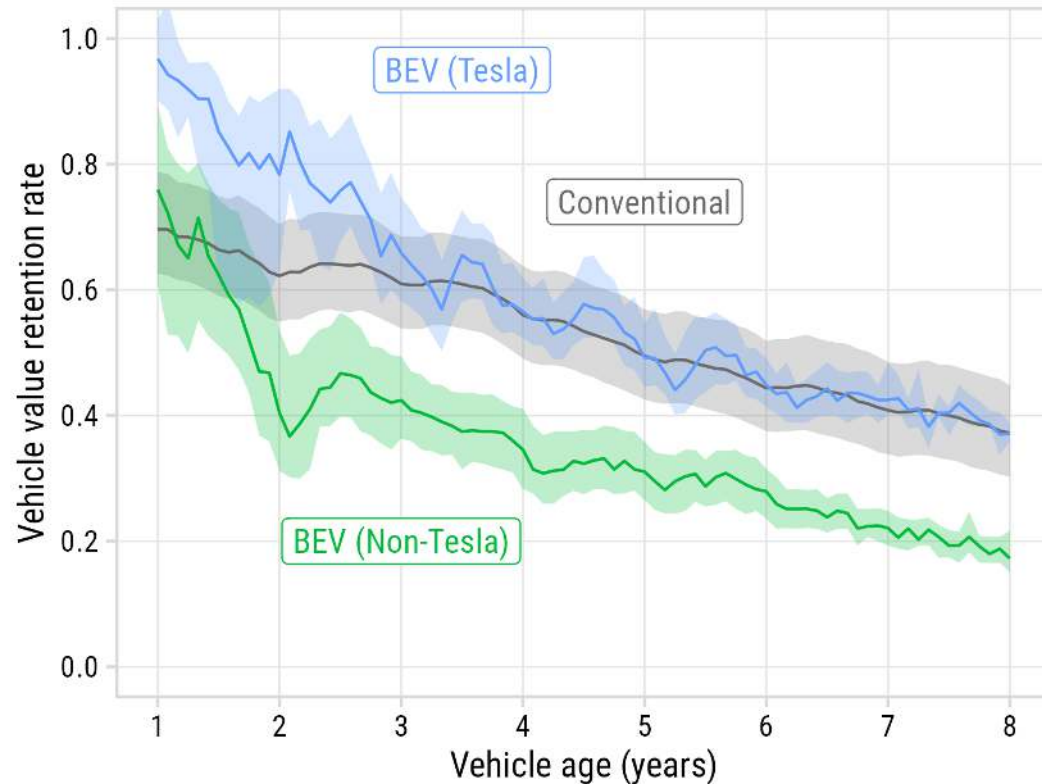
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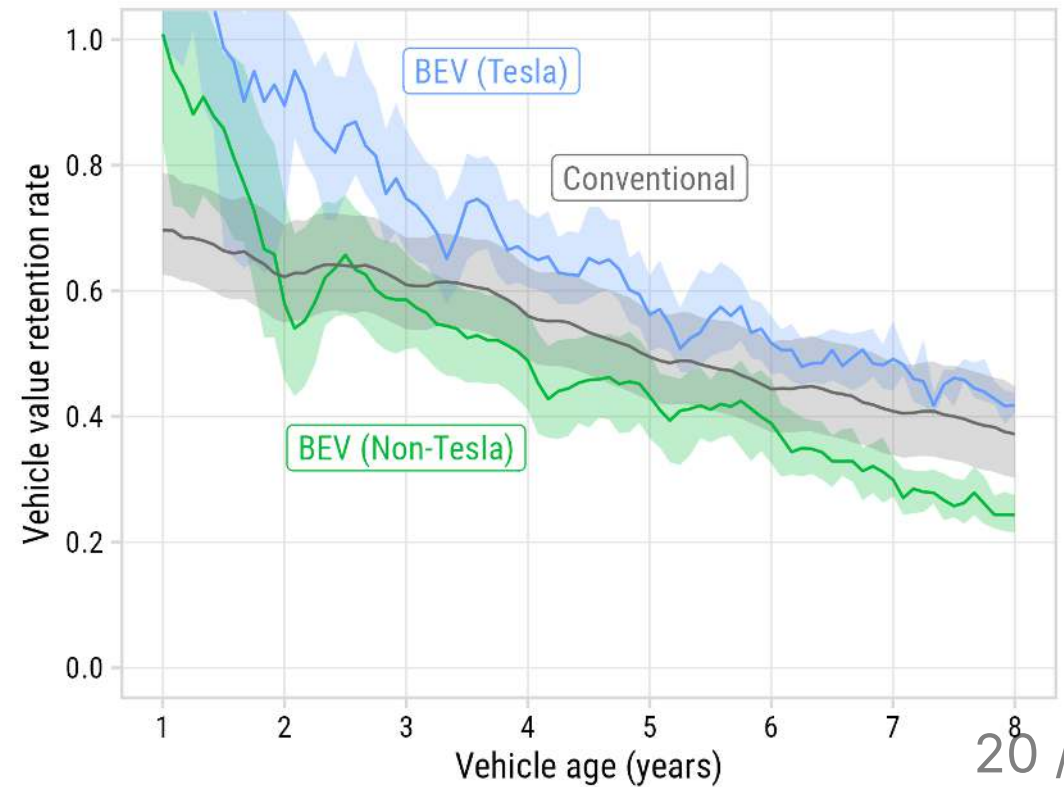
Extra slides

How you compute retention rate matters

We omit subsidies: $\frac{Price}{MSRP}$



Others: $\frac{Price}{MSRP - Subsidy}$



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Key sample stats	Conventional N = 8395 000	Hybrid N = 464 560	PHEV N = 58 915	BEV Tesla N = 22 518	BEV other N = 74 331
Model Year					
2012	764 383 (9.1%)	61 590 (13%)	6823 (12%)	390 (1.7%)	3943 (5.3%)
2013	1188 624 (14%)	93 803 (20%)	14 342 (24%)	2797 (12%)	11 245 (15%)
2014	1466 956 (17%)	86 350 (19%)	14 043 (24%)	2969 (13%)	13 665 (18%)
2015	1942 194 (23%)	102 049 (22%)	8217 (14%)	6645 (30%)	25 007 (34%)
2016	1598 340 (19%)	54 178 (12%)	4474 (7.6%)	6608 (29%)	15 193 (20%)
2017	1007 898 (12%)	45 596 (9.8%)	9905 (17%)	1232 (5.5%)	4075 (5.5%)
2018	426 605 (5.1%)	20 994 (4.5%)	1111 (1.9%)	1877 (8.3%)	1203 (1.6%)

Newer BEVs are holding value better than older BEVs

Predicted two-year old retention rate for model years 2014 vs. 2018

