Subsidizing Industry Growth in a Market with Lemons: Evidence from the Chinese Electric Vehicle Market

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Motivation: Worldwide embrace of green subsidies

- Nascent-stage green industrial policies
  - Worldwide governments subsidies 2022: **$40 billion** on EVs, **$10 billion** on solar panels

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- Nascent-stage green industrial policies
  - Worldwide governments subsidies 2022: **$40 billion** on EVs, **$10 billion** on solar panels
- **Impact of Consumer Subsidies**
  - Lower consumer prices, expand the market, incentivize entry
  - Technology spillovers, e.g., declining solar installation costs and EV battery costs
  - Consumer perception and reputation

Motivation: Unintended consequences of subsidies

- **Lemon entrants** with hidden low quality
  - Diminishing EV driving range and EV fires
  - Short-lived, poor-quality solar panels

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- **Lemon entrants** with hidden low quality
- **Reputation externality**

The New York Times

Hurdle to Broad Adoption of E.V.s: The Misperception They're Unsafe

Motivation: Unintended consequences of subsidies

- **Lemon entrants** with hidden low quality
- **Reputation externality**
- **Subsidies** may introduce low-quality entrants and damage the industry's reputation

The New York Times

Solar Industry Learns Lessons in Spanish Sun

But as low-quality, poorly designed solar plants sprang up on Spain's plateaus, Spanish officials came to realize that they would have to subsidize many of them indefinitely, and that the industry they had created might never produce efficient green energy on its own.

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电动汽车越卖抱怨越多的行业隐忧

Oct 28, 2020 — 电动汽车越卖抱怨越多的行业隐忧 ... 随着国务院常务会议日前通过《新能源汽车产业发展规划（2020-2035）》（以下简称《规划》），并提出将引导新能源汽车 ...

As Electric Car Sales Surge, Complaints on the Rise

Research Question: How to design an optimal consumer subsidy?

- Infant-stage policy to maximize welfare:
  - + **Direct channel:** prices $\downarrow$ adoption $\uparrow$ emission $\downarrow$; entry responses and permanent benefit
  - + **Upstream spillover channel:** agg. EV sales $\uparrow$ battery cost $\downarrow$
  - ? **Reputation channel:** lemons $\uparrow$ reputation externality $\downarrow$

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– Do subsidies attract lemons and why?

– How large are the impacts through the three channels?

This Paper: Formulate the impact of consumer subsidies on industry growth

- **Chinese EV industry 2012-2018**: more than 50 new EV firms

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- Evidence of reputation externality in the infant stage:
  - **Consumer survey**: friends have a lemon $\rightarrow$ potential buyers' prob(EV) $\downarrow$
  - After an **EV fire**, uninvolved EV firms' sales decrease by 10% in the next three months

This Paper: Formulate the impact of consumer subsidies on industry growth

- **Chinese EV industry 2012-2018**: more than 50 new EV firms
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  - After an **EV fire**, uninvolved EV firms' sales decrease by 10% in the next three months
- Model of **vehicle demand** and **firm entry and expansion**:
  - Consumers with heterogeneous price and reputation sensitivities

    $\Longrightarrow$ consumer subsidy may disproportionally increase the profitability of lemon firms
  - Entry responses of different types of firms with exogenous quality
  - Endogenize market structure, battery cost, and EV reputation dynamics
- **Counterfactual analysis**: Study the three channels' impacts and optimal subsidies

Literature

- EV subsidy analysis
  - Li et al. (2017); Li (2017); Springel (2021); Holland et al. (2021); Barwick et al. (2023) ...
  - Heutel and Muehlegger (2014): early access to low-quality hybrid vehicles $\downarrow$ later adoption rate

$\Longrightarrow$ Dynamic structural model with reputation evolution;

- Collective reputation and incomplete information in consumer adoption
  - Development: Bold et al (2017); Shiferaw et al. (2015); Suri (2011)
  - Theory: Tirole (1996); Levin (2009), Empirical: Volkswagen scandal (Bachmann, et al. (2021)); Dairy (Bai et al (2020)); pharmaceutical (Ching (2003))

$\Longrightarrow$ Firm responses and the equilibrium effects

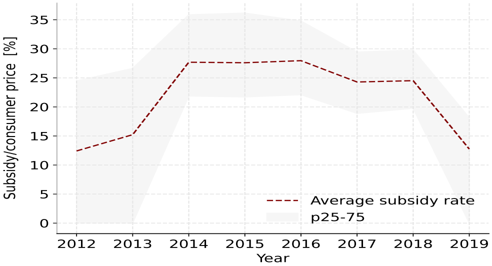
- Industrial policy
  - Barwick et al. (2023); Hansen et al. (2003); Aghion et al. (2015); Lane (2018)

$\Longrightarrow$ A novel reputation channel

Outline

Chinese EV market: Attribute-based consumer subsidy (driving range)

- **Central subsidy**: 13 cities in 2012 $\rightarrow$ 88 cities in 2014 $\rightarrow$ all cities in 2016 Details
- **City subsidy**: 0.5 $\sim$ 1.5 of the central subsidy
- **Other policies:** EV plate benefits, GV restrictions, charging stations Time trend in RMB

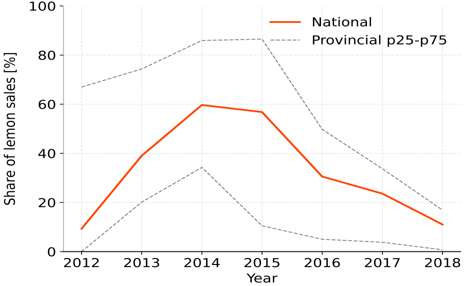


$\leftarrow$ Generous subsidies varying across time and markets

Data: Chinese EV industry 2012-2018

1. Vehicle prices and sales by month:
   - 2012-2014: province level (EV $< 0.2\%$), 2015-2018: top 40 EV cities (EV $1.8 \sim 8.2\%$)
   - 88 distinct firms set national prices, no luxury EV brand, prices $\$10 - 30k$ Summ Stats
2. Firm entry and expansion for 57 firms with EV models
   - EV Firms $6 \rightarrow 55$, average firm expands from $1 \rightarrow 6$ provinces
3. Review and experiential quality $\Longrightarrow$ **Lemons with low unobserved quality**
   - Largest review website and largest complaints filing and repair platform from 2014-2021
   - Review score ≤ 4.0 + reported repair rate $\geq$ p75 $\Longrightarrow$ **9 firms**
   - Assumption: Exogenous quality Reviews corr

Descriptive Pattern: Lemon sales



← Large share with variations across different markets

← Coincide with the subsidy pattern

Evidence: Reputation externality from **EV fire** and **Lemon share**

1. How do consumers respond to EV fires?
   - Treatment: 35 reported fire events during 2015-2018 example
   - Sales of **uninvolved** EV firms drop by 10% in the event city Results

2. Consumer survey
   - Friends' lemon experience → perception and prob(EV) Results

$\Longrightarrow$ Within-market externality and lemons share as consumer perception Bayesian

Reduced-form Results

corr

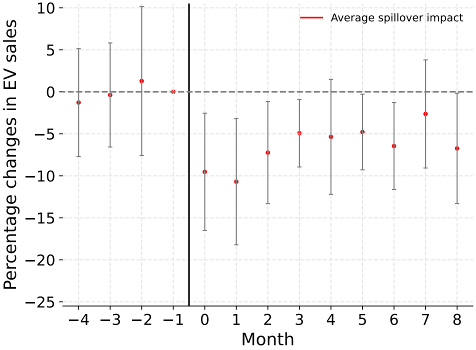
Reputation Externality: EV Fires decrease uninvolved firms' sales by 10%

- **DID:** Compare sales of the same firm in the city with EV fire and in other cities

$$logSales_{jct} =$$

$$\sum_{k=-4}^{k=8} \beta^k \mathbb{1}(Fire)^{Involved}_{j,c,t-k} + \underbrace{\sum_{k=-4}^{k=8} \beta^k \mathbb{1}(Fire)_{c,t-k}}_{\text{spillover}}$$

$$+ \xi_j \times \gamma_t + \gamma_c + \epsilon_{jct}$$



More results
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corr Bayesian

Outline

Model forces and key primitives

- A framework for analyzing the subsidy's impacts:
  - Direct channel ($p\downarrow$)
  - Upstream spillover channel ($mc\downarrow$)
  - Reputation channel

Model forces and key primitives

- A framework for analyzing the subsidy's impacts:
  - Direct channel ($p \downarrow$)
  - Upstream spillover channel ($mc \downarrow$)
  - Reputation channel
- The **demand system** explains why consumer subsidy increase lemon sales. And the **finite period dynamic entry model** explains entry responses of different types of firms

Key primitives: Price sensitivity α, reputation sensitivity θ, and FC

1. $\forall$ subsidy, fix market structure and reputation: corr
   - **Consumers**: $u = \beta x + (\theta_0 + \theta \cdot \mathbb{E}[q])\mathbb{1}(EV) - \alpha \cdot (p - s)$

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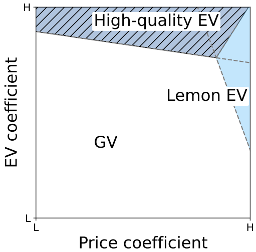

(a) Baseline

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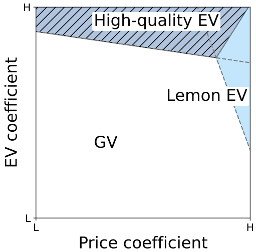
   - Subsidy shifts people from GV to EV (α)



