Local Subsidies, Local Protectionism and Market Concentration in China's New Energy Vehicle Industry

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Abstract. Local subsidies are financial incentives offered by local governments to promote new energy vehicle (NEV) adoption within their jurisdictions. In this study, we collect data from 270 Chinese cities between 2016 and 2019, and construct a two-way fixed-effect model to explore the impact of local subsidies on the market concentration ratio of China's NEV industry. We find that local subsidies significantly increase the market concentration ratio of China's NEV industry, with every 10,000 yuan increase in the subsidy standard leading to an 8% increase in the market concentration of the city's NEV market. Through a mechanism analysis, we further find that it is local protectionism embodied in local subsidy policies that leads to market concentration, while local subsidies per se do not affect market structure. These results have important implications for formulating and improving policies for the NEV industry.

Keywords: New energy vehicle; Local subsidy; Local protectionism; Market concentration

1 Introduction

China has laid great importance in developing the new energy vehicle (NEV) industry, as it plays a crucial role in achieving the goal of carbon peak and carbon neutral in China. To promote the development of the industry, both central and local governments have introduced a series of industry support policies, including purchase subsidies for NEV consumers. At the same time, people are concerned about local protectionism in this industry, as it hinders fair market play and may hinder technological progress of the NEV industry.

Many scholars have studied the impact of government subsidies on NEV industry, they find that these policies have both positive and negative effects. The positive effects of financial subsidies include: financial subsidies directly promote the adoption of NEVs (Li and Luo, 2019) [8], they help cultivate the NEV market (Xiong et al., 2018[11]; Xiong and Wang, 2020[12]), and they promote technological innovation in the NEV industry (Gao and Peng, 2018[2]; Guo et al., 2022[4]). The negative impacts of the subsidy policy are: subsidies lead to policy dependency and a lack of incentive for technological innovation (Tang and Liu, 2015)[10], some manufacturers act strategically or even cheat

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in order to obtain subsidies (He and Xiao, 2017[5]; Liu and Wu, 2021[9]), and the subsidy policy actually may actually result in an increase in carbon emissions under the current power generation mix (Guo and Wang, 2024[3]; Holland et al.,2016[6]).

These existing literatures have done a great job in assessing the government subsidy policy, but they are insufficient in two aspects. Firstly, most studies focus on how policies influence sales and technological progress, while few literatures considered how subsidies impact market structure of the NEV industry. Secondly, existing literatures mainly focus on subsidies from the central government and pay little attention to subsidies from local governments. In their studies, they took the national market as a unified whole and neglected market segmentation caused by strategic behavior of local governments. In this study, we focus on local subsidy policies in the NEV industry and construct a two-way fixed effect model to explore how local subsidies impact the industry's market structure.

2 Policy Background

In China, the purchase subsidy for NEVs represents a demand-side subsidy for consumers, initiated in 2009. The NEV purchase subsidy consists of two parts: the central subsidy and the local subsidy. The central subsidy is provided by the central government and is applied uniformly across the country. Consumers are entitled to the same subsidy for purchasing the same type of NEV in any city in China. While local subsidies for NEVs are formulated by local governments in the light of local conditions, using local financial resources to provide subsidies for NEV purchasers within their jurisdictions. Local governments have more autonomy in policy formulation and have their own requirements in terms of subsidized products, subsidy standards, enterprise conditions, etc., presenting large differences. For example, the subsidized products specified in Beijing's 2016 local subsidy policy exclude plug-in hybrid vehicles and only subsidize pure electric vehicles and fuel cell vehicles. The truth behind this is that in 2016, Beijing's largest new energy vehicle manufacturer, BAIC, only produced pure electric vehicles and almost no hybrids. This kind of requirements reflect the local protectionist tendency of the local government.

