

The causal effect of purchase subsidy removal on electric vehicle demand: evidence from New Zealand's clean car discount

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Abstract

Governments that deploy purchase subsidies to accelerate electric vehicle (EV) adoption must eventually phase them out. What happens to EV demand after removal? This paper provides causal evidence using New Zealand's Clean Car Discount (CCD), which was abruptly discontinued on 31 December 2023 after 20 months, creating a sharp policy discontinuity. Using a regression discontinuity in time (RDiT) design, we find that subsidy removal caused an immediate and permanent reduction of approximately 24.1 percentage points in BEV market share. The implied own-price elasticity is -8.2 (95% bootstrap CI: $[-8.8, -7.7]$) - substantially exceeding estimates from larger markets - consistent with a nascent market dominated by marginal buyers. Anticipation bunching analysis documents 1,206 vehicles brought forward in the final eight weeks, equivalent to 3.7 weeks of average demand. The effect is permanent over 24 months with no market recovery. New vehicles, mass-market buyers, and high-income households were most affected. ICEV registrations were unaffected, confirming market exit rather than fuel-type substitution.

Keywords: Electric vehicles; subsidy removal; regression discontinuity in time; New Zealand; price elasticity.

JEL classification: Q48; R48; H23; D12

1. Introduction

Electrification of the vehicle fleet is a central technology shift to reduce greenhouse gas (GHG) emissions (Lundberg et al., 2026). Although subsidies have played an important role in the diffusion of electric vehicles (EVs)¹ (Münzel et al., 2019; Schub et al., 2025), governments that rely on purchase subsidies to accelerate EV adoption must eventually phase them out. Yet the demand consequences of subsidy removal remain poorly understood, particularly in small open economies where the subsidy may represent a proportionally larger share of vehicle cost.

Two competing mechanisms are plausible. A static price effect implies that removal raises the effective purchase price and permanently reduces demand, consistent with evidence that EV demand is highly responsive to purchase price (Clinton and Steinberg, 2019; Rapson and Muehlegger, 2023). A dynamic anticipation effect implies that announced removal pulls purchases forward, generating a pre-cutoff spike followed by a temporary post-cutoff trough, after which the market recovers to its natural trajectory - a pattern well documented in the broader bunching literature (Saez, 2010; Kleven, 2016) and observed in recent EV subsidy phase-outs (Hu et al., 2025; Lundberg et al., 2026).

These mechanisms carry distinct policy implications. If the static effect dominates, premature removal risks a structural demand collapse with lasting consequences for fleet electrification goals (Fournel, 2025). If the dynamic effect dominates, well-signalled phase-outs are less costly than feared, and governments can withdraw subsidies without derailing long-run adoption trajectories. Distinguishing between the two is therefore essential for the design of credible EV policy exit strategies, yet direct empirical evidence remains scarce.

¹ In this study, electric vehicles (EVs) include battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs)

New Zealand provides a clean empirical setting to test these mechanisms. The Clean Car Discount (CCD), introduced in April 2022 as part of a broader Clean Car package designed to reduce transport emissions, provided point-of-sale rebates funded by a feebate on high-emission vehicles. New battery electric vehicles (BEVs) received a weighted average rebate of NZD 8,163²; used BEV imports received NZD 2,800. The programme operated without a predetermined end date.

The CCD was formally terminated on 31 December 2023, with the discontinuation publicly announced several weeks in advance. This advance announcement is critical for our identification strategy, as it creates the conditions for anticipatory bunching that we test directly. The sharp, precisely dated policy discontinuity combined with the pre-announced removal makes New Zealand an unusually clean setting for separating static and dynamic effects.

This paper exploits that discontinuity using a Regression Discontinuity in Time (RDiT) design, following Hausman and Rapson (2018). A key identification concern is that total vehicle registrations also declined at the cutoff ($\beta = -2,184.7$, $p < 0.05$), reflecting broader macroeconomic conditions in New Zealand during late 2023 rather than the policy change itself³. We address this by focusing on BEV market share - the fraction of new registrations that are fully electric - rather than raw sales volumes. This framing isolates consumer choice between vehicle types from

² New battery electric vehicles (BEVs) received a weighted average rebate of NZD 8,163 across the CCD's operating period; used BEV imports received NZD 2,800. The new-BEV rebate was reduced from NZD 8,625 to NZD 7,015 on 1 July 2023, so NZD 8,163 reflects the registration-weighted average across both the higher pre-July and lower post-July rates.

³ New Zealand's late 2023 macroeconomic environment was characterised by pandemic-era scarring, elevated Reserve Bank of New Zealand (RBNZ) interest rates constraining vehicle financing, and fiscal consolidation under the incoming government, all of which weighed on consumer confidence and discretionary spending during the estimation window.

economy-wide shifts in overall purchase activity, and more cleanly attributes any observed change to the policy itself. Count-based estimates are retained as a secondary specification.

Our main finding is that subsidy removal caused an immediate and permanent reduction of 24.1 percentage points in BEV market share, with no evidence of recovery over 24 months. We also document pronounced anticipation bunching (1,206 excess vehicles, equivalent to 3.7 weeks of average demand), consistent with forward-looking consumer behaviour - but with the static price effect dominating in the long run.

We provide causal estimates of EV subsidy removal that advance the existing literature in three respects. While Fournel (2025) examines subsidy removal in Ontario and Lundberg et al. (2026) study Sweden - both relatively small markets - neither exploits a sharp, precisely dated policy discontinuity of the kind that New Zealand's abrupt CCD termination provides.

Our contribution is therefore not solely the small open economy setting, but rather the combination of: (i) a clean policy discontinuity enabling credible causal identification; (ii) direct evidence on the permanence of the demand effect over a 24-month post-removal window, which neither existing study establishes; and (iii) the separation of static price effects from dynamic anticipation effects using bunching analysis alongside RDiT. Together, these features allow us to address gaps in the removal literature that prior studies have not resolved.

These features yield three substantive findings that speak directly to gaps in the removal literature. First, the implied own-price elasticity of -8.2 - approximately 2.5 times larger than the German estimate of -3.16 (Haan et al., 2025) and the US range of -3 to -5 (Clinton and Steinberg, 2019) - is consistent with the theoretical prediction that elasticities are higher in nascent markets characterised by a high share of marginal buyers (Rapson and Muehlegger, 2023). Second, the demand effect is permanent over 24 months with no evidence of market recovery, establishing that

premature subsidy removal risks structural demand collapse rather than temporary disruption. Third, the absence of ICEV substitution confirms market exit rather than fuel-type switching, limiting the direct carbon cost of removal but underscoring the fragility of EV adoption in nascent markets.

This paper tests four hypotheses:

H1 (static price effect): BEV market share declines immediately and permanently following subsidy removal.

H2 (anticipation effect): The pre-announced removal generates excess registrations in the weeks preceding the cutoff.

H3 (market maturity): The own-price elasticity of BEV demand exceeds estimates from larger, more mature markets.

H4 (heterogeneity): The demand response is larger for new vehicles and mass-market buyers, with no substitution to internal combustion engine vehicles.

The remainder of the paper is organised as follows. Section 2 reviews the literature. Section 3 describes the data and empirical strategy. Section 4 reports main results and price elasticity. Section 5 examines heterogeneity. Section 6 presents the cost-benefit and MVPF analysis. Section 7 presents robustness checks. Section 8 concludes.

2. Literature review

2.1. Subsidies for EVs in theory and practice

The theoretical case for EV purchase subsidies rests on several distinct but overlapping market failures. Rapson and Muehlegger (2023) provide a systematic taxonomy distinguishing

externalities on the intensive margin - those arising from each mile driven - and on the extensive margin, arising from the stock of EVs on the road.

On the intensive margin, the central externality is carbon emissions, with net effects varying substantially by grid composition and proximity to population centres. On the extensive margin, two further failures are relevant: learning-by-doing (LBD) spillovers in battery and EV production, where cumulative manufacturing experience reduces costs in ways individual firms cannot fully appropriate; and network externalities in charging infrastructure, where each additional EV owner increases the value of the network for prospective buyers. Parry et al. (2007) remain the foundational reference for the welfare calculus of vehicle pricing policy, spanning congestion, accidents, local pollution, and carbon externalities.