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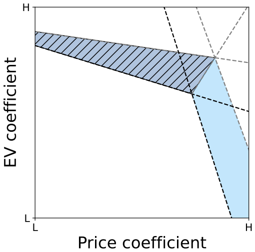

(b) Direct impact

Key primitives: Price sensitivity α, reputation sensitivity θ, and *FC*

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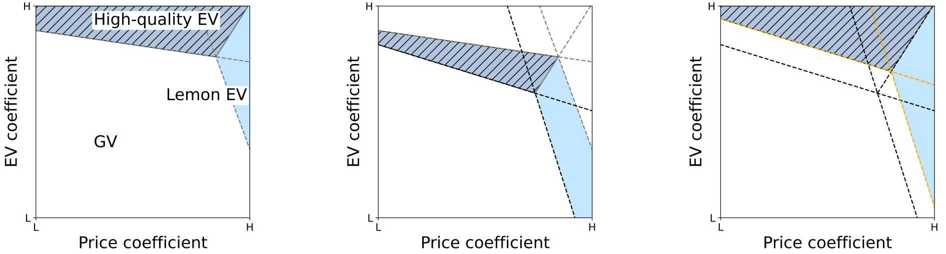


(a) Baseline (b) Direct impact (c) Reputation impact

Key primitives: Price sensitivity α, reputation sensitivity θ, and *FC*

1. $\forall$ subsidy, fix market structure and reputation:
   - **Consumers**: $u = \beta x + (\theta_0 + \theta \cdot \mathbb{E}[q])\mathbb{1}(EV) - \alpha \cdot (p - s)$
     - Subsidy shifts people from GV to EV (α)
     - Reputation decrease shifts people from EV back to GV (θ)
   - **Which firm gains more from the subsidy**: high-quality EV or lemon EV? (α)

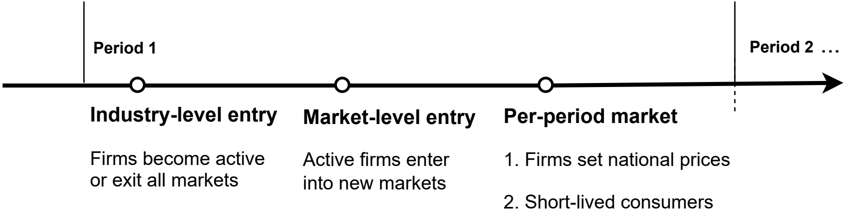
2. **Dynamic entry**: profit$_j$ $-FC_j$
   - Lemon entry $\rightarrow$ lower consumer EV perception $\rightarrow$ lower high-quality firms' profits

     $\uparrow$ $\downarrow$

     less high-quality entrants
   - Market structure and battery cost $\Longrightarrow$ The direct and upstream spillover channels

Model: Finite period dynamic discrete choice model

- 2012 - 2018, 20 provinces
- **Industry potential entrants:** all GV firms and all registered EV firms, exogenous location and exogenous quality
- Asymmetric information corr



1. Endogeneous transition: market structure, EV reputation, battery cost
2. Exogeneous evolution: policies, demographics

Empirical Model Estimation Results

Welfare analysis

1. **How does the subsidy impact the industry? How important are the three channels?**
2. **Why do consumer subsidies attract lemons?**
3. **How can a subsidy design suppress lemons, while stimulating industry growth?**

Welfare analysis: Reputation matters among the essential channels

- **How does the subsidy impact the industry?**
  - 83% EV sales, 57% lemon firms and 49% non-lemon firms wouldn't exist
  - **Net welfare impact is 0**: benefit $\sim$ cost 56.7 billion RMB ($8.7 bil.)

Welfare analysis: Reputation matters among the essential channels

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    - Reputation channel (-10.8%)

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- **Why do consumer subsidies attract lemons?**
  - High consumer price elasticity $\alpha = -3.97$
    (Literature: US -2.7, Norway -1.5, US low-inc -3.5)

Welfare analysis: Alternative policies

- **Information provision**: A perfect certification program +10.8% welfare
- **Optimal consumer subsidy design:** $T + t \cdot Drivingrange$

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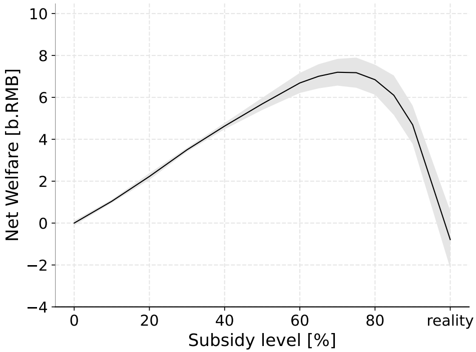

- **Static DWL vs dynamic gains**
- Welfare is maximized at 70% of the current subsidy → net welfare 7.4 b. ($1.14b.) Details

Welfare analysis: Alternative policies

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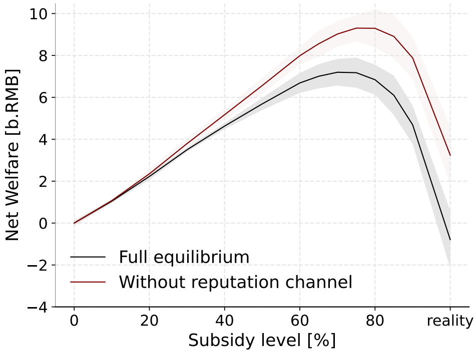
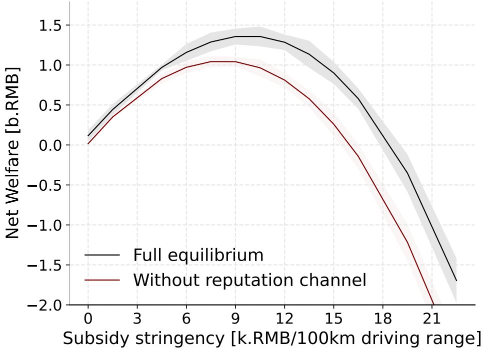


- **Ignore the reputation channel: waste 5% more subsidy** → 336.0 million RMB ($51.7 million) decrease in net welfare

Table Subsidy attracts lemons

Welfare analysis: Alternative policies

- **Information provision**: A perfect certification program +10.8% welfare
- **Optimal consumer subsidy design:** $T + t \cdot \mathit{Drivingrange}$
  - The **optimal stringency** t is mainly determined by the reputation channel



- Welfare is maximized at ¥10k per 100km
- Ignoring the reputation channel could almost double the reputation loss

Conclusion: Subsidizing industry growth in a market with lemons

- Developed a framework for green industrial policy design
- Added the novel reputation channel
    - Highlighted the importance of reputation in new markets
    - Established the relationship between subsidy and lemon entrants through consumer price elasticity
    - Pointed out that stringency in attribute-based subsidies can be a screening mechanism

Subsidizing industry growth in a market with lemons

Thank you!

All comments welcome.

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Data Pattern: Firm entry and expansion

- 40 firms from the GV industry and 17 new firms with exogenous locations Details

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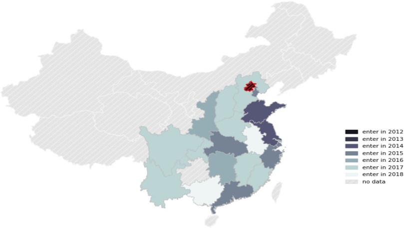
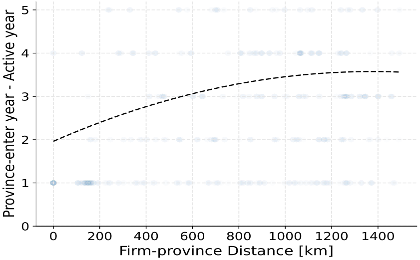
- Two entry margins: industry-level and market-level

1. EV Factory ⟶ 2. Retail chain in each province



Example: BAIC's expansion path



Firms enter into nearby markets first

Data Pattern: Firm entry and expansion

- 40 firms from the GV industry and 17 new firms with exogenous locations Details
- Two entry margins: industry-level and market-level

1. EV Factory $\longrightarrow$ 2. Retail chain in each province

	2012	2013	2014	2015	2016	2017	2018
# Firms with EV models	6	9	10	20	26	37	55
# Lemons	1	1	4	6	8	9	9
Number of provinces an EV firm entered							
25%	1	1	1	2	2	2	3
50%	1	1	2	3	4	4	6
75%	1	2	4	7	9	13	11

Attribute-based subsidy

	Range	2013	2014	2015	2016	2017	2018
BEV	$\geq$ 80km	¥35,000	¥33,250	¥31,500	-	-	-
	$\geq$ 100km				¥25,000	¥20,000	-
	$\geq$ 150km	¥50,000	¥47,000	¥45,000	¥45,000	¥36,000	¥15,000
	$\geq$ 200km						¥24,000
	$\geq$ 250km	¥60,000	¥57,000	¥54,000	¥55,000	¥44,000	¥34,000
	$\geq$ 300km						¥45,000
	$\geq$ 400km						¥50,000
PHEV	$\geq$ 50km	¥35,000	¥33,250	¥31,500	¥30,000	¥24,000	¥22,000