Referring to Chen et.al. (2023)[1], local protectionist tendencies in local subsidy policies can be summarized in the following categories: (1) Establishing a local product management system, e.g. creating a local product catalogue or requiring companies to pre-register. (2) Requiring foreign companies to establish local subsidiaries. (3) Requiring car manufacturers to use locally produced parts. (4) Setting a subsidy reciprocity requirement. The local government will allow a local car company from another city to enter the local market and subsidize it only if the local car company is able to obtain local subsidies in that city. (5) Promoting the priority purchase of locally produced vehicles in policies. These provisions protect local producers and the local market by preventing foreign producers from entering the local market or forcing foreign companies to invest locally.

3 Model Settings and Data

3.1 Model Settings

The Herfindahl-Hirschman Index (HHI) is a widely used measure of corporate monopoly power and industry-specific market concentration (Hu, 2022)[7]. We use the HHI to measure the concentration of the urban NEV market in this paper. The indicator is calculated as follows:

$$HHI_{mt} = \sum_{j \in H_{mt}} \left(s_{mt}^{j} \times 100\right)^{2} \tag{1}$$

In equation (1), *m* represents the city and *t* represents the year, and each city is treated as a market per year. HHI_{mt} measures the concentration of the corresponding market. s_{mt}^{j} is the market share of manufacturer *j* in city *m* at time *t*. H_{mt} is the set of all manufacturers that have NEV models for sale in city *m* at time *t*. The higher the HHI value, the more concentrated the market and the less competition in the market.

Then we construct a two-way fixed effects model to analyze whether local subsidy policies for NEVs lead to a more concentrated regional market. The econometric model is as follows:

$$HHI_{mt} = \alpha + \beta sub1_{mt} + \delta X_{mt} + \tau_t + \mu_m + \epsilon_{mt} \tag{2}$$

In model (2), HHI_{mt} is the Herfindahl-Hirschman Index of the NEV market, which measures the concentration of the NEV market in city *m* at time *t*. $sub1_{mt}$ denotes the local subsidy rate for NEVs in city *m* at time *t*. Cities apply different subsidy standards to different types of new energy vehicles, depending on the power and range of the model. In order to get a local subsidy rate that is representative of the city as a whole, we first calculated the total amount of local subsidies in the city and then divided it by the total sales in the city. X_{mt} is a set of city-level control variables that include (1) Subsidized NEV sales *sale1*. (2) Economic variables representing the characteristics of the city: income level denoted by *incom*, consumption level denoted by *rsc* and urbanization level denoted by *urb*. τ_t represents time-fixed effects and μ_m represents the individual-fixed effect. The random disturbance term is ϵ_{mt}.

To further analyze whether local protectionist tendencies in subsidy policies are the main cause of changes in market concentration, we add variable $sub1\_protect_{mt}$ to model (2) to construct the following model:

$$HHI_{mt} = \alpha + \beta sub1_{mt} + \gamma sub1\_protect_{mt} + \delta X_{mt} + \tau_t + \mu_m + \epsilon_{mt} \tag{3}$$

In model (2), $protect_m$ is a dummy variable representing local protection tendencies. Read each city's local subsidy policy for NEVs from 2016 to 2019. If there is a local protection-related statement in the policy, the city's subsidy policy is considered to have a local protection bias, at which point the value of the variable $protect_m$ is 1, otherwise it is 0. The variable $sub1\_protect_{mt}$ is obtained by multiplying $sub1_{\mathrm{mt}}$ and $protect_m$.

3.2 Data Description

Three main datasets have been used in this study. The first is NEV sales data, which includes annual sales of NEVs (passenger cars only) at the city level in China from 2016 to 2019. The second dataset is data on local subsidies and local protection tendencies for NEVs. We collected NEV subsidy policies from official government websites and manually sorted the local subsidy standards for NEVs in each city in each year. And we retrieved local protection terms in subsidy policies to assess whether cities have local protectionist tendencies. The third data item is data on the relevant variables at city and province level. This dataset includes the number of public charging points in each city, denoted as *pubcharg*, collected from relevant websites, and data on per capita income, per capita consumption and urbanization rate collected from the China Urban Statistical Yearbook. Table 1 presents descriptive statistics for the main variables.

