Online Appendix
Subsidizing Fuel-Efficient Cars:
Evidence from China's Automobile Industry

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November 2020

A Eligibility and Vehicle Attributes

In this section, we examine whether eligible vehicles had unobserved product attributes superior to those of other vehicles and whether the program favored indigenous vehicles. Columns (1) and (2) of Table A1 list means of sales and various attributes for eligible and ineligible models, respectively, with differences shown in column (3). All models in the table have an engine size less than or equal to 1.6 liters and were already on the market before the first wave of the program. On average, eligible vehicles had higher average province-model sales, were priced at 14,937 RMB higher, had larger values in horsepower, size, and weight, and were less likely to be indigenous brands than their peers, suggesting that the program was not designed to favor indigenous brands per se. We examine the relationship between vehicle price and eligibility by regressing vehicle price on eligibility status and other attributes. Columns (4) and (5) of Table A1 give results from price regressions that include country fixed effects and manufacturer fixed effects, respectively. After controlling for manufacturer fixed effects and other attributes, we find that a vehicle's eligibility was not associated with its price, suggesting that on average eligible products did not exhibit superior or inferior unobserved product attributes.

B Number of Subsidized Models by Manufacturer and Wave

Because the central government never revealed the rules it used to determine the sequence of subsidy waves, an important concern is that the government may have deliberately designed the sequence of subsidy waves to support domestic manufacturers or indigenous brands. To

Table A1: Eligibility and Vehicle Attributes

	Eligible	Ineligible	Difference	Price Regression	
	(1)	(2)	(3)	(4)	(5)
Sales	57.248	30.091	27.157		
	(86.814)	(42.037)	(6.941)		
Price (10,000 RMB)	9.181	7.688	1.494		
	(4.171)	(2.452)	(0.374)		
Automatic transmission	0.338	0.291	0.047	0.238	0.043
	(0.477)	(0.455)	(0.061)	(0.133)	(0.128)
Engine size (liters)	1.431	1.463	-0.032	-3.049	-2.147
	(0.157)	(0.179)	(0.023)	(1.023)	(1.136)
Fuel inefficiency (liters/100 km)	6.526	7.269	-0.743	-0.483	-0.215
	(0.500)	(0.605)	(0.078)	(0.214)	(0.228)
Horsepower (kw)	80.103	72.754	7.350	0.074	0.049
	(15.041)	(11.294)	(1.595)	(0.016)	(0.020)
Size (m^3)	10.988	10.591	0.397	0.046	-0.164
	(1.204)	(1.145)	(0.154)	(0.131)	(0.128)
Weight (kg)	1196.809	1141.433	55.376	0.013	0.015
	(164.377)	(123.147)	(17.403)	(0.002)	(0.002)
Chinese	0.324	0.504	-0.181	-2.236	
	(0.471)	(0.501)	(0.066)	(0.193)	
European	0.191	0.163	0.028	1.106	
	(0.396)	(0.370)	(0.050)	(0.234)	
Japanese	0.132	0.166	-0.034	0.765	
	(0.341)	(0.373)	(0.049)	(0.251)	
Korean	0.162	0.065	0.096	-0.627	
	(0.371)	(0.247)	(0.036)	(0.207)	
U.S.	0.191	0.101	0.090		
	(0.396)	(0.302)	(0.042)		
Eligibility				-0.587	0.084
				(0.215)	(0.217)
Constant				-3.898	-4.727
				(0.930)	(1.360)
Observations	68	337	405	405	405
Manufacturer fixed effects				No	Yes

Notes: This table reports average monthly sales in a province and vehicle attributes for eligible and ineligible models sold between January 2010 and May 2010 (before the first wave of subsidies). All vehicles have an engine size less than or equal to 1.6 liters. Columns (4) and (5) report results from price regressions with country fixed effects and manufacturer fixed effects, respectively.

explore this possibility, we show the entire distribution of subsidized models by manufacturer and subsidy wave in Table B1, as well as information about each subsidized manufacturer's type, the share of vehicles produced and subsidized, the share of vehicles produced and no greater than 1.6 liters, and each manufacturer's market share in all passenger vehicles during the first six waves (June 2010 to September 2011).[1] Several manufacturers are joint ventures of domestic and foreign manufacturers, offering indigenous and foreign brands at the same time. We thus define a manufacturer as "Chinese" if at least 50% of its vehicles belong to indigenous brands. We apply the same definition to define European, Japanese, South Korean, and U.S. manufacturers accordingly.

Table B1 suggests that manufacturers usually had vehicle models subsidized in multiple waves of subsidy. More importantly, if the program favored domestic manufacturers by adding these vehicles only to certain subsidy waves to boost their sales, then we would expect domestic manufacturers to receive higher shares of *sales* from subsidized vehicles compared to their foreign counterparts producing similar vehicles. For example, a domestic firm producing few vehicles below 1.6 liters may receive a lot of subsidized sales compared to foreign manufacturers also producing few such vehicles as a result of favoritism. Figure B1 visualizes the data in Table B1 by plotting the relationship between a manufacturer's share of models subsidized to all models produced, and its share of models no greater than 1.6 liters to all models produced, using the manufacturer's market share as weights (the size of the circle). As shown in Figure B1, at the manufacturer level, there is a strong positive relationship between the share of subsidized products and the share of vehicles produced no greater than 1.6 liters for both domestic and foreign manufacturers, which is not surprising because all subsidized vehicles must be no greater than 1.6 liters. The slopes of the fitted lines for domestic and foreign manufacturers are almost identical. Moreover, it seems that foreign manufacturers were more likely to produce fuel-efficient vehicles and be subsidized. Overall, we do not find evidence supporting the government favoring domestic manufacturers.

[1] There are 41 firms in the official 7 subsidy lists released by the government. Three different joint ventures owned by SAIC-GM (SAIC-GM, Shanghai GM DongYue Motors, and SAIC GM (ShenYang) NorSom Motors) are named as a single manufacturer (SAIC-GM) in the sales data. Similarly, two different manufacturers owned by Haima Automobile Group are named as a single manufacurer in the sales data. We thus identified 38 of them in the sales data and calculated market shares at the level of these 38 manufacturers.

Table B1: Share of Subsidized Vehicles by Manufacturer

firm ID	firm type	1	2	3	4	5	6	7	total	share subsidized	share no greater than 1.6 liters	market share
1	cn	6	2	2	8	0	23	2	43	0.436	1.000	0.020
2	cn	3	17	9	0	0	0	2	31	0.609	0.958	0.046
3	us	12	5	3	0	0	0	7	27	0.335	0.676	0.103
4	eu	7	0	4	4	2	8	0	25	0.156	0.556	0.094
5	cn	0	0	0	0	10	8	4	22	0.146	0.722	0.009
6	cn	0	0	3	3	13	1	0	20	0.176	1.000	0.003
7	cn	2	0	13	4	0	0	0	19	0.518	0.667	0.027
8	kr	6	4	3	6	0	0	0	19	0.531	0.717	0.066
9	cn	2	0	8	0	0	5	3	18	0.773	0.901	0.043
10	us	0	8	8	0	0	0	0	16	0.283	0.373	0.039
11	jp	0	6	0	0	6	4	0	16	0.188	0.607	0.066
12	cn	0	2	0	7	4	0	1	14	0.359	0.810	0.013
13	jp	0	4	7	0	3	0	0	14	0.467	1.000	0.007
14	cn	0	0	0	8	1	4	0	13	0.255	1.000	0.023
15	jp	2	0	0	0	1	10	0	13	0.393	0.985	0.019
16	kr	6	0	0	4	2	0	0	12	0.348	0.726	0.034
17	cn	8	0	0	0	1	3	0	12	0.353	0.509	0.014
18	us	6	0	0	0	5	0	0	11	0.526	1.000	0.007
19	cn	4	0	2	4	0	1	0	11	0.701	0.904	0.008
20	eu	0	9	0	1	0	0	0	10	0.248	0.655	0.080
21	jp	0	1	2	0	7	0	0	10	0.287	0.491	0.045
22	cn	0	0	0	0	2	5	0	7	0.054	1.000	0.005
23	eu	0	0	0	7	0	0	0	7	0.250	0.759	0.035
24	cn	0	0	0	3	4	0	0	7	0.236	0.997	0.004
25	jp	3	0	0	0	0	3	0	6	0.372	0.443	0.032
26	cn	0	0	0	0	3	2	0	5	NA	NA	NA
27	cn	1	0	0	1	0	2	0	4	0.087	0.965	0.016
28	jp	0	0	0	2	2	0	0	4	0.313	0.771	0.004
29	cn	0	0	2	0	2	0	0	4	0.027	0.445	0.014
30	cn	0	0	0	1	0	3	0	4	NA	NA	NA
31	cn	0	0	1	0	0	2	0	3	0.005	0.955	0.007
32	cn	0	0	3	0	0	0	0	3	0.013	0.560	0.013
33	cn	0	0	0	3	0	0	0	3	NA	NA	NA
34	cn	0	0	2	0	0	0	0	2	NA	NA	NA
35	cn	0	2	0	0	0	0	0	2	0.024	0.398	0.001
36	cn	0	0	2	0	0	0	0	2	NA	NA	NA
37	cn	0	0	0	0	1	1	0	2	0.393	0.668	0.005
38	eu	0	1	0	0	0	0	0	1	0.212	0.223	0.005
Total		68	61	74	66	69	85	19	442			