Figure: Central subsidy based on driving range

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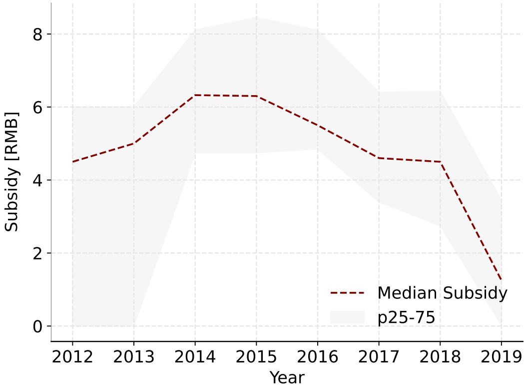
Attribute-based subsidy



Subsidy Path in 10k RMB

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Chinese EV market: Success with caveats

- A nascent-stage subsidy that successfully develops the industry
  - ¥90 billion,\$13.8 billion
  - EV Firms 6 $\rightarrow$ 55
  - Annual EV sales 8 thousand (2012) $\rightarrow$ 1 million (2019)
  - Battery cost reduced by 80% $\rightarrow$ Cost of producing an EV decreased by more than 1/3

[1] J.D. Power China electric vehicle consumer survey 2019

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- A nascent-stage subsidy that successfully develops the industry
  - ¥90 billion,$13.8 billion
  - EV Firms 6 $\rightarrow$ 55
  - Annual EV sales 8 thousand (2012) $\rightarrow$ 1 million (2019)
  - Battery cost reduced by 80% $\rightarrow$ Cost of producing an EV decreased by more than 1/3
- A rapid growing period with **mixed quality**
  - Varied engine performance and concerns over battery safety
  - Rising consumer complaints[1], coupled with numerous EV fires
  - Concerns from top-tier firms
  - Official documents on quality and consumer trust

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[1] J.D. Power China electric vehicle consumer survey 2019

Data: Model Summary Statistics: 2012 - 2018

year	2012	2013	2014	2015	2016	2017	2018
Panel A: Gasoline Vehicle Model-level Statistics							
# models	349	402	447	494	538	529	564
Total sales (1,000)	11,900	13,767	15,529	8,817	10,109	9,888	9,139
Sales per model	34,097.70	34,245.90	34,741.53	17,848.10	18,790.36	18,691.76	16,204.55
MSRP (10kRMB)	12.64	12.52	12.58	12.56	13.18	13.63	14.03
Net weight	1,349.51	1,351.23	1,356.88	1,368.24	1,404.21	1,434.43	1,457.04
Engine power	121.40	121.01	122.69	125.42	130.17	134.96	134.23
Panel B: Electric Vehicle Model-level Statistics							
# models	7	11	16	38	51	99	184
Total sales (1,000)	4	9	44	157	254	427	724
Sales per model	536.12	773.50	2459.28	3837.24	4622.29	4107.38	3751.33
MSRP (10kRMB)	23.00	22.10	20.99	22.89	23.02	20.06	19.69
Net weight	1,150.62	1,092.17	1,042.89	1,145.17	1,187.14	1,186.08	1,199.41
Engine power	47.75	48.25	50.04	63.24	72.18	73.34	85.90
Driving range	149.25	144.08	148.78	152.71	166.00	185.45	248.34

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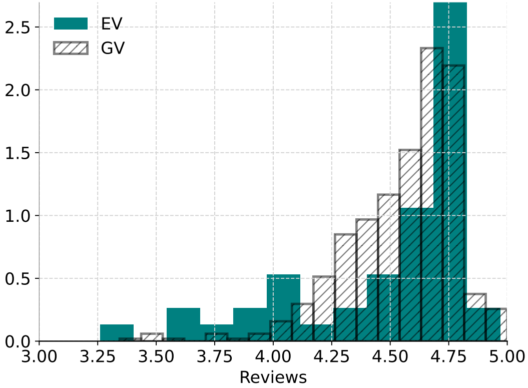
Data: Lemon firm definition



EV review score distribution has two peaks and a long tail

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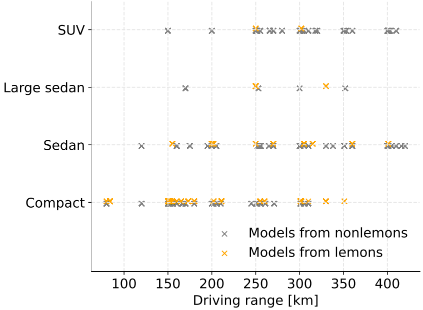
Lemons: Weak correlation with observables

- More than 50 new firms with a single production line



- Heuristic price and sales regressions
  - Lemon prices or sales are **NOT significantly lower** conditional on observables
- Reduced-form evidence of consumer **across-firm** inference (survey and DID)

Back to def Back to RF Back to forces Back to model Back to CF Back to CF Stringency

Lemons: Weak correlation with observables

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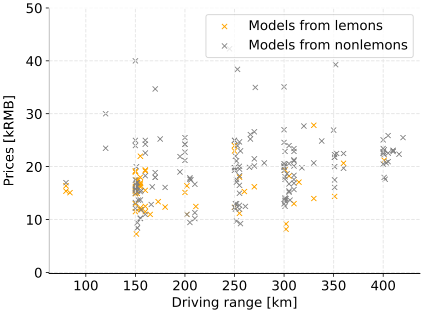

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Back to def Back to RF Back to forces Back to model Back to CF Back to CF Stringency

Lemons: Weak correlation between observables

- Share of lemons conditional on prices:

Price (10kRMB)	≤ 10	(10, 20]	(20,30]	> 30
2012	–	0.25	0.00	0.00
2013	–	0.33	0.00	0.00
2014	–	0.40	0.00	0.00
2015	–	0.62	0.08	0.00
2016	0.00	0.46	0.12	0.00
2017	0.25	0.30	0.05	0.00
2018	0.36	0.26	0.04	0.00

Back to lemon def

Lemons: Weak correlation between observables

- Share of lemons conditional on driving range:

Driving range (km)	≤ 100	(100, 150]	(150, 250]	> 250
2012	0.00	0.33	0.00	0.00
2013	0.00	0.50	0.00	0.00
2014	0.17	0.67	0.10	0.00
2015	0.21	0.50	0.41	0.00
2016	0.00	0.40	0.33	0.00
2017	0.00	0.40	0.31	0.06
2018	0.02	0.33	0.42	0.12

Back to lemon def

Lemons: Correlations with observables

- Correlation between lemons, prices, and driving range

	MSRP	Driving range
2012	-0.49	-0.07
2013	-0.52	-0.01
2014	-0.43	-0.29
2015	-0.51	-0.43
2016	-0.32	-0.38
2017	-0.22	-0.34
2018	-0.24	-0.30

Back to lemon def Back to CF summ

Firm background: Details

- **Firms**
  - New EV firms mostly entered around 2009-2015: 17 (2 exited)
  - Fringe GV firms mostly entered around 2012-2016: 24
  - Large GV firms mostly entered after 2017: 16 (until 2018)[2]
- Lemons: 3 new firms and 6 fringe GV firms

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[2] Market share $> 1\%$

Reputation Externality: Lemon sales decrease future adoption

- Potential Consumers in three mid-tier cities: Guangzhou, Tianjin, and Qingdao
- Impact on *log* potential buyer's perception (1-5 scale, mean 3.49) Results on Prob(EV)

Impact of friends' experiences				
Battery issues	-0.088***			
Engine issues		-0.051*		
Other quality issues			-0.090***	
Impact of lemons				
Friends' EV brand = lemon				-0.141***
Heard of lemon brands online				0.017
N	676	672	637	248
Income group, age group, and city FEs are included. $*p < 0.10; **p < 0.05; ***p < 0.01$				

$\Longrightarrow$ Low-quality signals from social network negatively impact potential consumers

$\Longrightarrow$ Lemon sales negatively impact consumer perceptions

$\Longrightarrow$ Reputation externality is more pronounced locally

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Reputation Externality: Lemon sales decrease future adoption

- Potential Consumers in three mid-tier cities: Guangzhou, Tianjin, and Qingdao
- Impact on potential buyer's prob(EV) (0-1 scale, mean $= 0.51$)

Impact of friends' experiences				
Battery issues	-0.036**			
Engine issues		-0.037*		
Other quality issues			-0.023	
Impact of lemons				
Friends' EV brand $=$ lemon				-0.057**
Heard of lemon brands				0.026**
N	676	672	637	248
Income group, age group, and city FEs are included. $*p < 0.10; **p < 0.05; ***p < 0.01$				

$\Longrightarrow$ Low-quality signals from social network negatively impact potential consumers

$\Longrightarrow$ Lemon sales negatively impact consumer choices

$\Longrightarrow$ Reputation externality is more pronounced locally

Back

Reduced-form evidence: Average Treatment effect

$$y_{jct} = \eta^{spillover} \mathbb{1}(PostFire)_{ct} + \eta^{involved} \mathbb{1}(PostFire)_{ct} \times \mathbb{1}(Involved)_j$$

$$+ \xi_j \cdot \gamma_t + \gamma_c + \varepsilon_{jct},$$

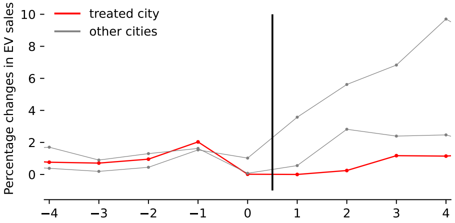
- Compare sales of the same firm in treated and controlled cities

$\eta^{spillover}$	-0.112***	$\eta^{involved}$	-0.097*
	(0.026)		(0.038)