Table 1. Descriptive statistics.

Varible	Obs.	mean	Std. Dev.	min	max
HHI	945	1989	1314	530	9095
sub1	945	0.660	0.990	0	4.500
protect	945	0.240	0.420	0	1
pubcharg	937	905.1	3425	1	48504
sale1	945	2.710	8.670	0	91.42
incom	945	10.44	0.220	9.990	11.21
rsc	945	16.06	0.890	12.92	18.88
urb	945	59.21	7.740	44.15	88.10

4 Empirical Results and Discussion

4.1 Benchmark Regression Results

Table 2 shows the results of the benchmark regressions of equations (2) and (3). As columns (1) and (3) show, the regression coefficient of sub1 is significantly positive when the HHI is regressed on sub1 alone. This indicates that as local subsidy levels increase, regional market concentration for NEVs will increase significantly, leading to a more monopolistic industry structure. The coefficient of *sub1* in column (3) is 152.182, about 8% of the average HHI value in our sample, indicating that every 10,000 yuan increase in the subsidy standard leads to an 8% increase in the market concentration of the city's NEV market.

However, when *sub1_protect* is added to the model, as shown in columns (2) and (4), the coefficient of *sub1* becomes insignificant and the coefficient of *sub1_protect* is positive at the 1% significance level. The regression results suggest that it is the local protectionist tendency that should be responsible for the increased concentration of the city's NEV market. Local subsidies per se do not affect the competitive structure of the market, but local protectionist tendencies in subsidy policies push the industry towards monopoly.

Table 2. Impact of local subsidy policies on the NEV market concentration.

	No control variables		With control variables	
	(1)	(2)	(3)	(4)
	HHI	HHI	HHI	HHI
sub1	126.369**	-33.775	152.182**	-30.487
	(57.710)	(53.548)	(58.851)	(49.535)
sub1_protect		319.667***		380.792***
		(98.551)		(103.059)
Control	N	N	Y	Y
Time-fixed	Y	Y	Y	Y
City-fixed	Y	Y	Y	Y
Observations	935	935	935	935
R^2	0.538	0.548	0.566	0.580

* Standard errors in brackets, *, ** and *** are significant at the 10%, 5%, and 1% levels, respectively. The table below is the same.

4.2 Robustness Analysis

To ensure that the results of the regressions are robust, a variety of testing methods are used in this paper.

Table 3. Regression results of robustness test.

	Change explanatory variable		Change explained variable		Consider pilot policy	Exclude first-tier cities
	(1)	(2)	(3)	(4)	(5)	(6)
	HHI	HHI	CR4	CR4	HHI	HHI
sub2	33.859***	9.988				
	(9.183)	(7.504)				
sub2_protect		82.875***				
		(23.981)				
sub1			0.827**	0.172	-18.582	-27.279
			(0.394)	(0.536)	(67.559)	(45.705)
sub1_protect				1.367*	382.555***	401.406***
				(0.727)	(106.168)	(102.603)
sub1_pilot					-24.940	
					(104.817)	
Control	Y	Y	Y	Y	Y	Y
Time-fixed	Y	Y	Y	Y	Y	Y
City-fixed	Y	Y	Y	Y	Y	Y
Observations	935	935	935	935	935	919
R^2	0.578	0.601	0.706	0.707	0.580	0.609

First, in columns (1) and (2) of Table 3, the explanatory variable is replaced from the individual subsidy rate *sub1* to the logarithm of the total local subsidy to be paid by

the city *sub2*. Second, in columns (3) and (4), the explained variable is changed from HHI to CR4, which is the sum of the market shares of the four largest firms in terms of market share. Third, to exclude the interference of related policies, column (5) takes into account the NEV Promotion City Pilot Policy implemented in 2009-2015 and adds a cross-multiplier term *sub1_pilot* to the model. Other industrial policies are national policies that do not lead to differences between cities and do not affect the estimated results. Finally, column (6) excludes the four first-tier cities (Beijing, Shanghai, Guangzhou, and Shenzhen) from the sample, as these four metropolises are the most populous and economically active, and differ significantly from the rest of the sample.