Notes: This table shows the number of subsidized vehicles by manufacturer and subsidy wave. Each manufacturer listed here has at least one vehicle listed in the subsidy program. 'cn': indigenous manufacturers, 'eu': European manufacturers, 'jp': Japanese manufacturers, 'kr': South Korean manufacturers, 'us': U.S. manufacturers. All shares are calculated using sales data from the first six subsidy waves (June 2010 to September 2011). NA: manufacturers cannot be identified in the sales data.

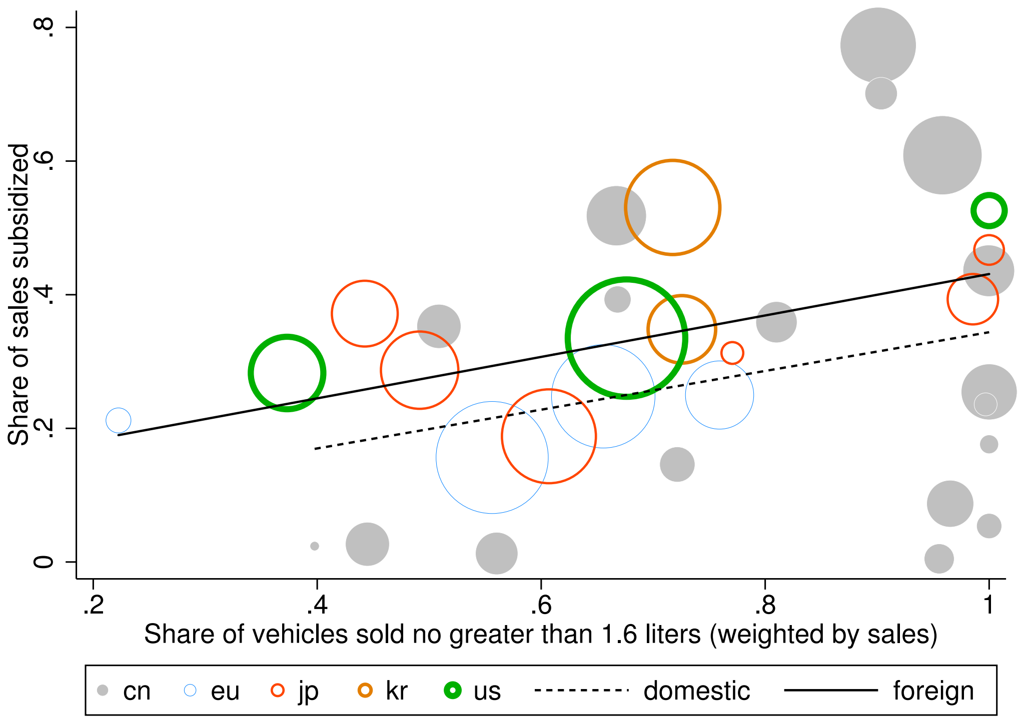


Figure B1: Share Subsidized and Share below 1.6 Liters

C Data Coverage

Our results are based on sales data from all passenger vehicles. There are two measures of vehicle sales in China. The first one is registrations of purchases of new vehicles, including passenger vehicles and commercial vehicles. The second one is sales shipped to dealers (reported by manufacturers), including vehicles purchased by consumers as well as inventories. Our data are registrations of purchases of new passenger vehicles, and so belong to the first type, while the China Association of Automobile Manufacturers (CAAM) publishes annual vehicle sales shipped to dealers (henceforth CAAM sales), and so this belongs to the second type.[2] Table C1 compares annual sales reported by CAAM and data used herein. Given that our data do not include commercial vehicles and inventories, total vehicle sales in the data accounted for 66.17%, 67.32%, and 61.94% of the CAAM sales in 2009, 2010, and 2011, respectively. For the purpose of this study, registered sales are more suitable for studying the effect of a subsidy on sales. Regarding new passenger vehicles, we believe that our data provide great coverage: there is almost no difference in total registered sales reported by biauto.com (a website specializing in publishing news on China's automotive industry) and ours.[3]

Of the subsidized passenger vehicles in the first six waves, only a total of 262 out of 423 can be matched in our data (based on vehicle model identification code). Of the 161 models that are not found in our data, we break them down by subsidy wave and present the cause of such missing data in Table C2 below. Among all missing models, 51 were passenger vehicles that were only available for sale in 2012 or 2013, and so they do not appear in our data (from 2007 to 2011). In addition, we find that there are 42 subsidized vehicles actually categorized as commercial vehicles and thus missing in the passenger vehicle database. Still, there are 68 subsidized vehicles that could not be identified in any sales data from our best knowledge. Given that there are already nearly 2,500 vehicle models in our 2010 and 2011 sales data, even including more than 500 vehicle models that did not have annual sales of more than five units, we believe that these 68 missing models were never launched to the market. Finally, considering that we have matched 3.62 million subsidized vehicles for the first six waves from 2010 to 2011, which already exceed the sales estimate disclosed by IBTS Investing Consulting Company during this period (3.57 million, see IBTS Investing Consulting Company (2012)), we believe that our sample is a good representation of the passenger vehicle population studied herein.

[2]The official website of China Association of Automobile Manufacturers can be found at: http://www.caam.org.cn.

[3]Registered sales reported by biauto.com can be found at http://news.bitauto.com/gdspl/20100223/1105104118.html.

Table C1: Data Coverage: Sales from CAAM and Registrations

	(1) Sales reported by CAAM	(2) Total registrations	(3) Registration without commercial vehicles	(4) (3)/(1)×100%
2009	10,331,315	7,692,421	6,836,710	66.17%
2010	13,757,794	10,000,659	9,262,051	67.32%
2011	14,472,416	9,539,235	8,963,912	61.94%
Total	38,561,525	27,232,315	25,062,673	

Notes: CAAM: China Association of Automobile Manufacturers.

Table C2: Breakdown of Missing Models

Wave	Number of new (total) models subsidized	Missing	Passenger vehicles	Commercial vehicles		Other
			After 2012	Before 2012	After 2012	
1	68(68)	12	3	5	-	4
2	61(129)	14	4	-	-	10
3	74(203)	22	6	5	1	10
4	66(269)	21	5	5	3	8
5	69(338)	41	16	7	9	9
6	85(423)	51	17	4	3	27
Total	423	161	51	26	16	68

Notes: This table breaks down missing models by vehicle type and model year. 'Missing': models cannot be identified in the passenger vehicles sales data from 2007 to 2011. 'After/Before 2012': models launched after/before 2012.