Back

Reduced-form evidence: Externality of EV Fires

- Example: January 2017 Tianjin, Zhidou's EV fire
- Not only the involved firm (Zhidou)'s sales decrease, other EVs are also affected



BAIC sales before and after Zhidou' EV fire

back

Reduced-form evidence: Impact of lagged lemon share on future EV sales

- Treatment: city-level historical lemon share

$$lnS_{ojct} - lnS_{0,ct} = \eta LemonShare_{c,t-1} + \beta x_{ojct} + \underbrace{\xi_{ojt} + \xi_c + \xi_{pr,yr,j}}_{\text{FEs}} + \varepsilon_{ojct}$$

- If the proportion of lemons is higher in a particular city $\rightarrow$ EV sales of **all firms** $\downarrow$
  - S_{ojct}: model o, firm j, city c, period (quarter) t
  - x_{ojct}: local subsidies, green plate policy, driving restrictions
  - ξ_{ojt}: product-period FE
  - ξ: time-invariant: city-fuel type FE, province firm FE; time-variant: province-year FE

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  - x_{ojct}: local subsidies, green plate policy, driving restrictions
  - ξ_{ojt}: product-period FE
  - ξ: time-invariant: city-fuel type FE, province firm FE; time-variant: province-year FE
- Endogeneity: unobserved demand shocks (consistently favoring cheaper cars)
  - Supply-side lemon share shifter: central subsidy and distance to lemon plant

Details

Reduced-form evidence: Impact of lagged lemon share on future EV sales

- A 10% increase in lemon share will decrease future EV sales by 5.2%, equivalent to a price increase of 2,751 RMB

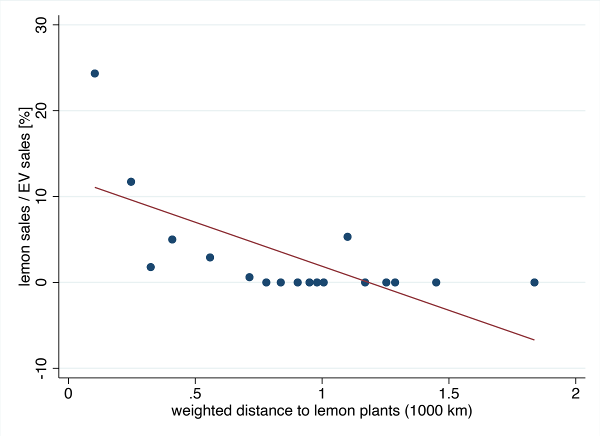
	(1)	(2)
$Lemonshare_{t-1}$	-0.052***	-0.060***
No drive rstr.	0.276*	0.263**
Greenplate	0.189*	0.164*
Subsidy	-0.176***	
Price		-0.189***
Motor power		0.449**
Driving range		0.137***
N	19448	19448
Model-period	Yes	
Firm-fuel type-period		Yes
City-fuel type, province-year, province firm	Yes	Yes

More specifications Heterogeneity Back

First stage: Distance to lemon plants and local lemon share

- X: proportion of lemon EVs
- Z: distance to lemon plants, weighted by annual plants' production
- When subsidies increase, cities close to lemon plants will have more lemons, and cities close to peach plants will have more peaches

Map of lemon plant locations



First stage: Distance to lemon plants and local lemon share

	(1) *lemonshare*	(2) *lemonshare*	(3) *lemonshare*	(4) *lemonshare*
Central S $\times$ distance^{-1}	0.584**	0.789***	0.763***	0.756***
	(0.266)	(0.255)	(0.257)	(0.267)
Inc 2020	0.207			
	(1.517)			
Bachelor 2020	-0.683**			
	(0.311)			
N	640	640	640	640
period FE	Yes	Yes	Yes	Yes
city FE		Yes	Yes	Yes
province–year FE	Yes	Yes	Yes	Yes
city–quarter FE				Yes
province–quarter FE			Yes	Yes

- Central subsidy and distance to lemon plants are exogeneous supply-side shifters of local proportion of lemon EVs Back to reduced form Back to identification

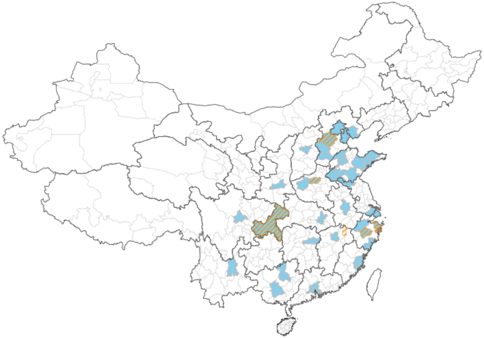
First stage: Distance to lemon plants and local lemon share

	$lemonshare_{t-1}$	$lemonshare_{t-1}$
$centrals_{t-1} \times$ Inv. $distance_{jc}$	0.151***	0.110***
	(0.021)	(0.025)
nodriverstr	-2.952*	-0.294
	(1.591)	(1.488)
greenplate	1.683***	1.948***
	(0.649)	(0.645)
Subsidy	-0.000	0.259
	(0.388)	(0.392)
Motor power		2.449
		(1.478)
Driving range		1.647
		(2.285)
N	19,448	19,448
Joint-F on excluded IVs	97.131	215.064
Underidentification stat	298.967	328.575
Weak identification stat	44.430	73.456

← Pass the first stage tests for various FE specifications

Back to reduced form Back to identification

First stage: Lemon plant locations



Lemon plants' locations

Back

Lemon Share: Average impact

Back

	(1) 2SLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
$lemonshare_{t-1}$	-0.039***	-0.058***	-0.052***	-0.031***	-0.047**	-0.057***
	(0.014)	(0.018)	(0.016)	(0.009)	(0.012)	(0.019)
No drive rstr.	0.188**	0.124**	0.276*	0.291***	0.147*	0.263**
	(0.094)	(0.061)	(0.172)	(0.107)	(0.097)	(0.132)
Green plate	0.173*	0.201**	0.189*	0.138*	0.154*	0.164*
	(0.115)	(0.100)	(0.135)	(0.092)	(0.097)	(0.109)
Subsidy	-0.164***	-0.171***	-0.176***			
	(0.016)	(0.015)	(0.021)			
Price				-0.193***	-0.190***	-0.189***
				(0.016)	(0.016)	(0.021)
Motor power				0.633***	0.424***	0.449***
				(0.140)	(0.142)	(0.146)
Driving range				0.038	0.018	0.037
				(0.041)	(0.041)	(0.040)
$adjR^2$	-0.235	-0.342	-0.339	-0.262	-0.181	-0.160
N	19,448	19,448	19,448	19,448	19,448	19,448
model–period	Yes	Yes	Yes			
firm–fuel type–period				Yes	Yes	Yes
city–fuel type	Yes	Yes	Yes	Yes	Yes	Yes
province–year		Yes	Yes		Yes	Yes
province–firm	Yes		Yes	Yes		Yes
Joint-F on excluded IVs	84.923	119.660	97.131	272.235	248.942	215.064
Underidentification stat	89.660	256.544	298.967	145.338	261.373	328.575
Weak identification stat	13.079	37.981	44.430	21.305	58.080	73.456

Lemon Share: Heterogeneous impact

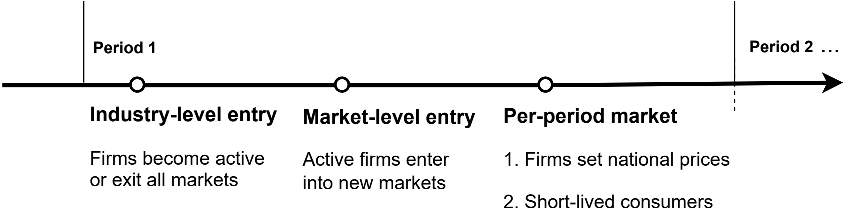
	(1)	(2)	(3)
$Lemonshare_{t-1}$	-0.052***		
PHEV $\times LS_{t-1}$		0.035	
BEV $\times LS_{t-1}$		-0.063***	
PHEV $\times LS_{t-1}$			0.039
lemon BEV $\times LS_{t-1}$			-0.012**
non-lemon BEV $\times LS_{t-1}$			-0.047***
N	19448	19448	19448
model-period	Yes	Yes	Yes
city-fuel type	Yes	Yes	Yes
province-firm	Yes	Yes	Yes
province-year	Yes	Yes	Yes

- Heterogeneity in the impact
- Separate impact on lemons and externality

back

Model: Finite period dynamic discrete choice model

- 2012 - 2018, 20 provinces
- **Industry potential entrants:** all GV firms and all registered EV firms, exogenous location and exogenous quality
- Asymmetric information corr



1. Endogeneous transition: market structure, EV reputation, battery cost
2. Exogeneous evolution: policies, demographics

Back to key primitives

Model: Demand system at city-quarter level

$$u_{i,oj,ct} = X_{oj}\beta_i - \underbrace{\alpha_i \cdot (p_{ojt} - s_{ojct})}_{\text{consumer price}} + \underbrace{q^e_{ct}\boldsymbol{\theta_i}}_{\text{reputation factors}} + \overline{\xi}_{jt} + \overline{\xi}_{ct} + \xi_{ojct} + \epsilon_{i,oj,ct}$$

$$q^e_{ct} = [lemonshare_{c,t-1}, \quad \mathbb{1}(fire)_{c,t-1}, \quad \mathbb{1}(fire)_{jc,t-1}] \cdot \mathbb{1}(EV)$$