A separate demand-side rationale concerns consumer undervaluation of future fuel savings. If buyers systematically discount the operational cost advantage of EVs over the vehicle's lifetime, the market will underprovide adoption relative to the social optimum (Rapson and Muehlegger, 2023). Fischer et al. (2013) show that energy efficiency undervaluation can be a more quantitatively significant market failure than supply-side knowledge spillovers, and that policies lowering electricity prices can worsen this distortion by weakening the efficiency price signal.

Theory also implies that optimal subsidy levels should vary by location, technology maturity, and time. Rapson and Muehlegger (2023) argue that charging infrastructure and LBD externalities exhibit diminishing marginal returns as markets mature, warranting front-loaded subsidies that decline over time. Fischer et al. (2013) reach a parallel conclusion: emissions pricing remains the most cost-effective single instrument, and aggressive deployment subsidies alongside carbon pricing tend to reduce welfare.

A final consideration concerns subsidy additionality. Rapson and Muehlegger (2023) estimate that under moderate elasticity assumptions, the majority of subsidised buyers would have purchased an EV regardless, yielding an effective cost per subsidy-induced vehicle well above \$50,000 - many times the face value of the subsidy. This inframarginal transfer problem provides a strong rationale for targeted or time-limited programmes and generates the testable hypothesis motivating this paper: if New Zealand's nascent EV market is dominated by marginal buyers, subsidy removal should produce a larger demand contraction than observed in mature markets. The heterogeneity analysis in Section 5 tests this directly.

2.2. From adoption to removal: what the literature tells us

Understanding the demand effects of EV subsidy removal requires drawing on three strands of literature: evidence on subsidy effectiveness in mature markets, evidence on the conditions under which financial incentives become binding, and the thin but growing literature on subsidy removal itself.

The first strand establishes that financial incentives are effective drivers of EV adoption where technology and infrastructure constraints are resolved. Clinton and Steinberg (2019) exploit variation in US state-level incentives and estimate own-price elasticities of -3 to -5, providing the foundational benchmark for subsidy responsiveness in a large, mature market. Haan et al. (2025) evaluate German purchase grants using neighbouring countries as a control group, finding that 40% of BEV registrations were subsidy-induced and reporting an implied elasticity of -3.16, a key benchmark for our comparison. Muehlegger and Rapson (2022) extend this evidence to a California programme targeting low- and middle-income buyers, documenting that subsidy design and targeting matter for both effectiveness and distributional outcomes.

The second strand reveals that this effectiveness is conditional on market maturity. Liu et al. (2021) examine 61 Chinese cities over 2009-2018 and find that convenience measures such as charging station construction and purchase restriction waivers were more effective than direct financial subsidies during the early adoption phase. Furthermore, non-price barriers were binding constraints on EV diffusion in China at this stage (Kalthaus and Sun (2021), Zhao et al. (2024), Li et al. (2019). Together, these findings suggest that financial incentives become most powerful once infrastructure constraints are resolved.

The third strand, on subsidy removal, is considerably thinner despite its growing policy relevance. Hu et al. (2025) study China's stepwise phase-out and document significant anticipatory behaviour, consistent with forward-looking consumers pulling purchases forward ahead of announced reductions. Fournel (2025) examines the abrupt removal of Ontario's EV incentive and finds large negative demand effects. Lundberg et al. (2026) study the elimination of Sweden's EV bonus and document a significant decline in private EV leasing, with disproportionate effects on low-income households - a distributional pattern that resonates with our heterogeneity findings, though their focus on the leasing segment distinguishes it from our purchase market setting. Across all three cases, the permanence of the demand effect and the mechanisms driving heterogeneous responses remain unresolved - gaps this paper directly addresses.

3. Data and empirical strategy

3.1 Data

The primary dataset consists of weekly vehicle registration records from the New Zealand Motor Vehicle Register, spanning December 2021 to December 2025 (approximately 210 weeks).

We aggregated weekly registrations by fuel type (BEV, PHEV, HEV, ICEV), import status (new vs. used), territorial authority of registration, and vehicle make and model.

Income tertiles are assigned at the territorial authority level using median household income from Statistics New Zealand census data: registrations in each territorial authority are classified as low, mid, or high income based on whether the area falls in the bottom, middle, or top third of the national median household income distribution.

To compute the effective price change at the subsidy cutoff, we supplement the registration data with vehicle price data from the Optifleet new vehicle database, which contains approximately 32,000 records for new light vehicles sold in New Zealand, including recommended retail price (RRP) and detailed vehicle characteristics. We restrict the price sample to new BEVs registered in 2022-2023, yielding 58 vehicle-model observations (Table 2).

Vehicle price segments (mass, mid, premium) are assigned by matching each vehicle make and model to its recommended retail price from the Optifleet new vehicle database, then classifying by list price tertile across all new BEV models registered during the sample period. The mass-market segment (bottom tertile) includes high-volume models such as the MG ZS EV, BYD Atto 3, and Nissan Leaf. The mid segment (middle tertile) includes the Tesla Model 3, Tesla Model Y, Hyundai IONIQ 5, and Kia EV6. The premium segment (top tertile) includes the Tesla Model S and X, Porsche Taycan, and Audi e-tron.

Summary statistics for the estimation sample are reported in Table 1, covering 44 weekly observations within the ± 26 -week bandwidth around the 31 December 2023 cutoff, after excluding the 8-week bunching window. A comparison of mean pre- and post-cutoff BEV outcomes is illustrated in Figure A9, Appendix.

The data reveal a dramatic decline in BEV registrations following the CCD's removal: mean weekly BEV registrations fell from 328.5 (SD = 188.3) in the pre-cutoff period to 70.6 (SD = 35.3) post-cutoff, representing a reduction of approximately 79%. BEV market share declined correspondingly, from a pre-cutoff mean of 10.6% to 2.27% post-cutoff. Notably, Total vehicle registrations remained broadly stable in aggregate across the two periods (2,916 vs. 3,041 weekly, on average), though this masks a general softening in overall market volumes visible in Figure 1.

Table 1. Summary statistics - estimation sample (± 26 -week bandwidth, bunching zone excluded)

Variable	Period	Mean	SD	Min	Max	N
BEV registrations (weekly)	Pre-cutoff	328.5	188.3	93	753	18
	Post-cutoff	70.6	35.3	15	138	26
BEV market share (%)	Pre-cutoff	10.6	3.47	7.2	17.3	18
	Post-cutoff	2.27	0.89	0.57	3.97	26
Total vehicle registrations	Pre-cutoff	2,916	823.3	1,269	4,338	18
	Post-cutoff	3,041	572.4	2,142	4,101	26

Notes: Bunching zone (weeks -8 to 0) excluded. Estimation sample spans ± 26 weeks around 31 December 2023 cutoff.

Table 2. Summary statistics for new BEV prices, 2022–2023 (NZD)

N	Mean	Median	SD	Min	25th percentile	75th percentile	Max
58	98,224	85,445	40,716	49,990	77,067	101,350	275,295

N: vehicle models

Weekly Vehicle Registrations by Type, New Zealand 2022-2025

Dashed = CCD removal (31 Dec 2023). Dotted = CCD start (1 Apr 2022) and rebate reduction (1 Jul 2023).