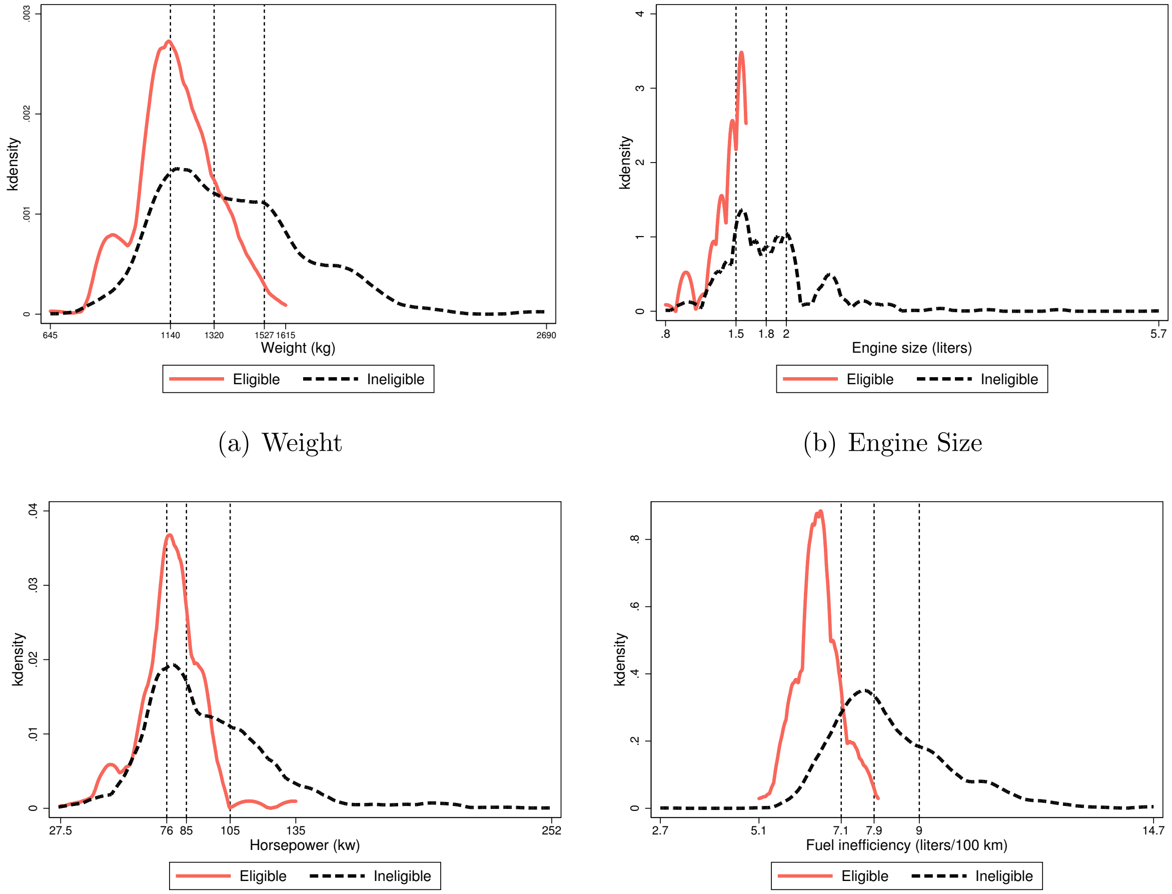
D Construction of the Alternative Control Group

Our identification strategy hinges on using vehicles that were not affected by the program to serve as the control group. We use vehicles in the fourth quartile of fuel inefficiency as our default control group. The subsidy program affected sales of unsubsidized vehicles through mainly two channels: (1) consumers' substitution effect between subsidized and unsubsidized vehicles (2) manufacturers' equilibrium response to the program. To explore the validity of our default control group, we construct an alternative control group. We address the above concerns by removing vehicles susceptible to these concerns from the alternative control group. In this section, we discuss the construction of this control group in detail.

D.1 Substitution Effects

To construct the alternative control group, we first look for vehicles that are 'far enough in the product space' from the subsidized vehicles, and so are extremely unlikely to suffer from the substitution effect. First, we remove vehicles with product attributes that 'overlap' with those from the subsidized products. Figure D1 shows how attributes of subsidized and unsubsidized vehicles overlap with each other in weight, engine size, horsepower and fuel inefficiency. Based on Figure D1, we remove vehicles from the alternative control group that meet any of the following criteria: (1) weight is less than or equal to 1650 kg (2) engine size is less than or equal to 1.6 liters (3) horsepower is less than or equal to 140 kw. We do not place any restrictions on fuel inefficiency because that is the policy effect that we would like to explore. But after applying these three restrictions, the minimum of fuel inefficiency of vehicles left in the control group is larger than that of the maximum of all subsidized vehicles.

To show that vehicles in the control group would not suffer from the substitution effect of the subsidy program, we calculate the minimum marginal rate of substitution (MRS) of horsepower and weight for a 1% price discount in order for a consumer whose original choice was a control group vehicle to switch to a subsidized vehicle. To this end, we calculate the percentage of the price discount received by each subsidized vehicle and the difference between the vehicle's horsepower and weight to the control group's threshold, i.e., 140 kw and 1650 kg, respectively. Then, for each vehicle, we calculate the minimum MRS of horsepower and weight for a 1% price discount required for a substitution effect between this vehicle and any vehicle in the control group to take place. Figure D2 shows the results from our calculations. In the figure, each solid dot represents a subsidized vehicle. Consider vehicle A on the sixth list, which received a 4.56% price discount after the subsidy became effective. Vehicle A's manufacturer's suggested retail price, horsepower and weight are 65,800 RMB, 83kw, and 1435kg, respectively. If a consumer's original choice was a vehicle in the alternative control group, then she must give up at least 57 kw in horsepower and 215 kg in weight to buy vehicle A. The resulting minimum MRS of horsepower and weight for a 1% decrease in price for this substitution to happen would thus be 12.5 kw and 47 kg for this consumer, which are the coordinates of point A in Figure D2. Previous demand estimates of China's automobile industry (Hu et al., 2014) put such estimates around 1.1 kw and 18.44 kg (point B). As shown in Figure D2, it is extremely unlikely for any alternative control group vehicle to suffer directly from the demand substitution effect due to the program's subsidy. Because we only use thresholds of the control group to calculate these minimum marginal rates of substitution, the actual 'distances' between vehicles in the control group and subsidized vehicles would only be larger than those shown in Figure D2, and so our alternative control group is unlikely to suffer from the demand substitution effect from the subsidy program.



(a) Weight

(b) Engine Size

(c) Horsepower

(d) Fuel inefficiency

Figure D1: Overlapping of Vehicle Attributes

D.2 Manufacturers' Equilibrium Response

Manufacturers may respond to the subsidy program by adjusting their pricing and advertising decisions, especially for those heavily affected by the program. To make our alternative control group more robust to this concern, we remove vehicles produced by manufacturers that may have strong incentives to adjust their pricing and advertising decisions in response to the subsidy program from our alternative control group.

By construction of the subsidy program, manufacturers focusing on producing large-engine (larger than 1.6 liters) vehicles were less likely to be subsidized. Figure D3 gives the distribution of all manufacturers' share of vehicles that were no greater than 1.6 liters in our data. As shown in Figure D3, almost all the vehicles produced by some manufacturers were less than 1.6 liters, and so their pricing and advertising decisions may be more likely to be affected by the subsidy program. To account for this concern, we remove vehicles produced by manufacturers whose share of sales from vehicles below 1.6 liters was greater than or equal

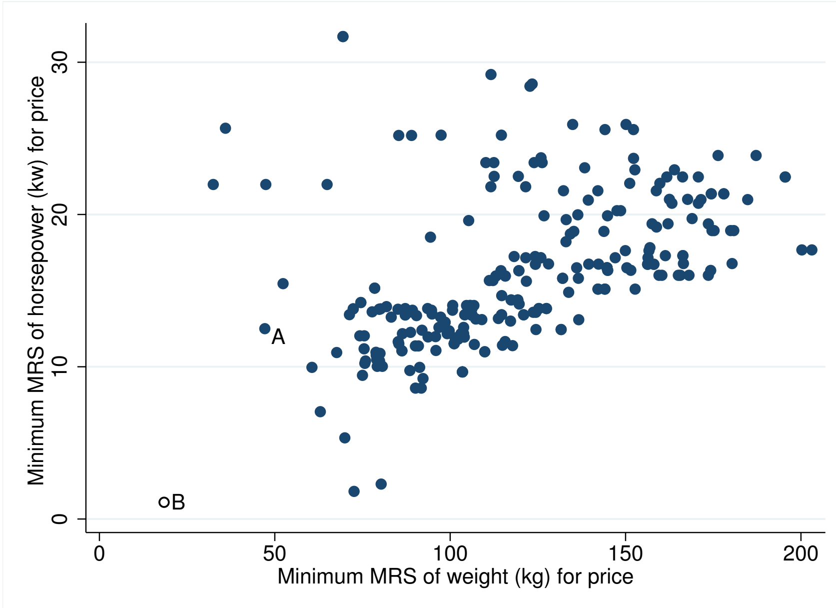


Figure D2: Minimum Marginal Rate of Substitution for a 1% Price Discount

to 50% from the control group. The final alternative control group thus consists of vehicles that satisfy all of the following restrictions: (1) weight is larger than 1650 kg (2) engine size is larger than 1.6 liters (3) horsepower is larger than 140 kw, and (4) manufacturer's share of sales from vehicles below 1.6 liters is less than 50%.

