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Short communication

China's electric car surge

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ABSTRACT

China's plug-in electric vehicle (PEV) sales, comprising both battery electric and plug-in hybrid vehicles, surged 343% in 2015, and are expected to reach 2 million by 2020. Two factors are crucial to this sudden transformation: 1) massive central and local government subsidies, and 2) huge non-monetary incentives via exemptions from restrictions on vehicle ownership in Beijing, Shanghai, and elsewhere. Innovative business models and greatly expanded vehicle offerings, especially by local Chinese manufacturers, also helped accelerate PEV sales and infrastructure deployment. However, continued sales growth is threatened by persistent regional protectionism, the unsustainability of these large subsidies, and widely reported cheating by some automakers. We suggest some innovative policies that China might pioneer and transfer elsewhere.

1. Introduction

China surpassed the United States in both annual and cumulative plug-in electric vehicle (PEV) sales in 2015. PEV sales jumped 343% in 2015 to about 331,000, three times the number sold in the U.S. (See Fig. 1). This dramatic increase suggests that the national goal of 5 million PEVs on road by 2020 is achievable. The rapid market uptake catapulted Chinese automaker BYD to No. 1 PEV producer in the world, edging out Tesla and Nissan, with another six Chinese automakers also ranking in the top 20 PEV automakers in the world (D1ev 2016). It was China's surge that prompted Bloomberg to project that PEV sales will account for 35% of the new global vehicle market in 2035, with an average annual growth rate of 30% (Bloomberg, 2016).

The Chinese government believes that PEVs are one of the best strategies to reduce air pollution, oil imports, and greenhouse gas emissions, as well as leapfrogging international automotive companies (Xinhua, 2016; Wang and Kimble, 2011).

Just two years ago in 2014, we wrote about "China's EV frustrations"—how PEV sales in China were stagnating, despite massive subsidies and incentives (Wan et al., 2015). What happened in such a short time?

First, monetary incentives by both central and local governments were boosted still higher. Second, several megacities, in particular Beijing, Shanghai, and Shenzhen, adopted aggressive non-monetary policies in 2014 and 2015 to boost PEV sales to reduce local pollution—with the result that PEV sales (D1ev, 2016a) in the three cities soared to 37% of total PEV sales in the entire country, even though those cities accounted for only 4% of the population. Third, led by local companies such as BYD, BAIC, and SAIC, automakers greatly expanded the supply of new PEV models, providing 832 approved models[1] as of June 2016 (compared with 28 PEV models available in California). Fourth, Chinese entrepreneurs started to experiment with innovative PEV deployment and infrastructure business models.

1.1. Monetary Incentives from the central and local governments

Previous studies found that high purchase price plays a central role in discouraging PEV sales (Egbue and Long, 2012). In 2015, the central government provided as much as $8.4 billion in PEV incentives to consumers (Table 1), about 10 times more than the US government.[2] Together with subsidies from local governments, the direct financial incentives can amount to as much as $16,000 per car in China. On top of that, the 10% sales tax on vehicles is exempted, and homeowners in many cities receive subsides for home chargers.

Many local governments match central government subsidies, often on a one-to-one basis. Among the most generous are Shanghai (with 16.8% of total PEVs sales in the country), Beijing (9.9%), and Shenzhen (10.4%). In Shanghai, some district governments offered still additional money on top of subsidies from the municipality: as much as 20,000 RMB. These generous subsidies were intended not only to reduce pollution but to assist local automakers (SAIC in Shanghai, BYD in Shenzhen, and BAIC in Beijing).

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[1] Many Chinese car companies just sell a few PEVs.

[2] We simply assumed that each of the total 115,262 PEVs sold in the U.S. in 2015 received a federal tax credit of $7500 to reach a total of $864 million in maximum.

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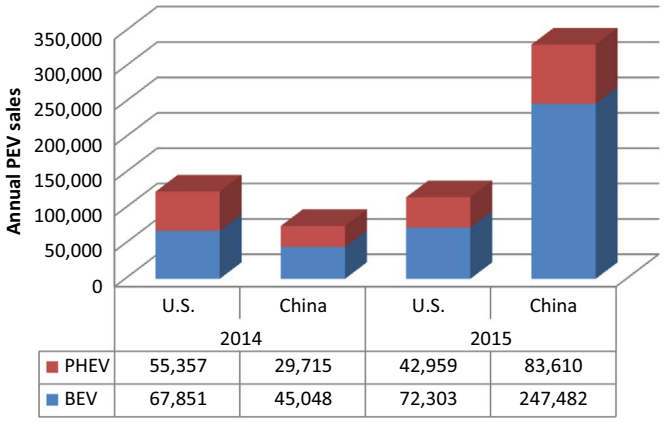

Fig. 1. China and U.S. PEV Sales.

Table 1
2015 Central Government Subsidies Estimated.
Source: Vehicle Sales Date from China Association of Automobile Manufacturers (CAAM).