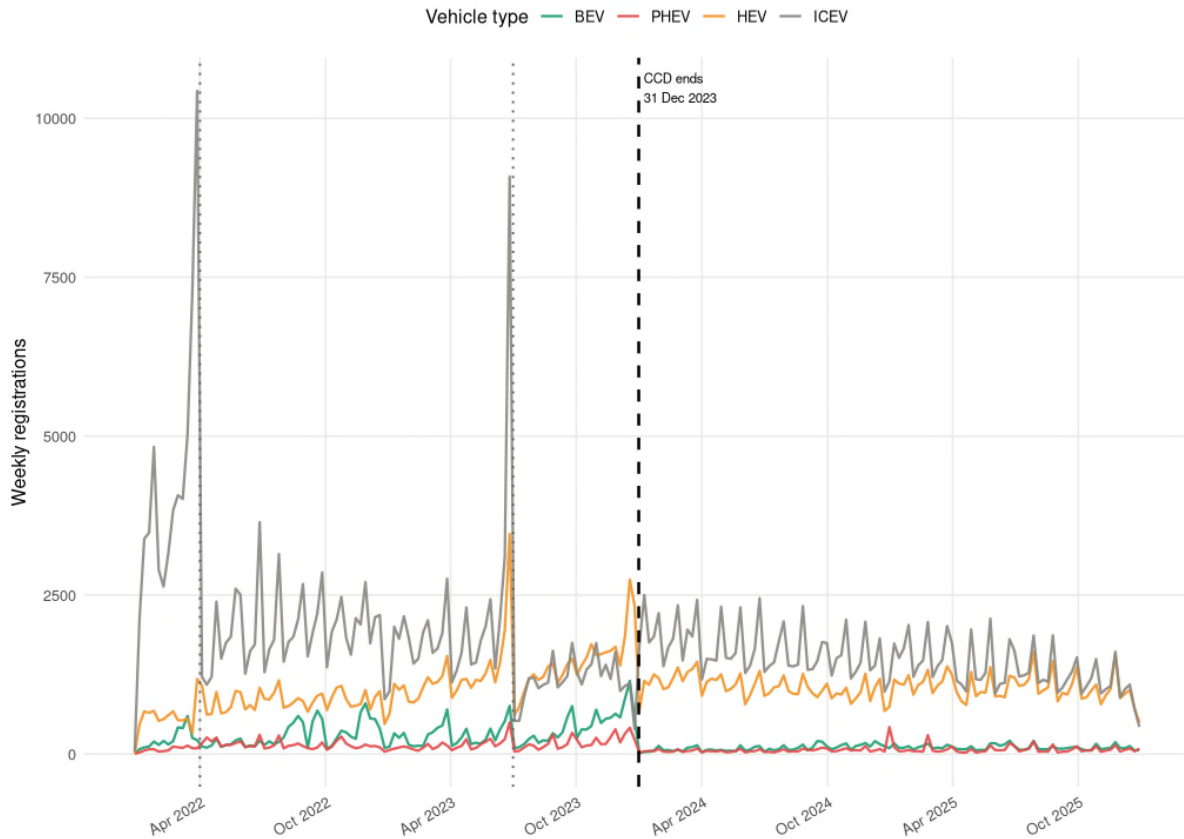


Figure 1. Weekly new registrations from December 2021 to December 2025.

Figure 1 presents weekly vehicle registrations by powertrain type from January 2022 to December 2025, with three key policy events marked: the introduction of the Clean Car Discount (CCD) on 1 April 2022, a rebate reduction on 1 July 2023, and the scheme's removal on 31 December 2023. Two sharp registration spikes - predominantly in ICEV and PHEV volumes - are visible immediately preceding the CCD's introduction and the rebate reduction respectively, consistent with anticipatory purchasing behaviour. BEV registrations show a modest upward trend during the subsidy period before declining sharply following the CCD's removal, falling to levels at or below pre-scheme baselines, while HEV registrations remain comparatively stable throughout. This pattern of demand response around each policy event motivates the empirical

analysis presented in the following section. Weekly BEV registrations by price segment are provided in Figure A7, Appendix.

3.2 Empirical strategy

We exploit the sharp policy discontinuity on 31 December 2023 using a regression discontinuity in time (RDiT) design. Our preferred specification is:

$$\text{share}_t = \alpha + \beta \text{Post}_t + \gamma t + \delta (\text{Post}_t \times t) + \lambda_m + \varepsilon_t \quad (1)$$

where share_t is weekly BEV market share in week t , Post_t is an indicator equal to one for weeks after 31 December 2023, t is a linear running variable (weeks relative to cutoff), and λ_m are month-of-year fixed effects. The coefficient β is our parameter of interest. Standard errors are computed using the Newey-West HAC estimator with a lag of four weeks. We restrict the estimation sample to ± 26 -week bandwidth and exclude the 8-week bunching window.

4. Main results

4.1 Pre-trend test

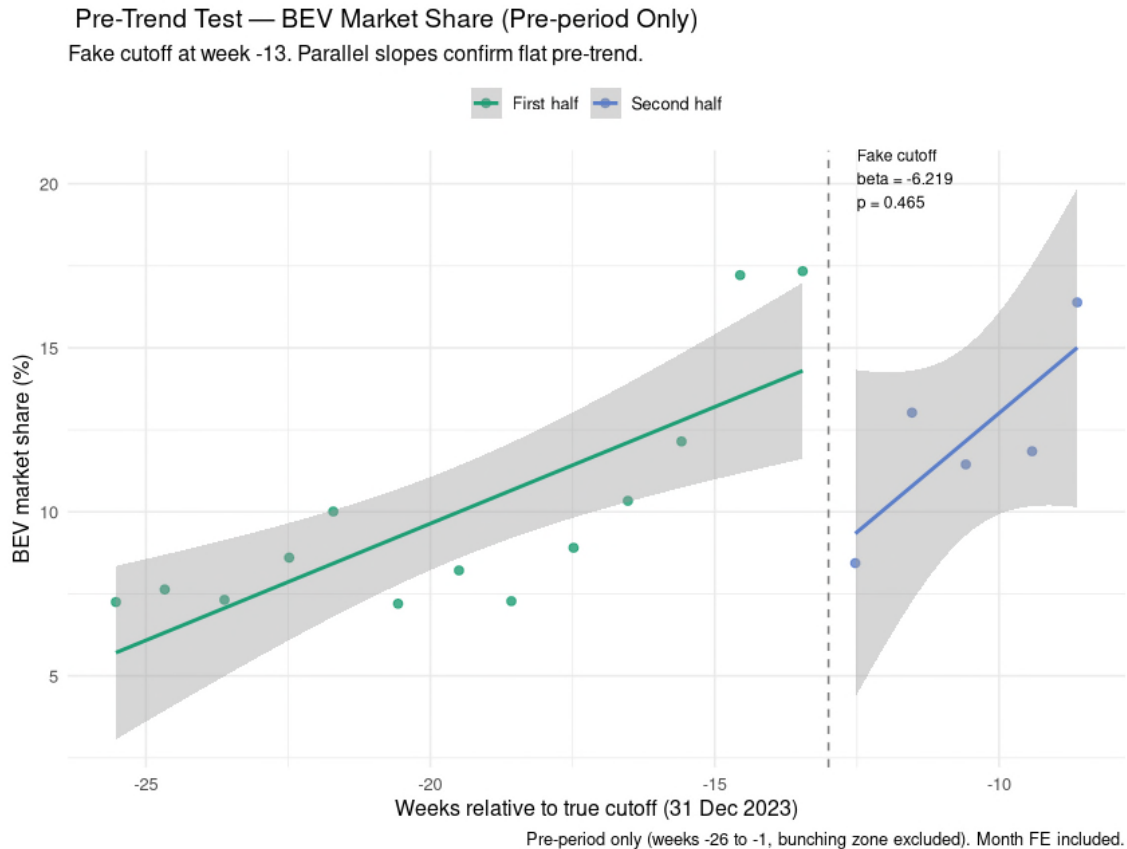
Before presenting the main causal estimates, we verify the identifying assumption of a flat pre-treatment trend. The pre-trend test for both outcomes yields large p-values (share: $\beta = -6.22$, $\text{SE} = 8.23$, $p = 0.47$; count: $\beta = -671.4$, $\text{SE} = 615.9$, $p = 0.3$), confirming that the RDiT design is valid. (Table 3). Figure 2 plots the pre-period data with the placebo cutoff at week -13 , confirming the flat pre-treatment trend reported in Table 3.

Table 3. Pre-trend test results

Outcome	Fake cutoff	Beta	SE	p-value	Conclusion
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BEV market share (%)	Week -13	-6.22	8.23	0.47	Flat (valid)
BEV count (weekly)	Week -13	-671.4	615.9	0.30	Flat (valid)

Notes: Flat pre-trend confirmed if $p > 0.05$ for both outcomes.



Note: Placebo cutoff placed at Week -13 relative to the true cutoff (31 December 2023). Parallel slopes and a statistically insignificant discontinuity confirm a flat pre-treatment trend.

Figure 2. Pre-trend test - BEV market share (pre-period only)

4.2 Core causal effect

Table 4 reports the main RDiT estimates. Subsidy removal caused an immediate reduction of 24.1 percentage points in BEV market share ($SE = 2.98$, $t = -9.9$, $p < 0.001$, 95%

CI: $[-30.0, -18.3]$), with the count-based estimate yielding $\beta = -1,319$ vehicles per week (SE = 111.6, $t = -11.8$, $p < 0.001$). Both estimates are statistically significant.