With this alternative control group, we add $\beta_4 1(\text{Unlisted})_j \times 1(\text{Post})_t \times 1(\text{Attribute quartile} = 4)_j$ to equation 2 in the main text and estimate the model using only unsubsidized vehicles to test if β_4 is significant. A significant β_4 would suggest that our default control group used in estimating equation 2 in the main text suffers from a substitution effect. As shown in Table D1, none of the estimated coefficients of $1(\text{Unlisted})_j \times 1(\text{Post})_t \times 1(\text{Attribute quartile} = 4)_j$ are significant: the p-values for the coefficients in columns (1) to (3) are 0.83, 0.75, and 0.87, respectively. Therefore, we do not find evidence that our default control group also suffered from the substitution effect.

Table D2 examines the robustness of our estimates for the program's effect on subsidized products by exploring different definitions of the control group. Column (1) of Table D2 provides estimation results using an alternative control group. The estimated coefficient for $1(\text{Receiving a subsidy})_{jt}$ is 0.515. Column (2) of Table D2 uses vehicles in the fourth quartile of fuel inefficiency as the control group (default control group), while columns (3) and (4) keep on expanding the control group used in column (2) by adding vehicles in the third and the second quartile of fuel inefficiency to the control group. The estimated coefficients for receiving a subsidy in columns (2) to (4) are between 0.580 to 0.613 and statistically significant, and the coefficients for $1(\text{Post})_t \times 1(\text{Attribute quartile} = 1)_j$ are all negative and

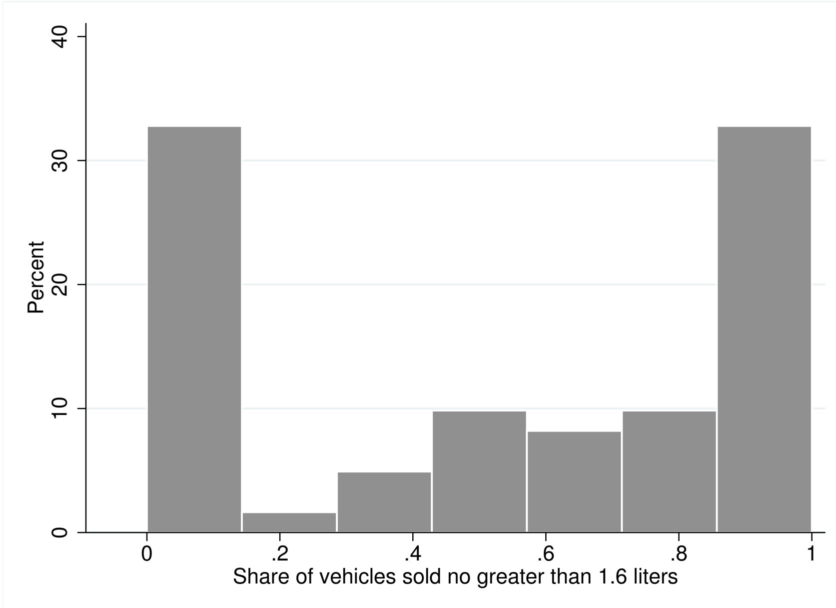


Figure D3: Share of vehicles sold no greater than 1.6 liters

significant. Finally, columns (5) and (6) provide estimates using attribute quartiles based on engine size and weight. The specifications in these two columns used the same control group as that used in column (1), i.e., the alternative control group. The estimated coefficients of 1(Receiving a subsidy)$_{jt}$ in these two columns are 0.469 and 0.493, similar to that shown in column (1). The results also suggest that the program decreased sales for vehicles with a smaller engine size or a lower weight, without creating a substitution effect in vehicles larger in engine size or heavier.

Table D1: Testing the Assumption of Interference

	(1)	(2)	(3)
Unlisted×Post×Attribute quartile 1	-0.364	-0.283	-0.276
	(0.196)	(0.198)	(0.181)
Unlisted×Post×Attribute quartile 2	-0.083	0.010	0.011
	(0.185)	(0.187)	(0.164)
Unlisted×Post×Attribute quartile 3	0.049	0.034	-0.004
	(0.187)	(0.188)	(0.162)
Unlisted×Post×Attribute quartile 4	0.038	-0.057	-0.025
	(0.175)	(0.180)	(0.157)
Gasoline expenditure	0.076	0.017	0.022
	(0.015)	(0.017)	(0.020)
Observations	370884	370884	328024
Category × trend controls	No	Yes	Yes
Birth quarter controls	No	No	Yes
Keep first months of each wave	No	No	No
Keep Beijing and Shanghai?	No	No	No

Notes: This table reports estimates of equation (2) using only unsubsidized products with an alternative control group. The dependent variable is the natural log of monthly vehicle model sales in a province. All regressions include vehicle model, province, and month-of-sample fixed effects. Standard errors are clustered at the vehicle model level.

Table D2: Different Control Groups and Attributes

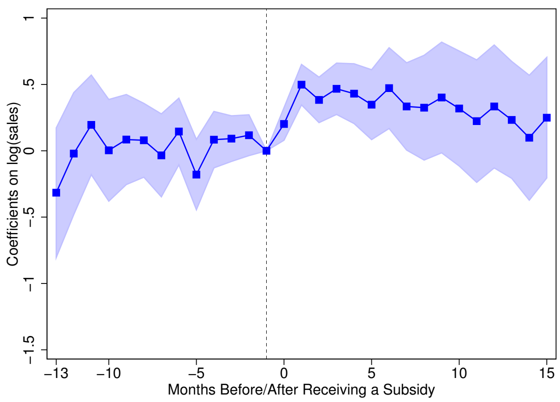
	(1) Fuel Inefficiency	(2) Fuel Inefficiency	(3) Fuel Inefficiency	(4) Fuel Inefficiency	(5) Engine Size	(6) Weight
Receiving a subsidy	0.515	0.580	0.602	0.613	0.469	0.493
	(0.116)	(0.139)	(0.147)	(0.152)	(0.117)	(0.117)
Unlisted×Post×Attribute quartile 1	-0.434	-0.352	-0.326	-0.313	-0.468	-0.359
	(0.144)	(0.125)	(0.128)	(0.121)	(0.154)	(0.140)
Unlisted×Post×Attribute quartile 2	-0.133	-0.051	-0.026		-0.388	-0.354
	(0.131)	(0.104)	(0.105)		(0.125)	(0.131)
Unlisted×Post×Attribute quartile 3	-0.124	-0.039			-0.021	-0.005
	(0.124)	(0.098)			(0.160)	(0.138)
Unlisted×Post×Attribute quartile 4	-0.104				0.066	-0.012
	(0.114)				(0.105)	(0.113)
Gasoline expenditure	-0.001	-0.001	0.001	0.002	0.002	0.007
	(0.020)	(0.020)	(0.020)	(0.021)	(0.022)	(0.022)
Observations	384438	384438	384438	384438	384438	384438
Category × trend controls	Yes	Yes	Yes	Yes	Yes	Yes
Birth quarter controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports estimates of equation (2) using variation from the first six waves, exploring different definitions of comparison groups. Columns (5) and (6) reports the results using engine size and weight to construct attribute quartiles, respectively. The dependent variable is the natural log of monthly vehicle model sales in a province. All regressions include vehicle model, province, and month-of-sample fixed effects. Standard errors are clustered at the vehicle model level.