- Consumer i, model o from firm j, in city c, period t
  - X_{oj}: driving range, engine power, weight, fuel type, policies
  - Colletive and firm-specific reputation (firm-EV-year FE)
  - FEs control unobserved demand: province-firm, city-fuel type, city-year
  - Random coefficients: fuel type and $\alpha_i = exp(\overline{\alpha} + \sigma_p \nu_{ip})/inc_i$, $\theta_{ik} = \theta_k exp(\nu_{iq})$

Back to key primitives

Bayesian Back to CF overview Back to three channels

Model: Firm pricing, entry, and expansion

- **National prices:** firms maximize per-period profit Details
- **MC:**

$$marginalcost_{ojt} = \omega_t \cdot batterycapacity_{oj} + X_{oj}\omega_2 + \overline{\xi}_j + \overline{\xi}_t + \varepsilon^c_{ojy}$$

- **Industry-level and market (province)-level entry**
  - Enter the EV industry (active):

$$\overline{FC}_j = \Gamma_0 + \Gamma_1 \mathbb{1}(GV)_j + \Gamma_2 \mathbb{1}(Lemon)_j$$

  - Enter province m that contains cities $c \in M$:

$$FC_{jm} = \gamma_0 + \gamma_1 \mathbb{1}(GV)_{jm} + \gamma_2 Distance_{jm} + \gamma_3 Distance_{jm} \mathbb{1}(GV)_j$$

Back to key primitives

Value Functions and Equilibrium: Partially oblivious equilibrium with 3 dominant firms

- $V_{jmt}(s_{mt}, s_{It}) = \pi_{jmt}(s_{mt}, \omega_t) + \beta E V_{jm,t+1}(s'_m, s'_I | s_{mt}, s_{It})$
  - Market state: 3 dominant firms' status, $n^h_{mt}, n^l_{mt}, reput_{mt}$
  - Industry state: 3 dominant firms' activation status, n^h_t, n^l_t, ω_t

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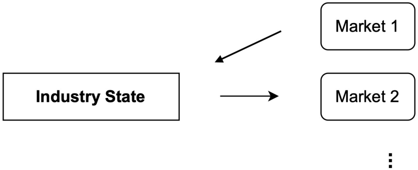

Details Value functions

Value Functions and Equilibrium: Partially oblivious equilibrium with 3 dominant firms

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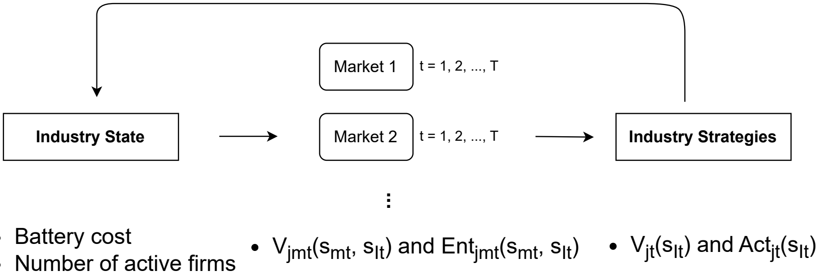

Details | Value functions

Value Functions and Equilibrium: Partially oblivious equilibrium with 3 dominant firms

- $V_{jmt}(s_{mt}, s_{lt}) = \pi_{jmt}(s_{mt}, \omega_t) + \beta E V_{jm,t+1}(s'_m, s'_l | s_{mt}, s_{lt})$
  - Market state: 3 dominant firms' status, $n^h_{mt}, n^l_{mt}, reput_{mt}$
  - Industry state: 3 dominant firms' activation status, n^h_t, n^l_t, ω_t

- Purpose:
  - Richly capture profit heterogeneity across firms and markets in a tractable way (V_{jmt})

    $\rightarrow$ Does the subsidy attract lemons or nonlemons? Heterogeneity in π_{jmt}
  - Allow for entry spillover and characterize firm expansion paths

    $\rightarrow$ Which provinces are responsible for the **nationwide** reputation concerns?

Details Value functions

Estimation

Estimation and Results

Estimation: Identification

- Demand system: $E[\xi_{ojct}|Z_{ojct}] = 0$ and micro-moments (Berry et al. (2004))
  - α price coefficient:
  - IVs: central subsidy/tax and battery weight; Micro-moments: income-segment
  - θ reputation coefficient:
  - IVs are supply side shifters: central subsidy$_t$ $\times$ distance to lemon firms$_m$ Details
  - ω_t battery cost
- Dynamic entry model: MLE $\Longrightarrow$ (γ, Γ) fixed cost parameters Details

Results: Demand and marginal cost

		Coef.	S.E.
α	$\overline{\alpha}$	1.589	(0.102)
	σ_p	0.298	(0.014)
θ	L.fires$_{involved}$	-0.067	(0.029)
	L.fires	-0.151	(0.013)
	L.lemon share	-0.137	(0.015)
	Engine power	0.104	(0.031)
	Driving range	0.365	(0.071)

(¥10K)		Coef.	S.E.
Battery capacity (kWh)	2015	0.415	(0.016)
	2016	0.344	(0.013)
	2017	0.264	(0.027)
	2018	0.215	(0.019)
Vehicle weight		5.014	(0.063)
Engine power (GV)		9.955	(0.042)
Engine power (EV)		0.207	(0.045)

- α_i price elasticity -3.97 (Literature: US -2.7, Norway -1.5, US low-inc -3.5)
- θ_i reputation: a 10% increase in historical lemon share decreases sales by 2.58%
- ω_t battery cost $\sim$ 57% of marginal costs, ¥4k(\$593) $\rightarrow$ ¥2k(\$307)$/kWh$ (annual rdc. 20%)
  - Upstream spillover calibration: baseline reduction rate = 9% Details

Details Back to key primitives

Results: Entry Cost

- The fixed cost of entering the EV industry is around **260 million RMB** ($40 mil.):

$$\overline{FC}_j = \Gamma_0 + \Gamma_1 \mathbb{1}(GV)_j + \Gamma_2 \mathbb{1}(Lemon)_j$$

- The fixed cost of entering each provinces is around **20 million RMB** ($3 mil.):

$$FC_{jm} = \gamma_0 + \gamma_1 \mathbb{1}(GV)_{jm} + \gamma_2 Distance_{jm} + \gamma_3 Distance_{jm} \mathbb{1}(GV)_j$$

			GV advantage		Lemon		Distance (100km)		ϵ	
Industry-level	Γ_0	26.18	Γ_1	-3.75	Γ_2	-1.92			ρ	3.24
		(3.57)		(1.19)		(0.11)				(1.23)
Market-level	γ_0	2.07	γ_1	-1.25			γ_2	0.03	ρ	0.18
		(0.01)		(0.02)				(0.01)		(0.03)
							γ_3	-0.02		
								(0.01)		

Model fit Back to key primitives

Policy Design: Welfare definition

Welfare: $\mathbb{E}[\sum_{t=2012}^{2022} CS_t - EE_t + FP_t - FI_t - \lambda \cdot SS_t]$

$$CS_{ct} = \sum_{oj \in O_{ct}} \int_i P_{ioct} \cdot [\underbrace{\frac{1}{\alpha_i} \cdot (\delta_{ioct} + \theta_i q^e{}_{ct} - \alpha_i (p_{ojt} - s_{ojct}))}_{\text{ex-ante utility } u_{i,oj,ct}} + \underbrace{\frac{\theta_i}{\alpha_i} \cdot (q_j - q^e{}_{ct})}_{\text{experience quality}}] di$$

- Subsidy period 2012-2018 + Post-subsidy period 2019-2022
- Fix other policies and restrict firm actions to pricing, entry, and exit responses

Policy Evaluation: Limited net welfare benefit and rise in lemon entrants

- Benefit 55.73 billion RMB ($8.57 bil.), cost 56.7 billion RMB ($8.72 bil.) Details
  - Simulated Reality – No subsidy counterfactual
  - 83% EV sales, 57% lemon firms and 49% non-lemon firms wouldn't exist Details

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- Do subsidies attract lemons and why?
  - The subsidy incentivizes price-sensitive consumers and benefits lemons more (α) Details

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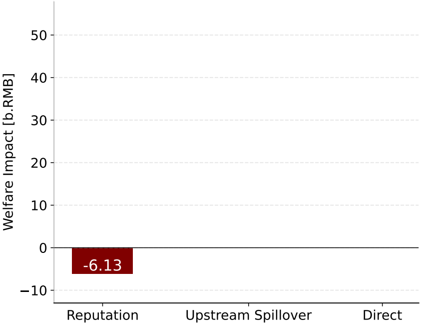
  - The subsidy incentivizes price-sensitive consumers and benefits lemons more (α) Details
  - Province heterogeneity Details

    Incentivizing low-price sensitive markets can drive high-quality entrants

Policy Evaluation: The three channels

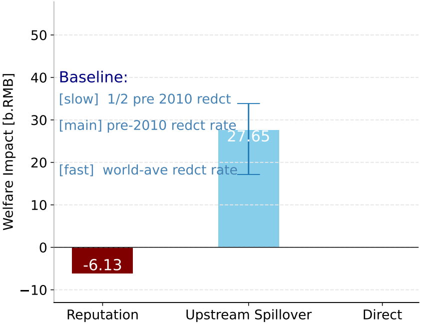


	Sim. reality	Full info.
Lemon share 2015	39.92	32.05
2018	13.65	11.85
Sales [1,000]	1,883.46	1,951.60
Emissions	3.37	3.14
Static loss	-3.45	–
Equilibrium loss	-6.13	–
Lemon prices [¥10k]	14.84	13.39
Lemon #prov	5.23	2.67
Non-lemon	6.79	7.42