As a validity check, we apply the same specification to total vehicle registrations - a variable that should be unaffected by the subsidy policy under valid identification. This yields $\beta = -2,184.7$ ($p < 0.05$), indicating that total registrations also declined around the cutoff. This decline reflects broader macroeconomic conditions in New Zealand during late 2023 rather than the policy itself and confirms why BEV market share is the appropriate outcome: by expressing BEV registrations as a fraction of all registrations, we isolate consumer choice between vehicle types from economy-wide movements in overall demand.

The market share specification therefore addresses both the macroeconomic confound and the compositional distortion that would arise from using raw counts. The strong visual discontinuity in Figure 3 corroborates this conclusion, showing a sharp and immediate break in BEV market share at the cutoff with no comparable movement in the pre-period trend. We accordingly retain the parametric estimates from Table 4 as our preferred specification; the count-based estimate yields a comparable discontinuity of $-1,319$ vehicles per week and is reported for completeness in Figure A1, Appendix.

Table 4. Main RDiT estimates - effect of Clean Car Discount removal on BEV demand

Outcome	Beta	SE	t-stat	p-value	95% CI
(1) Main outcome -BEV market share (pp)	-24.1	2.98	-9.9	< 0.001	$[-30.0, -18.3]$
(2) BEV count (vehicles/week)	-1,319	111.6	-11.8	< 0.001	$[-1,538, -1,100]$

Notes: ± 26 -week bandwidth. Bunching zone (weeks -8 to 0) excluded. Month fixed effects. Newey-West HAC standard errors, lag = 4 weeks. Linear time trend. N = 44 weekly observations.

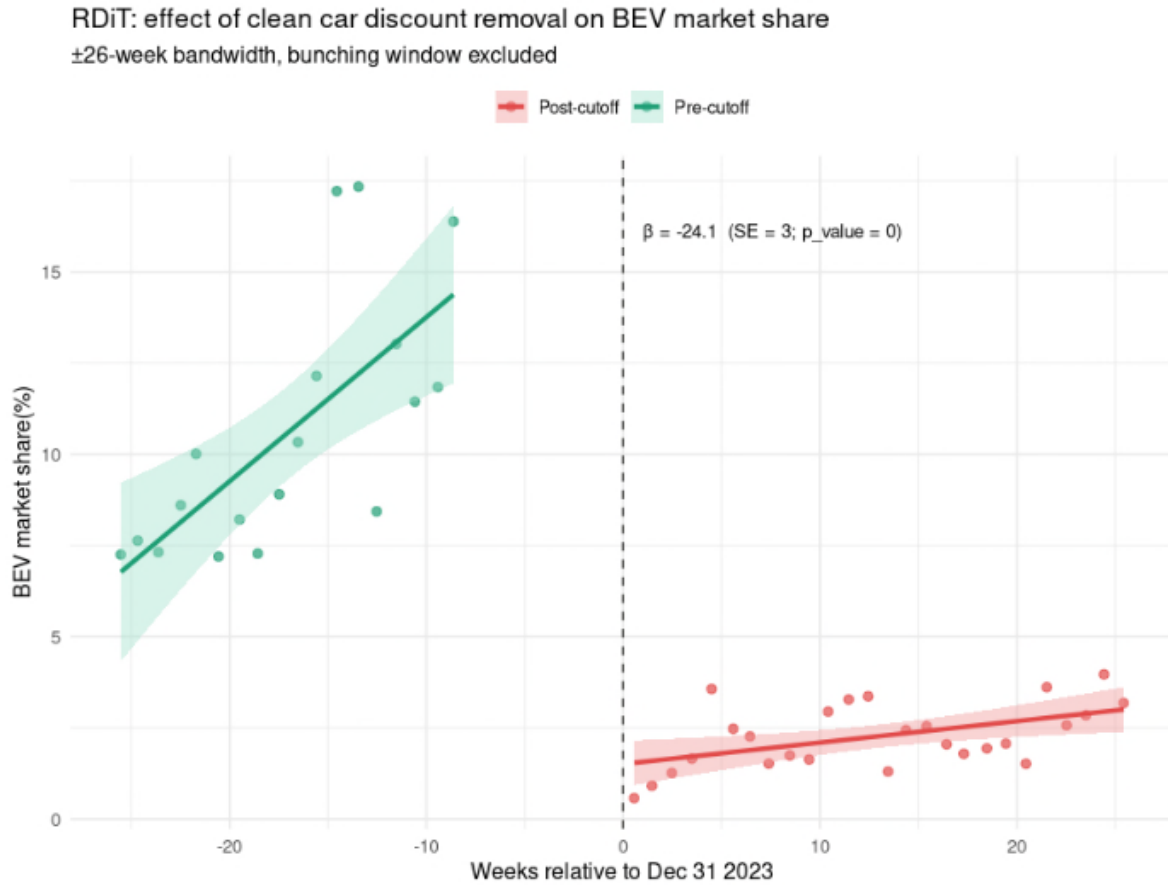


Figure 3. Core causal effect - BEV market share (%), with RDiT discontinuity at 31 December 2023.

4.3 Anticipation bunching

Table 5 and figure 4 document the bunching analysis. In the 8 weeks immediately preceding the cutoff, 5,393 vehicles were registered against a counterfactual of 4,187 implied by the pre-trend - an excess of 1,206 vehicles (28.8% above trend), equivalent to 3.7 weeks of average weekly demand. This confirms that consumers behaved in a forward-looking manner, responding to the announced discontinuation by pulling purchases forward.

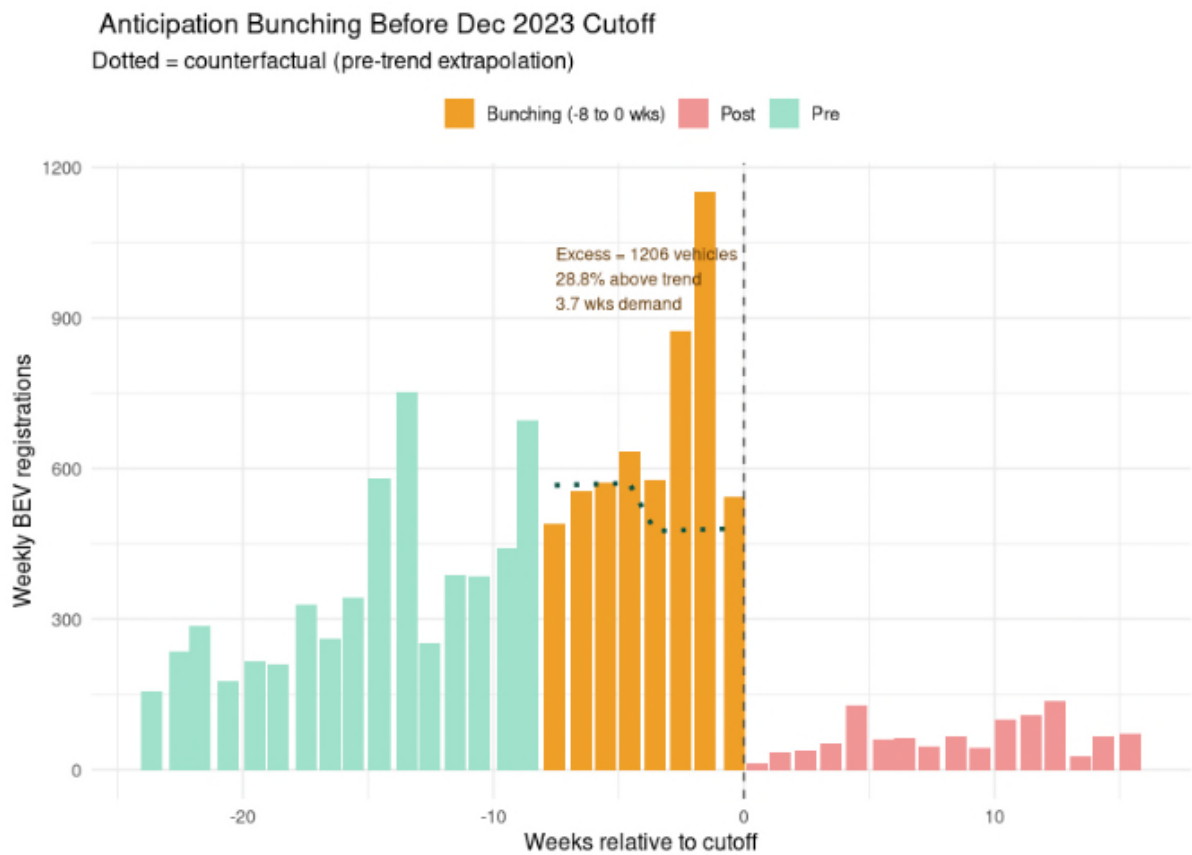
268

269 **Table 5.** Anticipation bunching estimates

Metric	Value
Observed registrations in bunching window (weeks -8 to 0)	5,393 vehicles
Counterfactual (pre-trend prediction)	4,187 vehicles
Excess brought-forward demand	1,206 vehicles (28.8%)
Hangover equivalent	3.7 weeks of average weekly demand

270 Notes: Counterfactual derived from pre-period regression (weeks -26 to -9) extrapolated to the bunching window.

271 Hangover equivalent = excess / average weekly registrations in pre-period.



272

Figure 4. Bunching quantification - excess BEV registrations in weeks -8 to 0 relative to counterfactual trend.