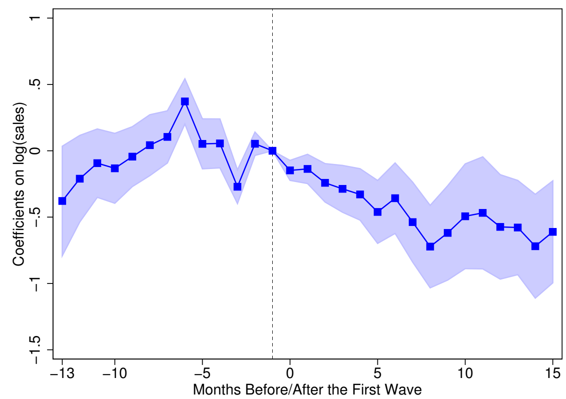
E Additional Event Study Graphs

In the main text, we provide event study graphs with coefficients from estimating equation 2 in the main text. In this section, we explore the robustness of the parallel trend assumption by providing event study graphs under other specifications. The first specification is still based on equation 2 in the main text, but instead of estimating the model jointly, we estimate the model separately, each time only including vehicles from a selected treatment group and the control group. The second specification allows for two types of event time for subsidized vehicles: the month when a vehicle became eligible for the subsidy, which is wave specific, and the month when the subsidy program began, i.e., June 2010. Note that vehicles listed in the first wave can only have one event time, which was set at the month they became eligible for the program. The third specification provides estimation results using only vehicles that were on the market before 2009 and still available after the sixth wave, and so estimated coefficients were less affected by vehicle entries or exits.

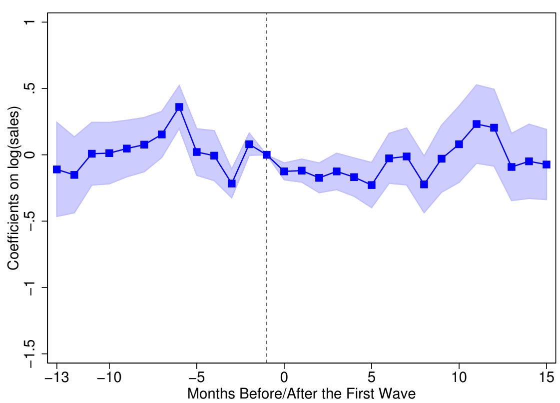
Figure E1 provides estimated coefficients for the first specification. The results are consistent with those shown in the main text. Figure E2 provides results following the same specification but with variables controlling for the category trend. The results are extremely close to those in Figure E2. Figure E3 provides estimated coefficients from the second specification. The main difference between Figure E3 and Figure 6 in the main text is that Figure E3 allows subsidized vehicles not listed in the first wave to have different monthly fixed effects (shown in Figure E3(b)) compared to those in the first wave and the control group. We also provide the results from the second specification with a category trend in Figure E4. Finally, Figures E5 and Figure E6 give the results from the third specification, excluding and including a category trend, respectively. We note that in this specification, by focusing on models that were available throughout the study period, we lose the majority (80%) of vehicle models in our sample and are left with only 12 subsidized products. The patterns from these graphs are in general consistent with those in the main text, but the coefficients in general cannot be estimated precisely.



(a) Subsidized Products



(b) Unsubsidized Products in Fuel Inefficiency Quartile 1



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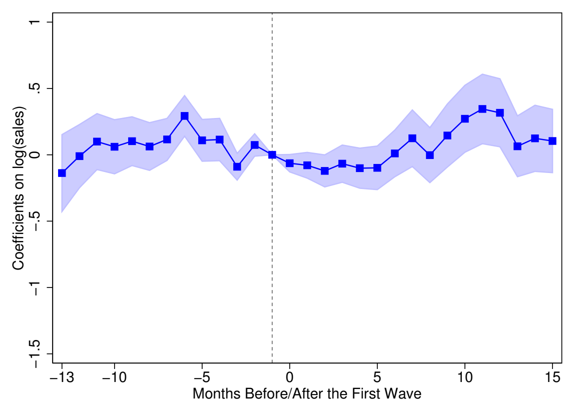
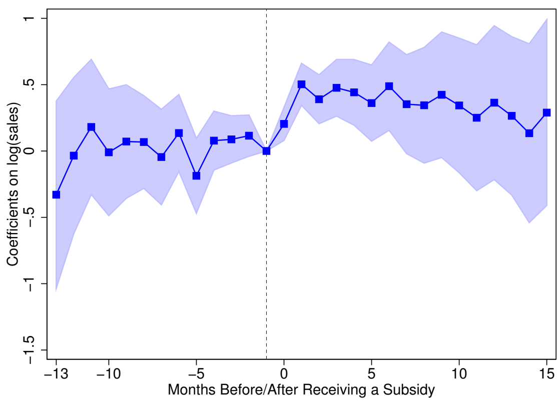
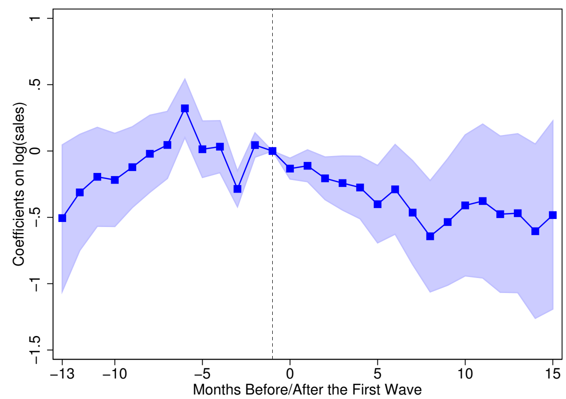


(d) Unsubsidized Products in Fuel Inefficiency Quartile 3

Figure E1: Single Treatment Group Estimation



(a) Subsidized Products



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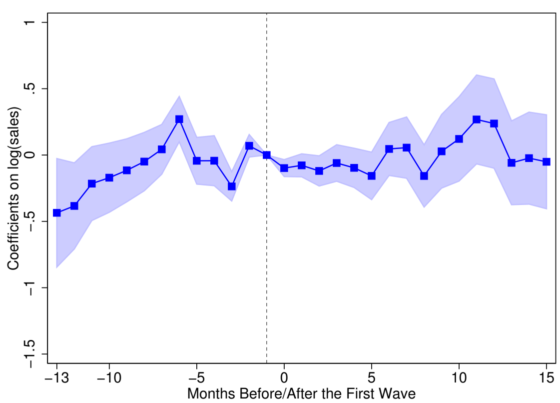

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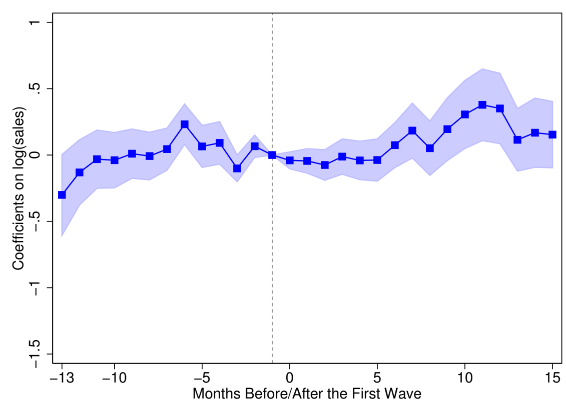
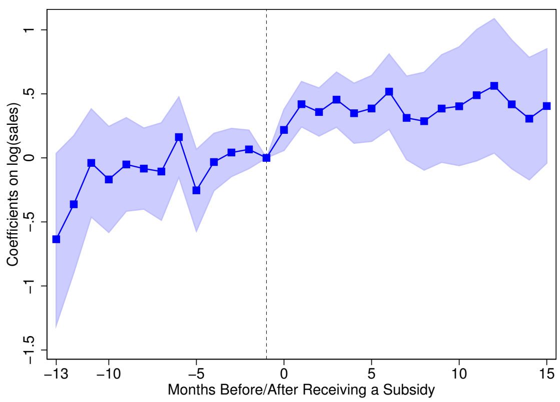
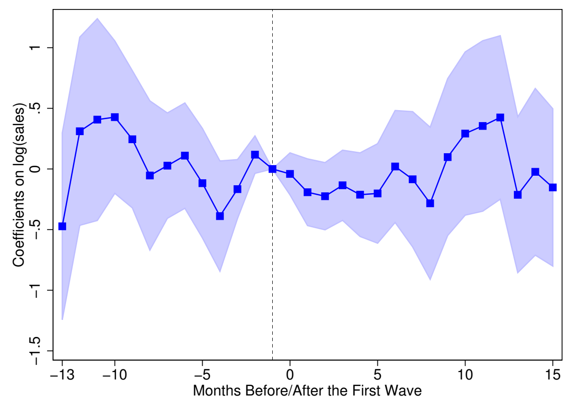