- **Reputation channel:** ex-post loss + choice distortion + market shrinkage (θ, FC)
- Upstream spillover: reduce mc by $1/3$ and expand the market (ω) Sensitivity
- Direct channel: reduce prices, expand the market, DWL and excess entry (α, FC)

Details Impact on π_{jmt} utility

Policy Evaluation: The three channels



	Sim. reality	No upstr. spl.
MC [¥1,000]	136.97	173.79
Sales [1,000] 2012-2018	1,883.46	768.59
post-subsidy annual	201.70	105.29

- Reputation channel: ex-post loss + choice distortion + market shrinkage (θ, FC)
- **Upstream spillover:** reduce mc by 1/3 and expand the market (ω) Sensitivity
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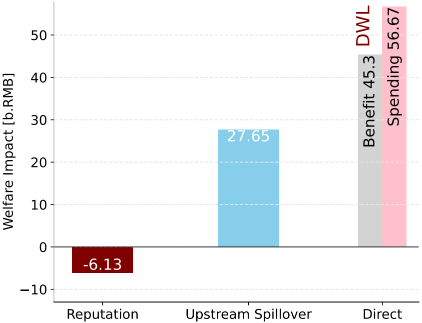
Policy Evaluation: The three channels



	Sim. reality	No direct impact
$p^c - mc + ee$	-7%	31%
Sales [1,000]	1,883.46	408.42

- Reputation channel: ex-post loss + choice distortion + market shrinkage (θ, FC)
- Upstream spillover: reduce mc by 1/3 and expand the market (ω) Sensitivity
- **Direct channel:** reduce prices, expand the market, DWL and excess entry (α, FC)

Details Impact on π_{jmt} utility

Optimal Subsidy: Results preview

- Evaluation: low efficiency and reputation loss (10.8%)

  → A perfect certification program: improve welfare by 10.8%

Optimal Subsidy: Results preview

- Evaluation: low efficiency and reputation loss (10.8%)

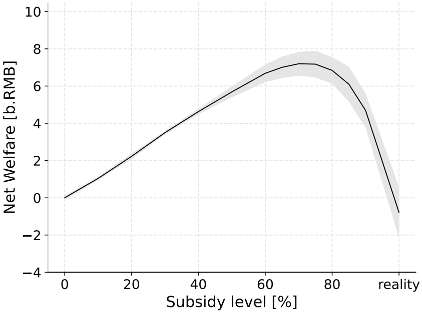
  → A perfect certification program: improve welfare by 10.8%

- Attribute-based subsidy: $T + t \times DrivingRange$
  - The **optimal level** is mainly determined by the direct and upstream spillover channel
  - The **optimal stringency** is mainly determined by the reputation channel corr

- Other policies: regional policy and investment subsidies
- Other parameter space and sensitivity

Subsidy Level: Direct impact dominates, with reputation considerations

Back to CF

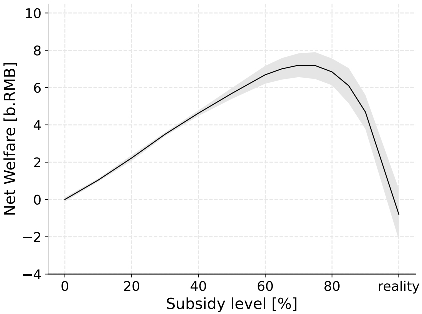


- Welfare is maximized at 70% of the current subsidy → net welfare 7.4 b. ($1.14b.)

Details

Subsidy Level: Direct impact dominates, with reputation considerations

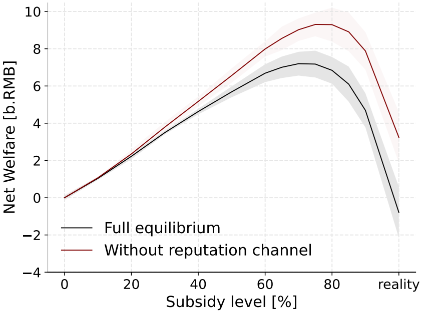
Back to CF



- **Direct channel: static DWL vs. Post-subsidy markup ↓ from entry**
  - Address underadoption as market power+env.ext; insuf. entry as profit < FC < SW
  - 70%+: Additional subsidy generates much DWL but little entry response Table

Subsidy Level: Direct impact dominates, with reputation considerations

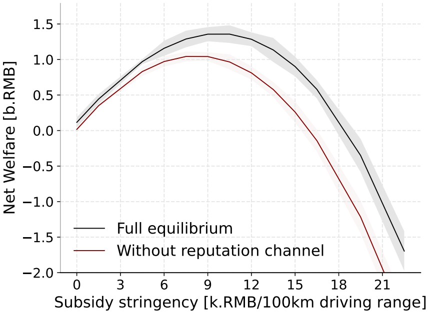
Back to CF



- **Ignore the reputation channel: waste 5% more subsidy** Table Subsidy attracts lemons
  - → 336.0 million RMB ($51.7 million) decrease in net welfare
  - Not the best way to differentiate lemons

Subsidy Stringency: Costly growth vs higher reputation

Back to CF

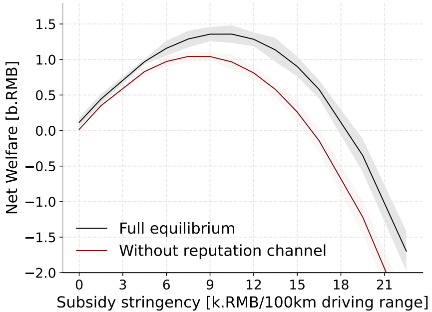


- Welfare is maximized at ¥10k ($1.3k) per 100km Details
- Ignore the reputation channel leads to a loss of 137.07 million RMB ($20.77 million)

Compare to reality Table of the three channels

Subsidy Stringency: Costly growth vs higher reputation

Back to CF



- **Reputation channel:** corr
  - + Higher stringency can suppress lemon growth Lemons profits
  - − Per GV/EV switch is more expensive

Compare to reality Table of the three channels

Optimal Subsidy: A framework of green industrial policy design

- **Attribute-based consumer subsidy**
  - **Optimal level** (¥7.4b.,$1.14b.) $\leftarrow$ the direct channel (α, *FC*, ω)
  - **Optimal stringency** (¥137.07m.,$20.77m.) $\leftarrow$ the reputation channel (α, *corr*; θ, *FC*)
- Other policies
  - Regional policies: Starting from low-p-sensitive markets and utilizing across market entry spillover $\rightarrow$ reduce reputation concerns nationwide Results
  - Investment subsidy to non-lemons: can decrease the required stringency level Results
- Other parameter space: reputation impact can dominate, subsidy $\uparrow$ EV sales $\downarrow$ Results

A Toy Bayesian Model: Firm common + private quality leads to across-firm inference

N Firms:

- Quality $q_j = q^{tech} + y_j$
  - q^{tech}: the performance of the innovative technology
  - y_j: drawn from $F_y(y)$. The firm's ability to implement the technology or relative ranking
- All firms have the same constant marginal cost.

1 continuum of short-lived consumers in each period

- ex-post $u_{ij} = \underbrace{\beta x_j + \theta q_j}_{v_j} - \alpha_i p_j + \epsilon_{ij}$
- Consumers do not observe q_j.

A Toy Bayesian Model: Timing

- Nature draws a innovative technology $q^{tech} \sim N(\mu_0, 1/\tau_0^2)$
- At the beginning of period 1:
  - Firms get a random draw of its own $y_j \sim N(0, 1/\tau_y^2)$, and decide entry simultaneously
  - If a firm enters, consumers get a signal $s_j \sim N(y_j, 1/\tau_s^2)$
- **Period 1:**
  - Firms set static prices
  - Short-lived consumers: $u_{ij} = \beta x_j + \theta E[q^{tech} + y_j | \mu_0, s_j] - \alpha_i p_j + \epsilon_{ij}$
- **Period 2:**
  - Firms set static prices
  - Consumers arrive and update beliefs on q^{tech} based on what was sold $\{s_j, q_j, share_j\}_{j=1}^n$
  - Consumers purchase or leave

Back to reduced-form   Back to demand

A Toy Bayesian Model: Market share as signal frequency

$$u_{ij,t=2,m} = \beta x_j + \underbrace{\theta \mu_{2,m}}_{\text{technology perception}} + \underbrace{\theta E[y_j|s_j]}_{\text{brand perception}} - \alpha p_j + \epsilon_{ij}$$

$$\mu_{2,m} = \mu_0 + \left(1 + \frac{\tau_0^2}{n\sum_j share_j \tau_{sj}^2 + n\tau_y^2}\right) \times \left[[q^{tech} - \mu_0] + \sum_j share_j (1-\gamma_j) y_j + \sum_j share_j \gamma_j (y_j - s_j) \right]$$

Posterior $q^{tech} \sim N(\mu_{2,m}, 1/\tau^2_{2,m})$, signal precision $\gamma_j := \frac{\tau_{sj}^2/\tau_y^2}{1+\tau_{sj}^2/\tau_y^2}$

- Tesla: high γ_j, high s_j $\implies$ a low y_j leads to a large impact on collective reput.
- Unbranded car: low γ_j $\implies$ a low y_j decreases collective reputation