4.4 Persistence

Tables 6 and 7 present the persistence analysis. BEV registrations remained 716–780 vehicles per week below counterfactual levels across all four post-cutoff windows, while market share remained 16.6–19.3 percentage points below counterfactual levels. P-values are near zero throughout. There is no evidence of market recovery or adaptation over the 24-month post-cutoff period.

Table 6. Persistence of BEV registration decline following CCD removal

Post-cutoff window	Beta	SE	95% CI	p-value
0–6 months	–723	67.1	[–855, –592]	2.94e-13
6–12 months	–780	71.2	[–919, –640]	1.84e-13
12–18 months	–735	108.0	[–947, –523]	4.26e-8
18–24 months	–716	91.7	[–896, –536]	1.72e-9

Notes: All estimates $p < 0.001$ (***). Each window estimated against the same pre-period anchor (weeks -26 to -1, bunching zone excluded). Newey-West HAC SE, lag = 4 weeks.

Table 7. Persistence of BEV market share decline following CCD removal

Post-cutoff window	Beta (pp)	SE	95% CI	p-value
0–6 months	–16.6	1.4	[–19.4, –13.7]	3.91e-14
6–12 months	–19.0	1.6	[–22.2, –15.9]	1.73e-14
12–18 months	–18.9	3.4	[–25.6, –12.2]	2.31e-6
18–24 months	–19.3	1.8	[–22.9, –15.8]	4.12e-13

Notes: All estimates $p < 0.001$ (***). Beta expressed in percentage points. Same estimation procedure as Table 6.

The absence of recovery is visually confirmed in Figure 5, which plots the RDiT point estimates and 95% confidence intervals across all four post-cutoff windows both the count and market share outcomes. Persistence estimates for the count outcome are presented separately in Figure A2, Appendix, and follow an identical pattern.

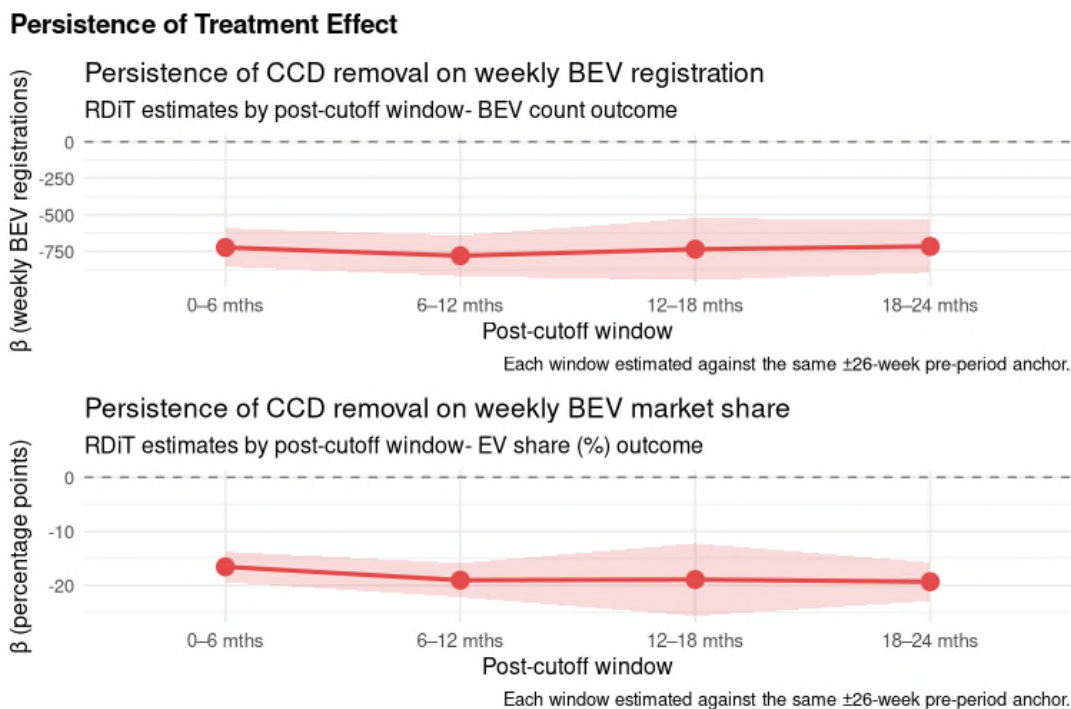


Figure 5. Persistence of BEV demand decline following CCD removal.

4.5 Price elasticity

Table 8 summarises the implied own-price elasticity of BEV demand. To compute the effective price change at the cutoff, we use vehicle price data from the Optifleet new vehicle database. Restricting to new BEVs with model year 2022–2023 yields 58 vehicle-model observations with a median recommended retail price of NZD 85,445 (mean: NZD 98,224; see Table 2). The weighted average rebate across all new BEVs registered during the CCD period,

computed from actual rebate schedules and monthly registration counts from the NZ Motor Vehicle Register, was NZD 8,163. The effective price increase at the cutoff is therefore 9.55% ($= 8,163 / 85,445$).

The quantity change is computed as the percentage difference between pre- and post-cutoff mean BEV market share (10.6% versus 2.27%), yielding a quantity change of -78.6% and an implied own-price elasticity of -8.2 (95% bootstrap CI: $[-8.8, -7.7]$). We note that this elasticity computation uses raw pre- and post-cutoff means rather than the RDiT point estimate directly.

This approach is appropriate for two reasons. First, elasticity computation requires a quantity level change rather than a marginal discontinuity estimate, and the pre- and post-cutoff means directly capture the realised market-level adjustment following subsidy removal. Second, these means are themselves products of the RDiT design - the estimation sample, bandwidth, and bunching exclusion window are identical to the causal specification - ensuring that the mean comparison inherits the identification logic of the causal design while translating it into a price-responsive quantity metric suitable for elasticity computation.

The implied elasticity of -8.2 substantially exceeds estimates from larger, more mature markets - including the US (-3 to -5 , Clinton and Steinberg, 2019) and Germany (-3.16 , Haan et al., 2025) - consistent with New Zealand's nascent EV market being dominated by marginal buyers for whom the subsidy represented a decisive share of vehicle purchase price. By contrast, the elasticity for used BEVs is approximately zero ($\beta = +0.8$ pp, $p = 0.578$), consistent with used BEV buyers being price-inelastic: this segment is dominated by budget-conscious buyers for whom used imports represent the only affordable electric option regardless of subsidy availability.

Together, these findings confirm H3 - that own-price elasticity exceeds estimates from more mature markets - and provide direct empirical support for the theoretical prediction that elasticities are higher in nascent markets characterised by a high share of marginal buyers (Rapson and Muehlegger, 2023).