(d) Unsubsidized Products in Fuel Inefficiency Quartile 3

Figure E2: Single Treatment Group Estimation (with Category Trend)



(a) Subsidized Products



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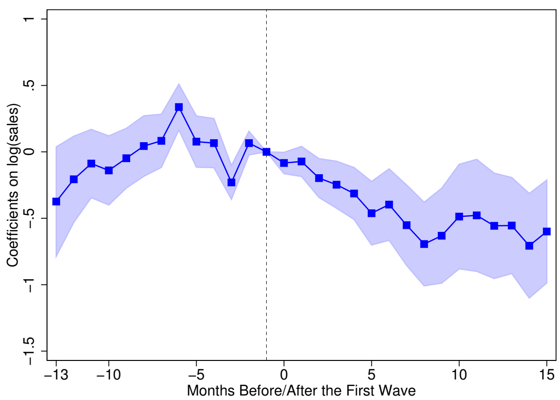
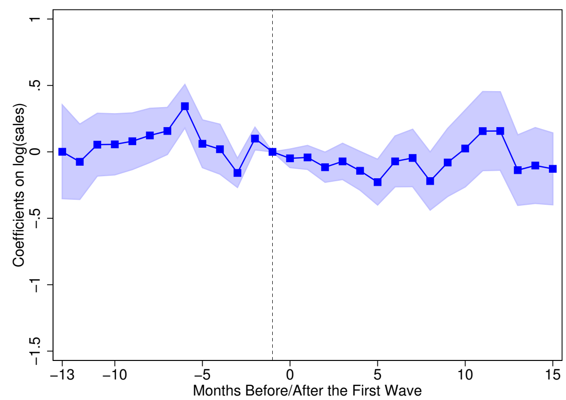


(c) Unsubsidized Products in Fuel Inefficiency Quartile 1



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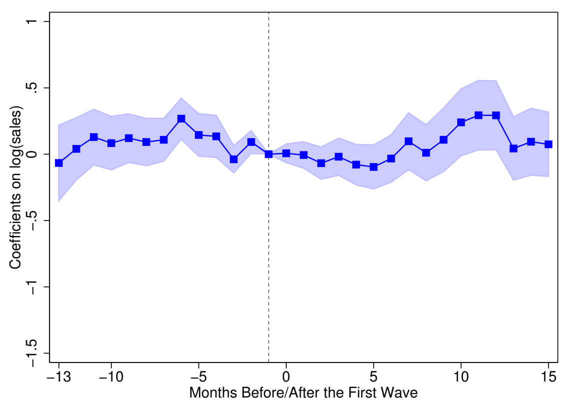
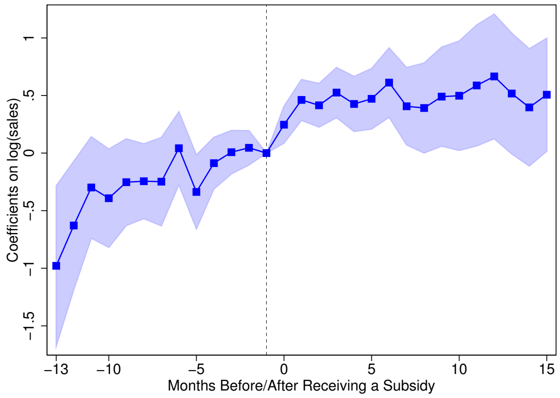
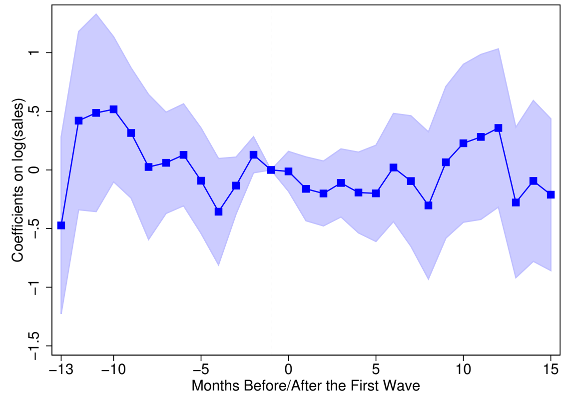


(e) Unsubsidized Products in Fuel Inefficiency Quartile 3

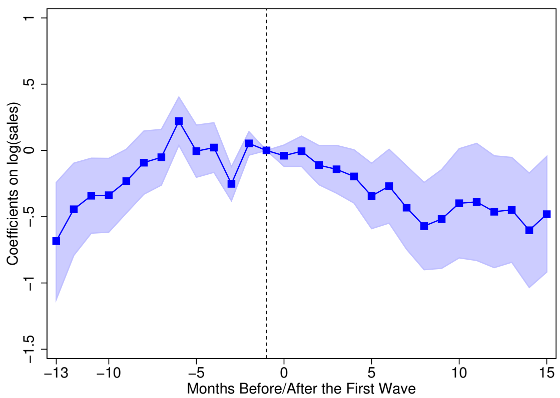
Figure E3: Allowing for Two Types of Event Time for Subsidized Vehicles



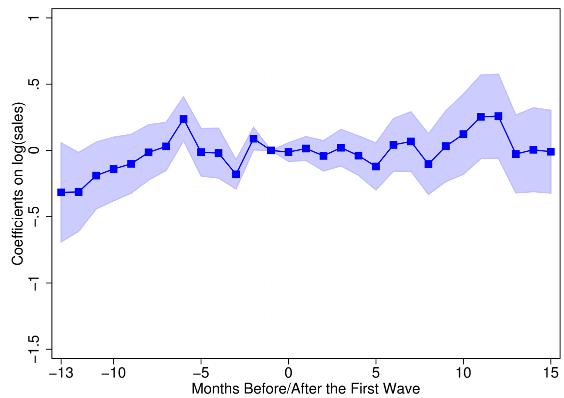
(a) Subsidized Products



(b) Subsidized Products



(c) Unsubsidized Products in Fuel Inefficiency Quartile 1



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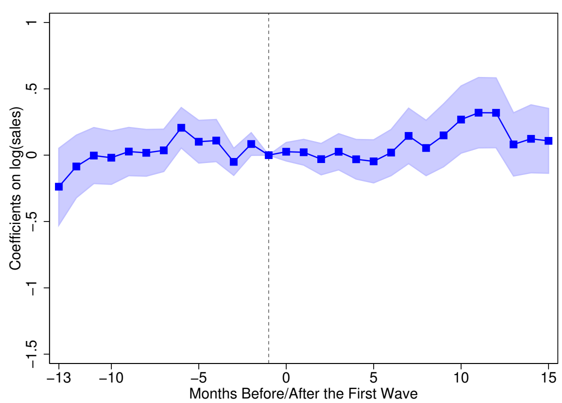
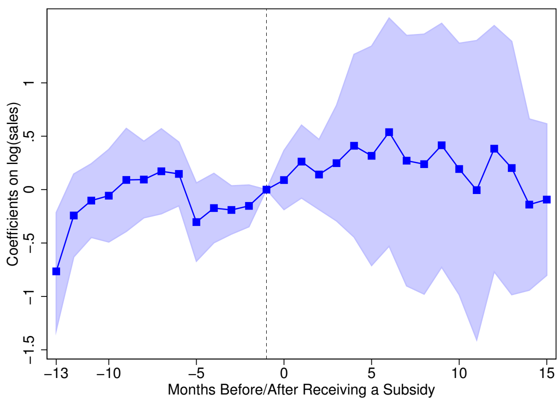
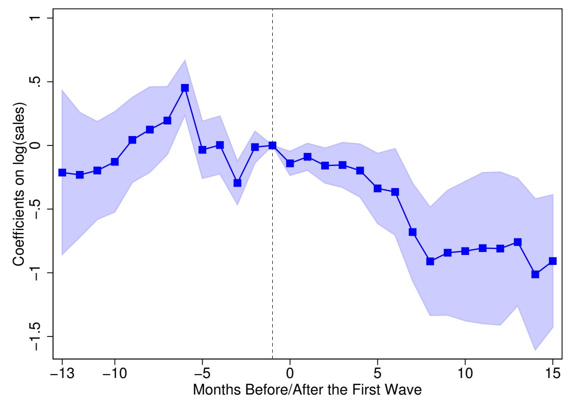