The regression results are consistent with the baseline regression. The coefficient on local subsidy is significantly positive when the cross-multiplier term *sub1_protect* is not included. After adding the cross-multiplier term to the model, the coefficient of the subsidy term becomes insignificant, and the coefficient of *sub1_protect* is significantly positive. According to these results, the higher the local subsidy rate, the higher the regional market concentration, but it is the local protection bias in subsidies that plays a major role.

4.3 Instrumental Variable Regression

Table 4. Instrument variable.

	IV first stage		IV second stage
	(1)	(2)	(3)
	sub1	sub1_protect	HHI
pubcharg	-0.000**	0.000***	
	(0.000)	(0.000)	
pubcharg_protect	0.000	-0.000***	
	(0.000)	(0.000)	
sub1			-594.808
			(391.174)
sub1_protect			1082.713***
			(317.529)
Control variables	Y	Y	Y
Time-fixed effect	Y	Y	Y
City-fixed effect	Y	Y	Y
Observations	926	926	926
Cragg-Donald Wald F	9.455		
Kleibergen-Paap rk LM	8.445		

In addition, we use the instrumental variable regression technique to deal with potential endogeneity. The instrumental variable used in this paper is the number of public charging piles in the city, denoted as *pubcharg*. Using *pubcharg* as the instrumental variable for *sub1*, we use a two-stage ordinary least squares approach to the regression. The results of the first stage regression are shown in columns (1) and (2) in Table 4, with a Cragg-Donald Wald F-statistic of 9.455 indicating that it passes the weak instrumental

variable test, and a Kleibergen-Paap rk LM statistic of 8.445 indicating that it also passes the unidentifiable test. The results of the second stage regression are shown in column (3), where *HHI* is the explained variable. The coefficient on *sub1* is not significant, while the coefficient on *sub1_protect* is still significantly positive and its absolute value increases from the baseline regression. Table 4 suggests that after mitigating the endogeneity problem, the regression results remain robust.

5 Conclusion and Policy Implications

5.1 Conclusion

In this study, we collect NEV sales data from 270 Chinese cities between 2016 and 2019 and empirically test the impact of local subsidies on regional market concentration ratio of China's NEV industry. We identify the local protectionist tendency in subsidy policies, reveal the mechanism by which subsidy policies affect the concentration of the NEV market, and draw the following conclusions: (1) local subsidies significantly increase the regional market concentration of China's NEV industry. (2) it is the local protectionism embodied in local subsidy policies that lead to market concentration, while local subsidies per se do not affect market structure. It can be reasonably concluded that local protectionism is the primary reason for regional market segmentation of NEV industry.

Market segmentation hinders fair market play by setting entry barriers for players, it hinders factor mobility and inhibits technological progress, which is detrimental to the long-term development of the NEV industry. As the industry matures, international competition in the sector becomes increasingly fierce, China needs to build a unified national market for NEVs to gain a competitive edge.

5.2 Policy Implications

These conclusions can provide important guidance for the development of policies to support the NEV industry. The policy implications are as follows: (1) The central government should strengthen its guidance and regulation of NEV industrial policies throughout the country, guide local governments to set uniform standards, and prohibit the introduction of policies with local protectionist tendencies. (2) Local governments need to consider not only short-term but also long-term interests when implementing industrial policies. Local protectionism not only undermines market competition, but also creates market segmentation that hinders technological progress - a short-sighted behavior at the expense of long-term interests. (3) One effective way to eliminate local protectionism is to change the sources of incentives for local governments, such as adjusting the tax structure of the automobile industry, e.g. increasing the tax rate on the use and ownership of automobiles and reducing the tax rate on the production and purchase of automobiles.

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