A Toy Bayesian Model: Reduced-form parametrization and lemon share

$$u_{ij} = \beta x_j + \underbrace{\theta_i \mu_{t,m}}_{\text{rand. taste on } \mathbb{1}(EV) \times \mathbb{1}_{city-yr}} + \underbrace{\overline{\xi_{jt}}}_{\text{captures } E[y_j|s_j]} - \alpha_i (p_j - subsidy_{jmt}) + \varepsilon_{ij}$$

Full model
$$\mu_{t,m} = \mu_0 + \left(1 + \frac{\tau_0^2}{n \sum_j share_{j,t-1,m} \tau_{sj}^2 + n\tau_y^2}\right) \times \left[[q^{tech} - \mu_0] + \sum_j share_{j,t-1,m} (1 - \gamma_j) y_j + \sum_j share_{j,t-1,m} \gamma_j (y_j - s_j) \right]$$

Reduced form
$$\mu_{t,m} = \mu_0 + \theta_i \times lemonshare_{t-1,m}$$

Back to reduced-form   Back to demand

Value Functions: Market-level

- Last period:

$$V^{j}_{mT}(s_{mT}, s^{I}) = \frac{1}{1-\beta}\pi^{j}_{mt}(s_{mT}, \underbrace{s^{I}}_{mc \text{ and } prices}) \tag{1}$$

$$V^{pe,j}_{mT,s^{I}}(s_{mT}, s^{I}) = 0 \tag{2}$$

Back to equilibrium Back to firm strategy

Value Functions: Market-level

- Incumbent firm:

$$V^j_{mt}(str_{mt}, reput_{mt}, s_{lt}) = \pi^j_{mt}(str_{mt}, reput_{mt}, \underbrace{s_{lt}}_{\text{mc and prices}}) + \beta \int_{s'} V_{m,t+1}(s') f(\underbrace{s'}_{str'_m, reput'_m, s'_l} | s_{mt}, s_{lt}) ds' \times \underbrace{(1 - Pr^j_{exit,t}(s_{lt}))}_{\text{from outer loop}} \quad (3)$$

- Potential entrants :

$$V^{pe,j}_{mt}(str_{mt}, reput_{mt}, s_{lt}) = max \begin{cases} -FC^j_{mt} + \beta \int_{s'} V^j_{m,t+1}(s') f(s'|s_{mt}, s_{lt}) ds' \times (1 - Pr^j_{exit,t}(s_{lt})) + \epsilon_{jmt,1} \\ \beta \int_{s'} V^{pe,j}_{m,t+1}(s') f(s'|s_{mt}, s_{lt}) ds' \times (1 - Pr^j_{exit,t}(s_{lt})) + \epsilon_{jmt,0} \end{cases} \quad (4)$$

Back to equilibrium Back to firm strategy

Value Functions: Industry-level

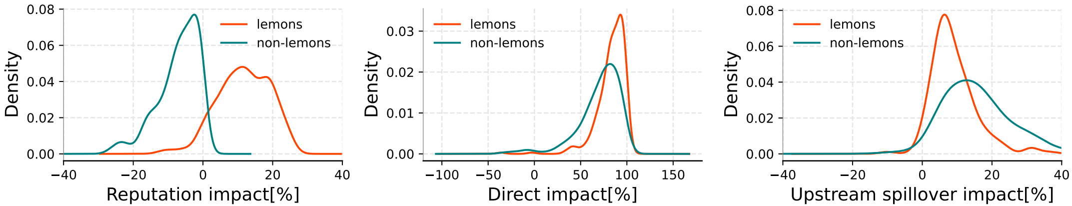
- For all firms:

$$V_t^j(s_{It}) = \sum_m \int_{s_{mt}} V_{mt}^j(\underbrace{s_{mt}}_{str_{mt}, reput_{mt}}, s_{It}) \underbrace{P_t(s_{mt}|s_{It}) ds_{mt}}_{\text{guess where each firm would enter from inner loop}} \quad (5)$$

- Probability of active: $Pr(V_t^j - \beta V_{t+1}^j > \overline{FC}^j)$
- Probability of exit: $Pr(V_t^j <$ scrap value$)$

Back to equilibrium Back to firm strategies

Static Results: Impact of the subsidy on firm per-period profits



- Fix market structures:

1. Reputation impact: simulated reality − full info counterfactual
2. Direct impact: simulated reality − no subsidy counterfactual
3. Upstream spillover impact: simulated reality − mc in baseline counterfactual

Back to POE Back to mc Back to decomposition

Results: Upstream Spillover

- Calibrate the impact of EV sales on battery cost with a log-log regression following Nykvist and Nilsson (2015) and Ziegler and Trancik (2021)

	Reality [$k.RMB/kWh$]		Baseline [$k.RMB/kWh$]		
EV Sales (1,000)	Estimated	Industry report	**Main**	Conservative	Aggressive
47.96	4.15	3.73	6.34	5.17	7.22
161.54	3.24	2.88	5.77	4.39	6.86
267.43	2.64	2.14	5.25	3.73	6.51
448.52	2.15	1.76	4.78	3.17	6.19

- Average annual reduction rate:

  Reality: 20%, Baseline: 5% (aggressive), 9% (main), 15% (conservative)

Back to MC Sensitivity

Estimation: Dynamic Entry

Table: Number of observations in the MLE

	2012	2013	2014	2015	2016	2017	2018
Number of new firm-province $\mathbb{1}_{jmt} == 1$	10	31	54	39	152	273	–
Number of firm-province $\mathbb{1}_{jmt} == 0$	110	149	166	301	308	427	–
Number of new firm $\mathbb{1}^{a}_{jt} == 1$	3	2	6	6	12	20	–

- Rich entry and expansion actions help identify entry costs

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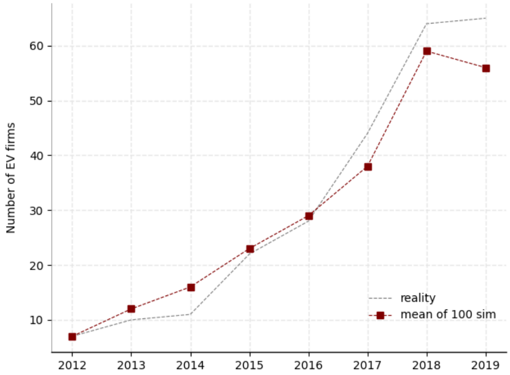
Model Fit



Number of firms by year (100 simulations)

- At the industry level, model prediction fits the data well
- Our model can capture most firms' actions at the market level
  - Observed number of firm-market in 2017 and 2018: 281, 504
  - Simulated reality: 241 and 415
  - Sales data fits well, 1,605 thousand EV, 1,569 thousand, accounting for 97% of observed EV sales.

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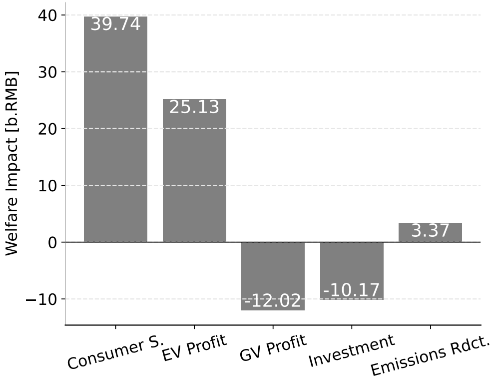
Policy Evaluation: Welfare components



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Policy Evaluation: Sales and firm entry responses

- Increase EV sales by 83%
- Speed up firm entry, especially in early years like 2015
- Lemons are more elastic at the market-level entry margin

	No subsidy	Simulated Reality
Sales in 1,000		
EVs	311.28	1,883.46
GVs ·	–	-660.67
Firms and markets		
a. Industry-level entry margin		
Lemon firms 2015	1.67	5.03
2018	5.49	7.20
Non-lemons 2015	4.73	9.50
2018	20.79	35.15
b. Market-level entry margin		
# prov. lemons 2015	0.40	7.80
lemons 2018	7.29	9.43
non-lemons 2015	1.57	3.50
non-lemons 2018	5.52	7.48

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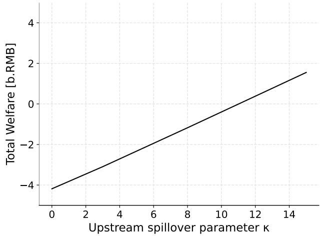
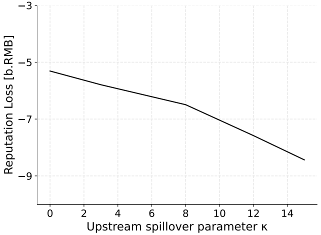
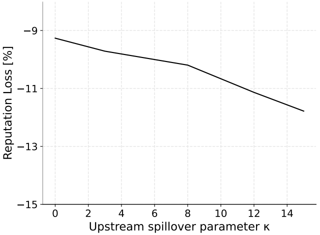
Policy evaluation: Upstream spillover sensitivity



(a) Impact on total welfare [b.RMB]



(b) Impact on the reputation channel [b.RMB]