(e) Unsubsidized Products in Fuel Inefficiency Quartile 3

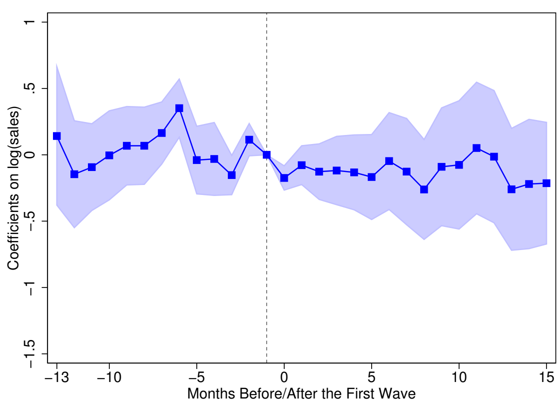
Figure E4: Allowing for Two Types of Event Time for Subsidized Vehicles (with Category Trend)



(a) Subsidized Products



(b) Unsubsidized Products in Fuel Inefficiency Quartile 1



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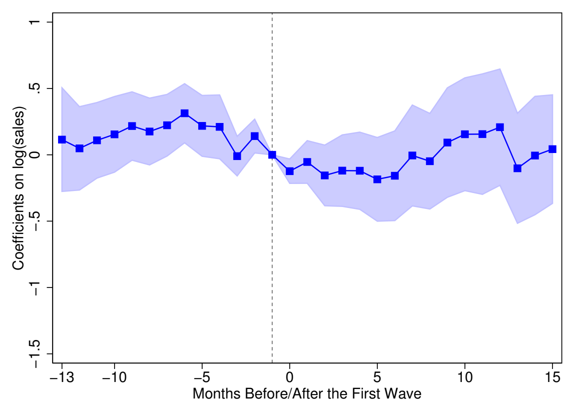
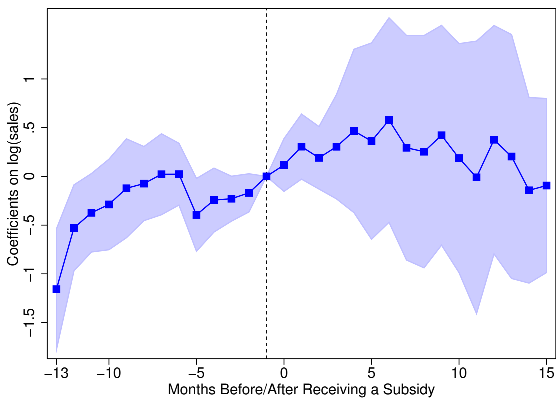
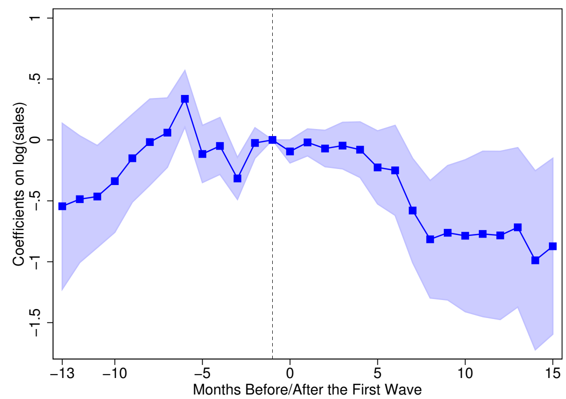


(d) Unsubsidized Products in Fuel Inefficiency Quartile 3

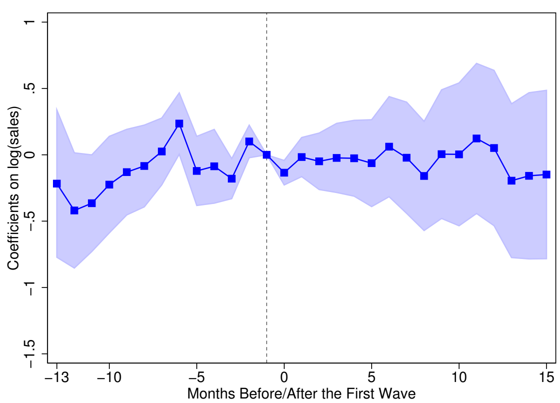
Figure E5: Balanced Panel without Category Trend



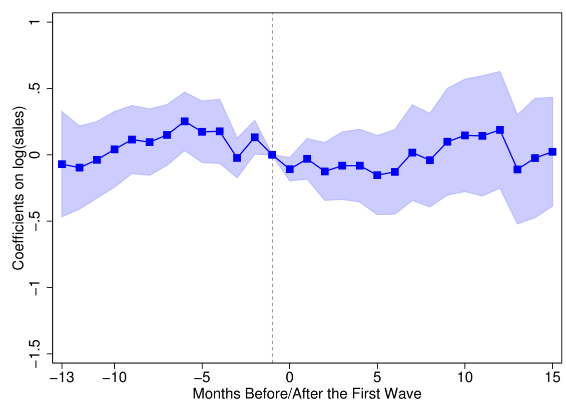
(a) Subsidized Products



(b) Unsubsidized Products in Fuel Inefficiency Quartile 1



(c) Unsubsidized Products in Fuel Inefficiency Quartile 2



(d) Unsubsidized Products in Fuel Inefficiency Quartile 3

Figure E6: Balanced Panel with Category Trend

F Welfare Calculations with Attribute Adjustments

In the main text, our estimates of welfare loss for consumers switching between their original choice of vehicles and subsidized vehicles do not take attribute adjustments into account. When there were many close subsidized substitutes around each consumer's original choice of vehicle, the welfare loss for consumers to make a substitution may be less than that estimated under a simple linear demand assumption. In this section, we discuss how to use existing estimates from Hu et al. (2014) to calculate deadweight loss from the subsidy program that takes attribute adjustments into account. We find that our results in the main text are robust to the above attribute adjustments.

Consider a subsidized vehicle B. Let the marginal consumer's original choice be A. After vehicle B was subsidized, the marginal consumer decided to purchase B instead of A. The utilities from consumer products A and B for the marginal consumer are as follows:

$$\begin{aligned} u(x_A, p_A) &= \beta' x_A + \alpha \ln(p_A) \\ u(x_B, p_B) &= \beta' x_B + \alpha \ln(p_B), \end{aligned}$$

where $x = (\text{horsepower}, \text{weight}, \text{fuel inefficiency})'$. Because the consumer's original choice was vehicle A, it must be the case that $u(x_A, p_A) - u(x_B, p_B) > 0$. Thus

$$\Delta \equiv \beta' (x_A - x_B) + \alpha \big[\ln(p_A) - \ln(p_B) \big] > 0.$$

In addition, because the consumer would choose to purchase vehicle B once B was subsidized, it must be that $u(x_A, p_A) - u(x_B, p_B - 3000) < 0$. Thus

$$\beta' (x_A - x_B) + \alpha \big[\ln(p_A) - \ln(p_B - 3000) \big] < 0.$$

Rewriting the above equation using Δ,

$$\Delta + \alpha \big[\ln(p_B) - \ln(p_B - 3000) \big] < 0 \Rightarrow \Delta < -\alpha \big[\ln(p_B) - \ln(p_B - 3000) \big].$$

Therefore, it must be that $0 < \Delta < -\alpha \big[\ln(p_B) - \ln(p_B - 3000) \big]$. Once we know the range of Δ, we can turn Δ, which is the difference in utility, into a monetary measure, to find the equivalent loss of income for the consumer without any change in vehicle attribute.

We find that the deadweight loss is $-p_A + \exp\big[\ln(p_A) - \Delta/\alpha\big]$.[4]

To find the deadweight loss, we follow three steps. First, for each subsidized vehicle in the first fuel inefficiency quartile, we find all unsubsidized vehicles with attributes satisfying $0 < \Delta < -\alpha\big[\ln(p_B) - \ln(p_B - 3000)\big]$. Second, for unsubsidized vehicles with Δ satisfying step one, we calculate the average deadweight loss $-p_A + \exp\big[\ln(p_A) - \Delta/\alpha\big]$ for these subsidized vehicles, using sales before the program as weights. Third, we weight the deadweight loss associated with each subsidized vehicle using their sales after the subsidy program.

We use demand estimates from Hu et al. (2014) (both nested-logit OLS and nested-logit with IV) for (α, β) and calculate the corresponding Δ and deadweight loss for each subsidized vehicle. The results suggest that the deadweight loss from the marginal consumers is around 1320 RMB, which is close to our simple back-of-envelope estimate of 1500 RMB used in the paper, and our welfare calculations are robust after we take attribute adjustments into account.