Table 8. Price elasticity of BEV demand

Metric	Value
Weighted avg. subsidy - new BEV (NZD)	8,163
Median new BEV RRP (NZD)	85,445
Price change at cutoff (new BEV)	+9.55%
Pre-cutoff mean BEV market share	10.6%
Post-cutoff mean BEV market share	2.27%
Quantity changes at cutoff	-78.6%
Own-price elasticity (new BEV)	-8.2
Own-price elasticity (used BEV)	~0 (p = 0.578)
95% Bootstrap CI (new BEV)	[-8.8, -7.7]

Notes: Bootstrap CI based on 1,000 replications. 1% increase in effective price reduces demand by approximately 8%;

The weighted average subsidy of NZD 8,163 is computed as the registration-weighted mean rebate across all new BEV models eligible under the CCD, using actual rebate schedules and monthly registration counts from the NZ Motor Vehicle Register over the period April 2022 to December 2023

5. Heterogeneity analysis

5.1 New versus used BEVs

Table 9 reports heterogeneous effects by import status. New BEV market share fell by 26.3 percentage points (significant), while used BEV share showed a negligible and insignificant change of +0.8 percentage points. Count estimates are −1,252 (new) and −152 (used) vehicles per week. The disparity is more than 8 times in count terms, consistent with the higher subsidy rate for new vehicles (NZD 7,015 versus NZD 2,800)⁴. The absence of a significant used BEV share effect implies that consumers who exited the new BEV market did not substitute to used imports but withdrew from the electric vehicle market entirely.

Table 9. Heterogeneous effects by import status

Group	Outcome	Beta	SE	p-value	95% CI
New BEV	Share	−26.3	3.3	0.000	[−32.8, −19.8]
Used BEV	Share	+0.8	1.4	0.578	[−1.9, +3.5]
New BEV	Count	−1,252.2	189.6	0.000	[−1,624, −880.6]
Used BEV	Count	−152.0	15.8	0.000	[−183, −121]

Notes: *** p < 0.001. Month FE included. Newey-West HAC SE, lag = 4 weeks. ±26-week bandwidth, bunching zone excluded.

⁴ NZD 7,015 refers to the flat new-BEV rebate rate applicable in the final rebate tier before removal; NZD 8,163 (reported in Section 4.5 and Table 8) is the registration-weighted average across the full CCD period, which included an earlier, higher rebate tier

New vs used BEV imports

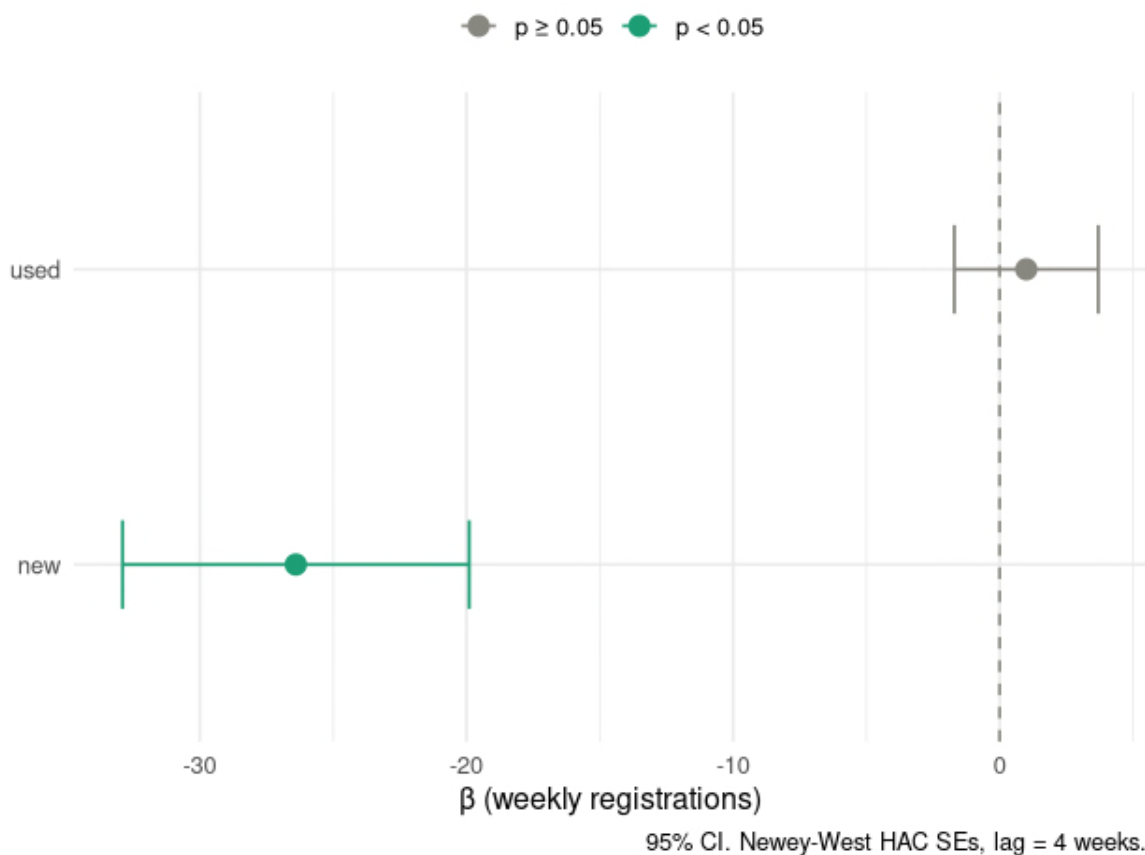


Figure 6. New vs. used BEV heterogeneity - BEV market share by import status.

Figure 6 presents the corresponding coefficient plot, illustrating the sharp contrast between the large, precisely estimated decline for new BEVs and the near-zero, statistically insignificant effect for used imports. Count-based estimates by import status are reported in Figure A3, Appendix, and confirm the same pattern.

5.2 Income tertile

Income tertiles are assigned at the territorial authority level using median household income from Statistics New Zealand census data, as described in Section 3.1. Table 10 presents distributional effects by income group. All three income groups show significant market share

declines. High-income households were most affected (−11.1 pp), followed by low-income (−6.6 pp) and mid-income (−3.7 pp) households. In count terms, high-income households saw 553.7 fewer BEV registrations per week, compared to 350.1 and 219.6 for low- and mid-income groups respectively. The relatively modest mid-income effect is consistent with greater substitution flexibility - mid-income buyers may have shifted to used BEV imports rather than exiting the market entirely.

Table 10. Heterogeneous effects by income tertile

Income tertile	Outcome	Beta	SE	p-value	95% CI
Low	Share	−6.6	1.1	0.000	[−8.8, −4.4]
Mid	Share	−3.7	0.3	0.000	[−4.3, −3.1]
High	Share	−11.1	1.7	0.000	[−14.4, −7.8]
Low	Count	−350.1	49.6	0.000	[−447.3, −252.9]
Mid	Count	−219.6	19.8	0.000	[−258.4, −180.8]
High	Count	−553.7	59.8	0.000	[−670.9, −436.5]

Note: All estimates $p < 0.001$. Income tertile assigned by median household income of territorial authority of registration. Month fixed effects included. Beta represents the change in weekly BEV registrations (Count) and BEV market share in percentage points (Share) at the subsidy removal cutoff. ± 26 -week bandwidth, bunching zone excluded. Newey-West HAC SE, lag = 4 weeks.

Figure 7 plots the count-based estimates by income group, confirming that the demand response is monotonically ordered by income level, with high-income territorial authorities showing the largest absolute decline. The corresponding count estimates by income group are shown in Figure A4, Appendix.