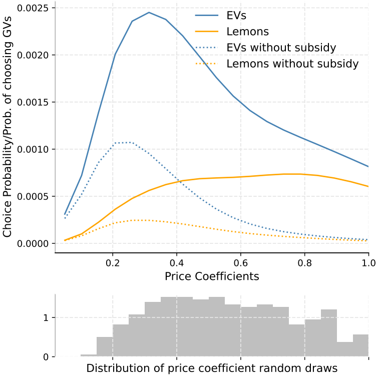


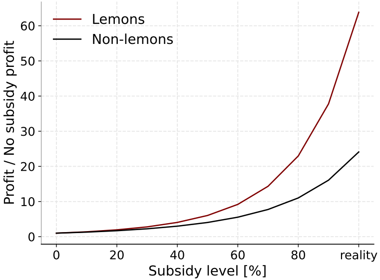
(c) Impact on the reputation channel [%]

- Even with the most aggressive assumption, subsidy benefit only marginally exceeds government spending
- The reputation loss remains around 10%

Back to channels Calibration

Lemon attractiveness: Higher subsidy benefits lemons



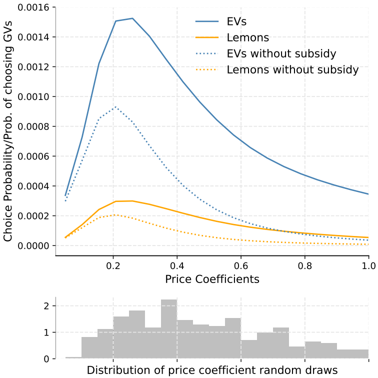


(a) P-sensitive consumers (right) switch to lemons (b) Lemon profits increase more as subsidy increase

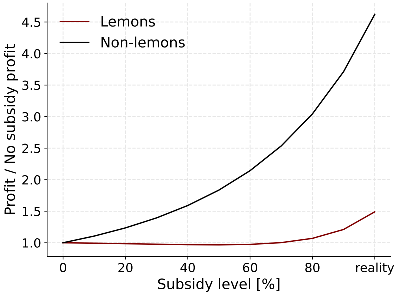
- More subsidies incentivize price-sensitive consumers, who switch to lemon EVs

Back to policy eval Back to subsidy levels

Lemons attractiveness: A different example



(a) A high-income province Jiangsu



(b) Non-lemon profits increase more as subsidy increase

- Higher price sensitivity distribution. More subsidies benefit non-lemons more

Back to policy eval Back to subsidy levels

Subsidy level: Details on the three channels

	Alternative levels of subsidy			Sim. Reality
	0	50	70	100
Direct impact				
Markup [%]	0.31	0.20	0.13	-0.07
Markup [1,000 RMB]	85.64	46.83	30.42	4.30
Upstream spillover impact				
MC [1,000 RMB]	155.26	147.95	144.81	137.73
Reputation Impact (billion RMB)				
One-period impact				
CS ex-post loss	–	-0.17	-0.32	-0.85
CS misinfo distortion	–	-0.09	-0.17	-0.42
Spillover	–	-0.40	-0.76	-1.27
Equilibrium impact				
CS loss	–	-0.48	-1.07	-2.44
Spillover	–	-0.44	-1.45	-2.17
Spillover [%]	–	-5.54	-6.61	-7.32
Environmental Benefit	–	-0.05	-0.11	-0.23

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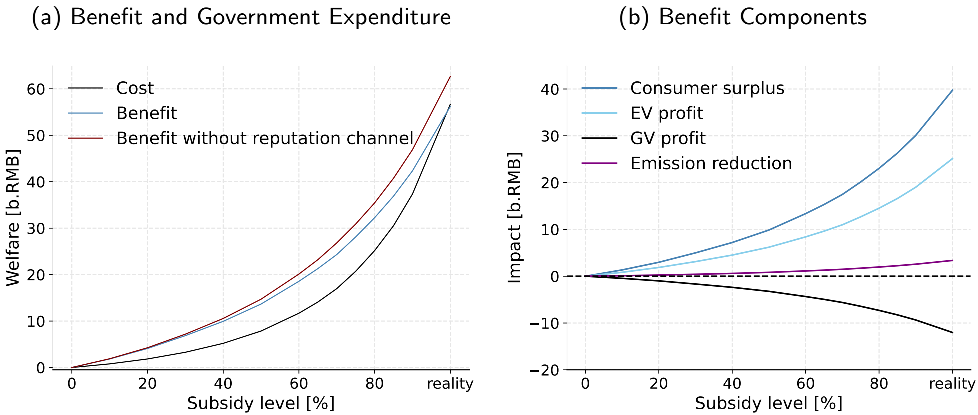
Subsidy level: Details on welfare components

Figure: Alternative level of subsidy



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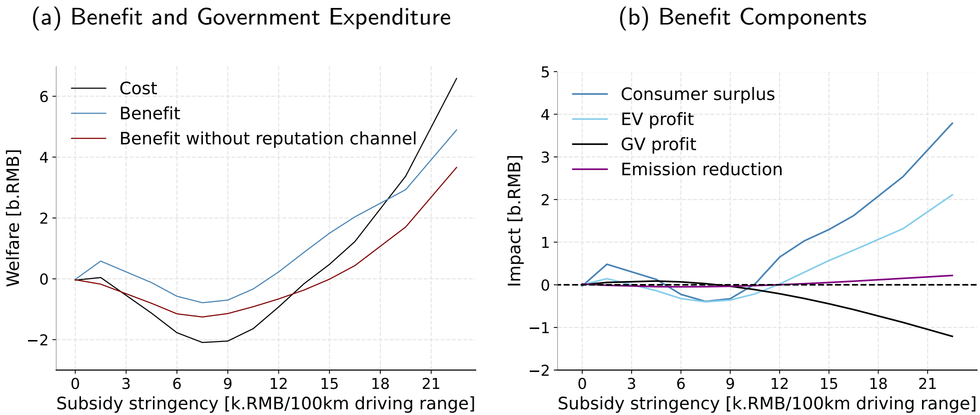
Subsidy Stringency: Details on welfare components

Figure: Alternative stringency of subsidy



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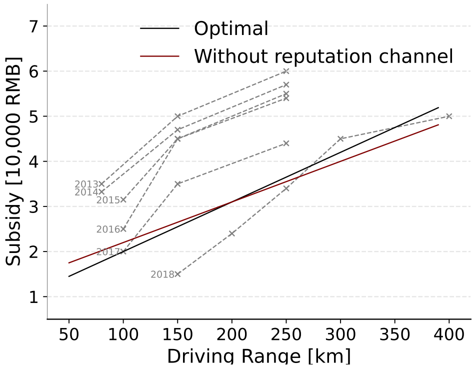
Subsidy Stringency: Compare with the actual policy



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Subsidy Stringency: Details on the three channels

	Subsidy Stringency		
	0	10	18
Direct Impact			
Markup [%]	-0.04	-0.01	0.02
Markup [1,000 RMB]	10.25	9.80	7.90
Upstream Spillover Impact			
MC [1,000 RMB]	140.89	141.40	141.37
Reputation Impact (billion RMB)			
One-period impact			
CS ex-post loss	-0.49	-0.44	-0.38
misinfo distortion	-0.25	-0.23	-0.21
Spillover	-0.60	-0.61	-0.69
Equilibrium impact			
CS loss	-1.57	-1.31	-0.65
Spillover	-1.72	-1.23	-0.86
Environmental Benefit	-0.18	-0.12	-0.06

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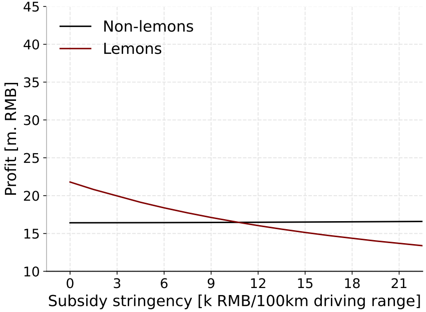
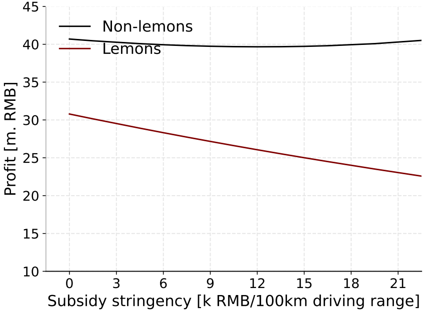
Subsidy Stringency: Higher stringency benefit non-lemon firms



(a) 2015



(b) 2017

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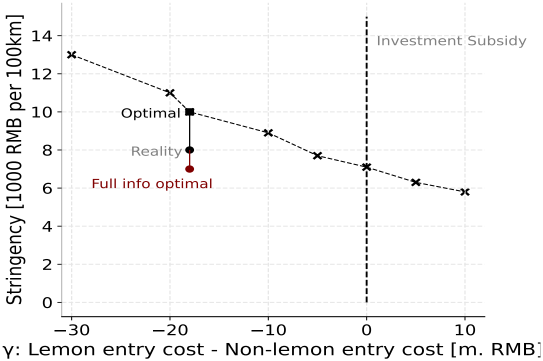
Investment Subsidy: can decrease the required subsidy stringency

- Investment subsidy to non-lemons can save the large cost from increasing stringency



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Regional Policies: Entry spillover helps

- Starting from low-p-sensitive markets and utilizing the across market entry spillover
  - Policy in reality: 13 cities → 88 cities in 2014 → all cities in 2016
  - Postpone four selected province's subsidies until 2018

	Simulated reality	Δ CF policy
Net welfare	-0.94	+2.15
Reputation loss	6.13	-1.16
EV sales [1,000]	1883.46	-213.15
Subsidy spending	56.67	-5.21
For the 4 provinces		
EV firms 2018		-3.2%
EV sales 2018 [1,000]	45.44	42.93

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