[4]We look for x such that $u(x_A, p_A) - u(x_A, p_A + x) = \Delta$. Thus

$$\Delta = \alpha\big[\ln(p_A) - \ln(p_A + x)\big] \Rightarrow x = -p_A + \exp\big[\ln(p_A) - \Delta/\alpha\big].$$

G Bunching Analysis

In the subsidy program, heavier vehicles face less stringent standards of fuel economy, and so manufacturers may change vehicle weight to meet the eligibility cutoffs. If so, the program could have unintended consequences by affecting the distribution of attributes other than fuel inefficiency. To illustrate, suppose that the fuel inefficiency cutoffs for vehicles with weight w (kg) in the range of $1205 < w \leq 1320$, and $1320 < w \leq 1430$ are 6.9 L/100 km and 7.3 L/100 km, respectively. A manufacturer producing an ineligible vehicle weighing 1300 kg and 7.2 L/100 km fuel inefficiency and seeking to benefit from the program could either adopt gasoline-saving technologies to meet the fuel inefficiency cutoff (making it be at most 6.9 L/100 km), or increase vehicle weight to meet the weight cutoff (making it heavier than 1320 kg). The manufacturer's final decision would depend on the cost structure of vehicle attributes and the demand response from product repositioning. If the manufacturer chose to meet the weight cutoff, and increasing vehicle weight had an additional cost, we would expect to see an excess bunch in the distribution of vehicle weight at the 1320 kg cutoff.

Ito and Sallee (2018) study Japan's fuel efficiency program and find excess bunching in the distribution of vehicle weight at eligibility cutoffs, suggesting that manufacturers manipulated vehicle weights to meet the government's fuel-economy regulations. Following their methods, we estimate the counterfactual distribution of vehicle weight to test excess bunching at eligibility cutoffs (or notches). The idea is straightforward: use the data *not* at the notch to fit a flexible model, take the model to estimate the density of vehicle weight at the notch, and compare the observed density to the estimated density at the notch. However, the actual implementation requires additional distributional assumptions to meet the integration constraint. In particular, one has to make assumptions about where excess bunches at the notch come from. Excess bunches at the notch are assumed to be drawn from vehicles weighing between the notch and the notch right before it, but they could be drawn uniformly (the 'uniform' assumption) or in a particular way that led to discrepancies in the observed and the predicted distribution (the 'empirical' assumption). We refer interested readers to Ito and Sallee (2018) for more details.

In our estimation, each bin has a width of 5 kg.[5] For example, the 1320 kg bin includes all vehicles with $1320 < w \leq 1325$. Columns (1) and (2) of Table G1 report notches associated with vehicles with engine size less than 1.6 liters and the number of vehicles at each notch. For notches with a positive number of vehicles in the corresponding 5 kg bin, columns (3) and (4) report the estimated excess bunching at the notch, under the uniform and the empirical assumption, respectively. Panel A provides results using vehicles launched

[5] All notches are multiples of 5 kg.

before the program. We do not find evidence of excess bunching under either the uniform or the empirical assumption. Panel B shows results using vehicles launched after the program. Here, we find excess bunching at notches 1090 kg, 1205 kg, and 1320 kg: the estimated numbers of excess vehicles at each notch are 12.04, 9.06, and 11.63, respectively, suggesting that after the program was launched, manufacturers adjusted vehicle weights to meet the eligibility cutoffs of the program. Finally, we note that the above analysis does not use any information from each vehicle's actual eligibility status, yet we find that the numbers of eligible vehicles launched after receiving a subsidy at the above three notches are 12, 8, and 6, respectively (shown in Figure G1), suggesting that the majority of excess bunching at notches may come from new eligible models. Such distortion of attributes other than fuel inefficiency was not the goal of the subsidy program and may even increase the overall fuel inefficiency. Even though a comprehensive welfare analysis taking vehicle redesign into account is beyond the scope of this paper, we do note that because changes in vehicle weights would affect vehicle safety or driving behaviors, it is important to examine the long-term effect of fuel efficiency programs that takes vehicle redesign into account (Jacobsen, 2013; Anderson and Auffhammer, 2013).

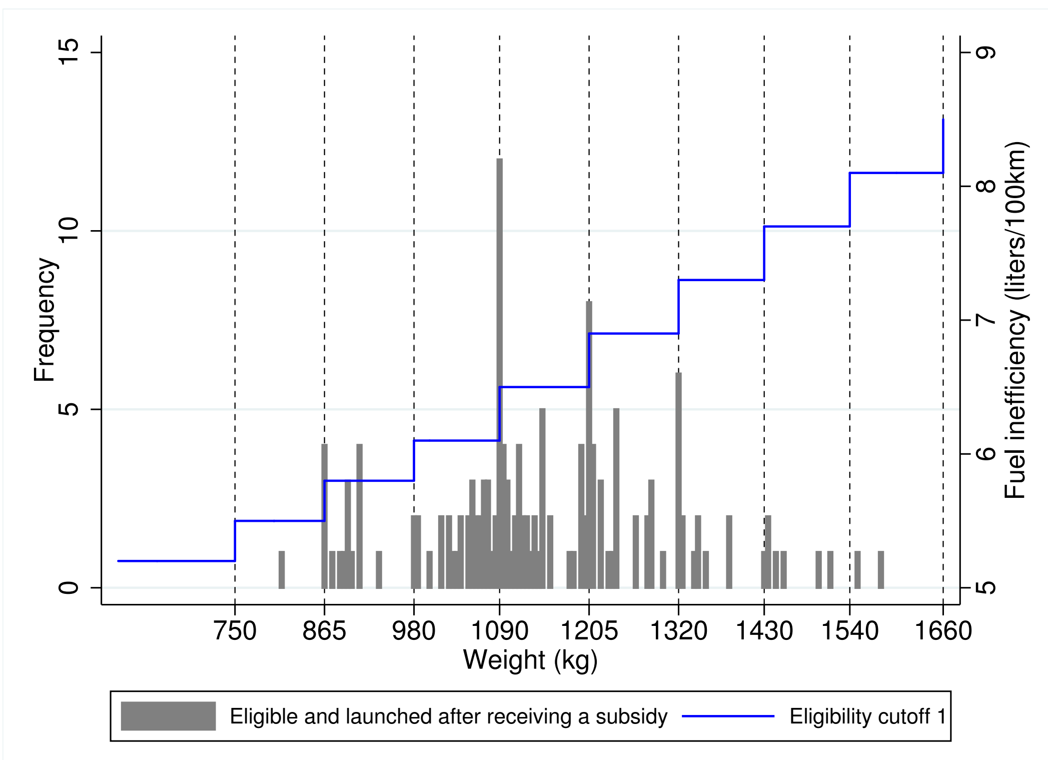


Figure G1: Number of New Eligible Vehicles at Each Notch

Table G1: Excess Bunching

(1) Notches	(2) Number of Cars	(3) Uniform assumption	(4) Empirical assumption
Panel A: Vehicles launched before the program			
750	0	-	-
		-	-
865	5	2.78	2.81
		(4.83)	(5.06)
980	1	-5.06	-5.05
		(4.54)	(4.54)
1090	4	-5.29	-5.30
		(4.65)	(4.71)
1205	15	5.75	5.74
		(4.66)	(4.78)
1320	10	5.19	5.19
		(4.85)	(5.08)
1430	0	-	-
		-	-
1540	1	-1.95	-1.96
		(5.52)	(5.34)
Panel B: Vehicles launched after the program			
750	0	-	-
		-	-
865	4	2.48	2.60
		(2.37)	(2.31)
980	4	0.42	0.47
		(2.39)	(1.92)
1090	17	12.04	12.05
		(2.28)	(2.25)
1205	14	9.06	9.06
		(2.23)	(2.16)
1320	15	11.63	11.64
		(2.30)	(1.95)
1430	2	0.69	0.69
		(2.47)	(2.11)
1540	0	-	-
		-	-

Notes: Standard errors are defined as the standard deviations of corresponding estimates from 1000 bootstrap samples (with random resampling of residuals).

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Hu, W., J. Xiao, and X. Zhou (2014). Collusion or competition? Interfirm relationships in the Chinese auto industry. *The Journal of Industrial Economics 62*(1), 1–40.

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