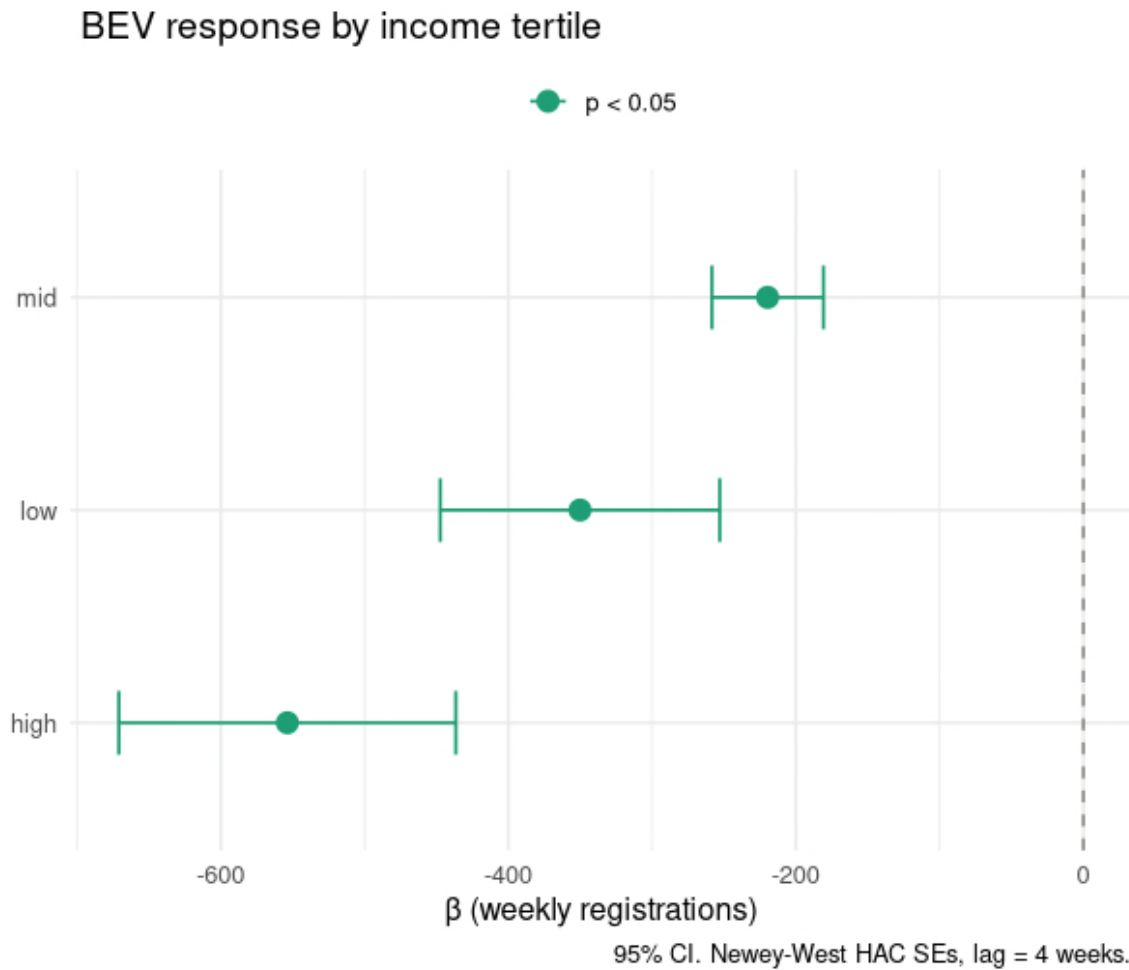


Figure 7. Income tertile heterogeneity - BEV demand response by household income group.

5.3 Charging infrastructure

Table 11 examines whether charging infrastructure density moderated the post-removal demand decline. Neither the split analysis (Table 11) nor the interaction models (Tables A1&A2, Appendix) yield robust evidence of a moderating effect.

The three-way interaction model yields a marginally significant moderating effect in the count outcome ($\beta = 8.81$, $p = 0.04$), suggesting regions with higher charger density experienced a somewhat smaller post-removal decline (Table A1, Appendix). However, this result is not robust

to specification change - the restricted two-way model produces an attenuated, insignificant estimate ($\beta = 2.59$, $p = 0.17$) - and the share outcome shows no significant moderating effect in either specification (Table A2, Appendix). The evidence is therefore insufficient to conclude that charging accessibility buffered the demand response; financial cost was the binding constraint on BEV adoption following CCD removal. Figure 8 plots the market share estimates by infrastructure level, visually confirming the absence of a robust moderating effect across both high- and low-charger-density regions. Count-based results by infrastructure level are provided in Figure A5, Appendix, and are consistent with the share outcome.

Table 11. BEV response by charging infrastructure — split analysis

Infrastructure level	Outcome	Beta	SE	p-value	95% CI
Low	Share	+0.5	12.7	0.967	[−24.4, 25.4]
High	Share	+0.2	0.1	0.035	[0.0, 0.4]
Low	Count	+0.8	12.7	0.950	[−24.1, 25.7]
High	Count	−1.5	2.9	0.612	[−7.2, 4.2]

Notes: * $p < 0.05$. Split by high/low public EV chargers per 100,000 population; Count - weekly BEV registrations (change at cutoff); Share - BEV market share in percentage points (change at cutoff)

BEV response by charging infrastructure

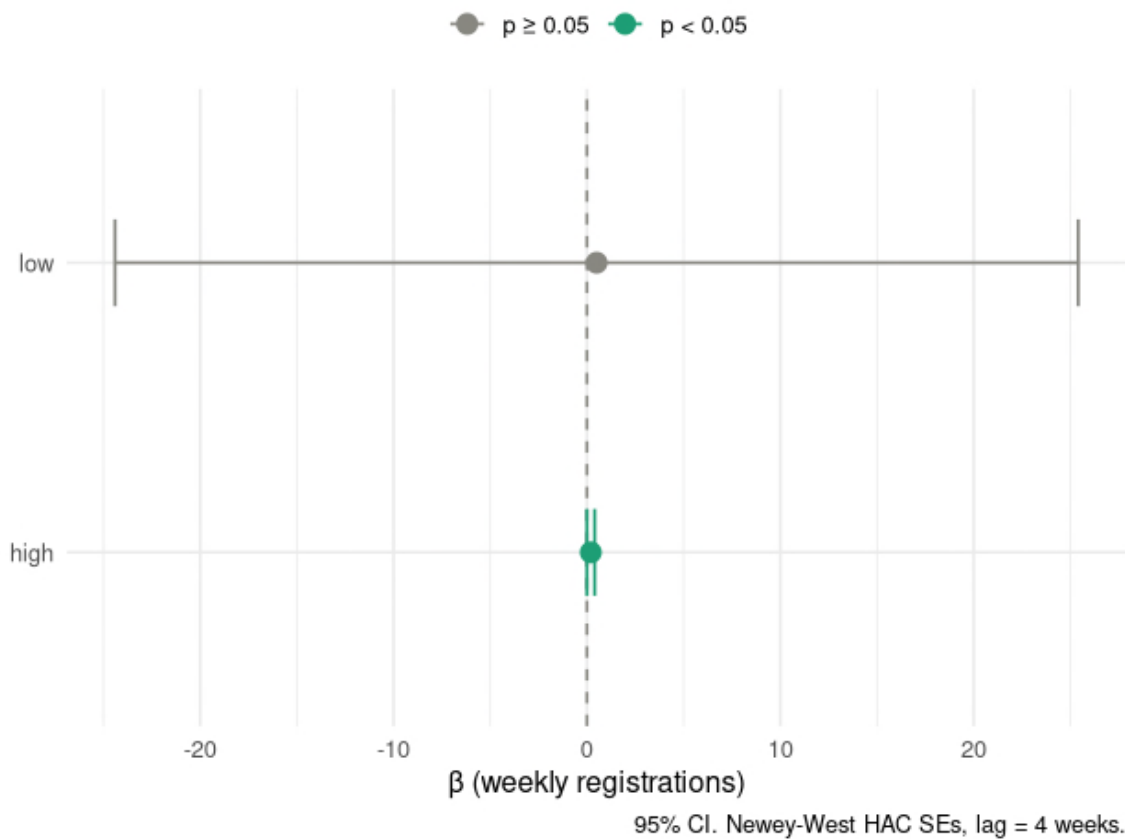


Figure 8. BEV response by charging infrastructure - market share.

5.4 Price segment

Table 12 presents result by vehicle price segment. Mass-market vehicles experienced the largest BEV market share decline (-15.4 pp), compared to mid (-8.3 pp) and premium (-1.5 pp) segments. The mass-market decline was nearly twice that of the mid-tier segment, consistent with the subsidy representing a proportionally larger share of the purchase price for lower-priced vehicles, making mass-market buyers substantially more price-sensitive.

Figure 9 plots the market share estimates by segment, illustrating the steep gradient from mass to premium, consistent with the subsidy representing a proportionally larger price reduction

for lower-priced vehicles. Count estimates by price segment are presented in Figure A6, Appendix, and show the same ordering across mass, mid, and premium segments.