Vehicle type	2015 sales	Subsidies per vehicle	Received
Passenger vehicle	**207,382**		**8,513,239,500**
PHEV	60,663	31,500[a]	1,910,884,500
BEV	146,719	45,000	6,602,355,000
Commercial vehicle[b]	**123,710**		**46,041,950,000**
PHEV	22,947	250,000	5,736,750,000
BEV	100,763	400,000	40,305,200,000
Total	**331,092**		**54,555,189,500**
Total in US dollars		(6.489 RMB=1 USD)	**8,407,333,873**

[a] The subsidies rate for PHEVs is slightly smaller than that of BEVs, but they must have an electric range of 50 km or above to receive subsidies.
[b] For simplicity, we assume that all the commercial trucks and buses are between 8 m and 10 m in length.

1.2. Non-monetary incentives

The most effective incentive for PEV sales appears to be the offering of free license plates (i.e., permission to purchase a vehicle), an incentive that jumpstarted the sales of PEVs in several cities. In Shanghai, for example, conventional (gasoline) vehicle purchasers must bid through the "controlled auction" to acquire a license plate. As indicated in Table 2, the average auction price in 2015 was RMB 80,686. The bidding success rate in 2015 was only 5%, because a complicated and opaque formula was used to only accept a portion of the high bids. PEV buyers can bypass this controlled auction system, thus saving $12,434 and potentially a long waiting time.

Beijing instead conducts a lottery for the right to register new vehicles. The probability of success was only 0.15% in early 2016 (Financial Daily, 2016), Buyers of battery electric vehicles (BEVs), but not PHEVs, can bypass the lottery system–gaining a huge non-monetary incentive to purchase a BEV. This incentive is especially valuable in Beijing, the most car-dependent city in the country, with an extensive network of limited-access highways, cold winters, and high levels of pollution for those not in cars (Campbell et al., 2016).

PEVs receive another non-monetary incentive in Beijing: they are not subject to a rule banning cars from roads one work-day per week—adding an additional 1/5 or 1/7 premium to the PEV license plate.

Combining the direct and indirect subsidies at both the national and municipal level, the incentives in Pudong district of Shanghai in 2015 amounted to about US$25,000 for a PHEV and US$28,600 for a BEV (Table 3). The magnitudes are comparable for Beijing for a BEV.

Table 2
The Successful Auction Price of A License Plate for a Private Car in Shanghai.
Source: http://www.bitenews.cn/shchepai/

2015	No. Lic. plates	Bottom price	Average price	No. of bidders	Success rate
January	7990	74,000	74,216	98,203	8.14%
February	7653	76,500	76,618	103,224	7.41%
March	7406	74,600	74,830	132,690	5.58%
April	8288	80,600	80,759	152,298	5.44%
May	7482	79,000	79,099	156,007	4.80%
June	7441	80,000	80,020	172,205	4.32%
July	7531	83,100	83,171	166,302	4.53%
August	7454	82,600	82,642	166,939	4.47%
September	8727	82,100	82,172	165,765	5.26%
October	7763	85,300	85,424	170,995	4.54%
November	7514	84,600	84,703	169,159	4.44%
December	7698	84,500	84,572	179,133	4.30%
Average/ Total	**92,947**	**80,575**	**80,686**	**1,832,920**	**5.07%**

Note: To cap the bidding price, the system only accepts the bids that hit the right price level at the earliest time after opening of the bid each month. Since the average success rate is only about 5%, it means, on average, a bidder has to try 20 months to win the bid.

Table 3
Direct and Implied Subsidies in Shanghai (Pudong).

	PHEV	BEV 150–250[a]
National	31,500	45,000
Shanghai	30,000	40,000
Pudong (Financial District)[b]	20,000	20,000
Sub-total	81,500	105,000
2015 License Plate Price	80,686	80,686
Total Subsidies, RMB	162,186	185,686
2015 Exchange Rate	6.489	6.489
Total Subsidies, US$	**$24,994**	**$28,615**

[a] We listed the typical BEV range of 150–200 km; for those above 250 km, they receivedmore subsidies: 54,000 RMB per vehicle.
[b] We selected Pudong District, which provided additional support.

1.3. Innovative business models

Even with generous government subsidies, sales of PEVs are limited by high price, lack of charging infrastructure (Sathaye and Kelley, 2013), and conservative buying behavior (Bjerkan et al., 2016). To overcome these early barriers, many Chinese PEV makers have formed car-leasing and shared mobility businesses. These businesses create a new market for PEVs and have the added marketing benefit of exposing potential buyers to otherwise unfamiliar technologies.

The most successful innovator is Kandi. The company launched a car sharing service in Hangzhou City in September 2013 using BEVs. As of April 2016, it had deployed 9851 BEVs in Hangzhou. Kandi cars are parked in stations mostly near hotels, business centers, and residential communities (See Fig. 2). Customers can lease those cars on an hourly or yearly basis. For each BEV, Kandi receives up to RMB 120,000 (US$ 18,493) in direct monetary subsidies. In 2015, the Kandi EV Group received RMB 364.6 million from the central government and RMB 200 million from Hangzhou City government. Kandi is likely making a profit on these low-cost, simple BEVs, even without gaining revenue from car sharing usage. Since 2013, Kandi has sold 38,000 BEVs nationwide. 74% of those were sold to its car-share and leasing company (Global Time, 2016).

These various innovative business models have accelerated the deployment of PEVs, but they have also brought unintended consequences that could potentially slow market growth, as discussed below.

2. Case studies: Shanghai and Beijing

Beijing and Shanghai present contrasting case studies on car and