Table 12. Heterogeneous effects by price segment

Segment	Outcome	Beta	SE	p-value	95% CI
Mass	Share	-15.4	4.0	0.001	[-23.2, -7.6]
Mid	Share	-8.3	1.3	0.000	[-10.8, -5.8]
Premium	Share	-1.5	0.7	0.050	[-2.9, -0.1]
Mass	Count	-823.2	112.7	0.000	[-1,044, -602]
Mid	Count	-433.0	62.0	0.000	[-555, -312]
Premium	Count	-86.3	32.0	0.012	[-149, -23.6]

Notes: *** $p < 0.001$; ** $p < 0.01$. Segments defined by vehicle list price tertile. Month FE included. Count - weekly BEV registrations (change at cutoff); Share - BEV market share in percentage points (change at cutoff)

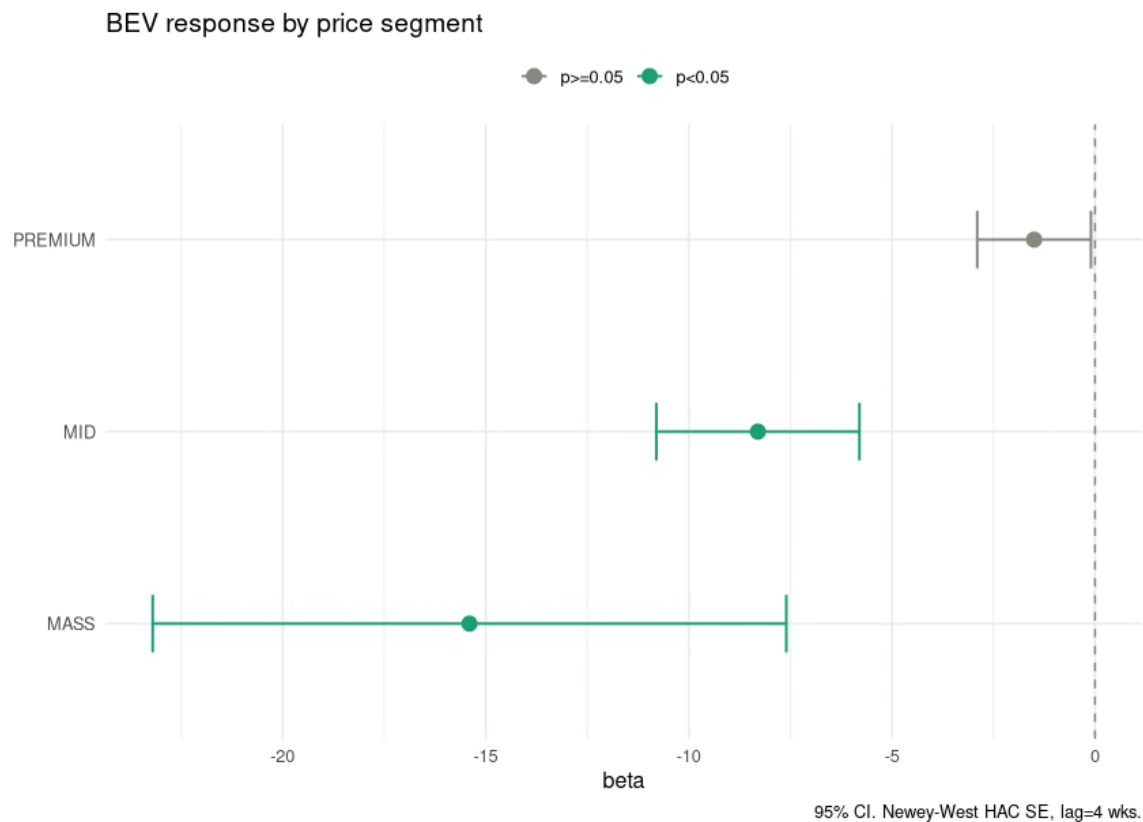


Figure 9. Price segment heterogeneity - BEV market share by vehicle price segment.

5.5 Substitution across vehicle types

Table 13 examines substitution patterns across vehicle types. We use registration counts rather than market share, as share estimates are mechanically distorted by composition effects when BEV share falls. BEV registrations declined significantly ($\beta = -731.4$, $p < 0.001$), as did PHEV ($\beta = -234.5$, $p < 0.001$) and HEV ($\beta = -876.3$, $p < 0.001$). Crucially, ICEV registrations showed a near-zero and statistically insignificant change ($\beta = -56.3$, $p = 0.738$), confirming that consumers who exited the BEV market did not substitute to petrol vehicles but instead withdrew from the market entirely or delayed their purchase - limiting the direct carbon cost of the subsidy removal.

Table 13. Registrations by vehicle type following CCD removal (count outcome)

Vehicle type	CCD eligible	Beta	SE	p-value	95% CI
BEV	Yes (NZD 7,015)	-731.4	69.4	0.000	[-867.4, -595.4]
PHEV	Yes (partial)	-234.5	37.0	0.000	[-307, -162]
HEV	No	-876.3	127.9	0.000	[-1,127, -625.6]
ICEV	No	-56.3	167.4	0.738	[-384.4, +271.8]

Notes: *** $p < 0.001$. Market share outcome not used for substitution inference due to mechanical composition effects.

Month FE excluded; time trend controls included. Count - weekly BEV registrations (change at cutoff).

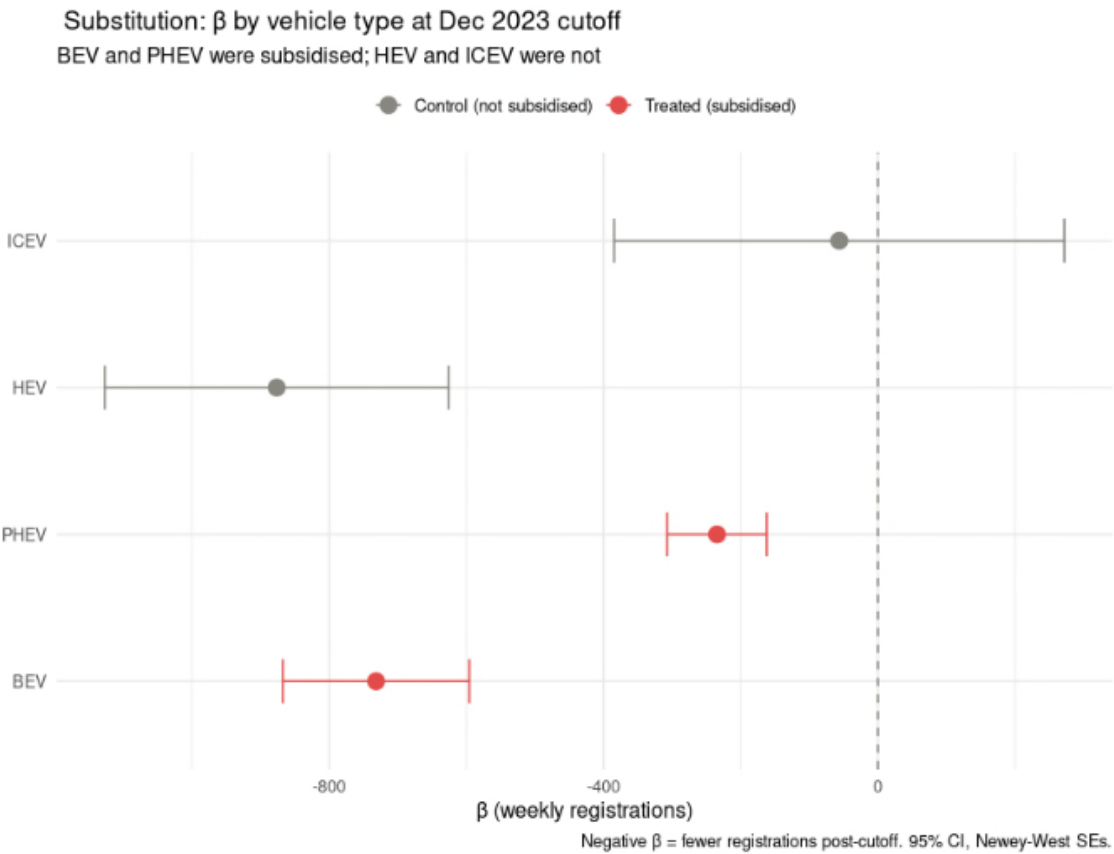


Figure 10. Substitution across vehicle types - weekly registrations by fuel type following CCD removal

Figure 10 presents the coefficient plot across all four powertrain types, clearly distinguishing the subsidised vehicles (BEV, PHEV) - which declined significantly - from the unsubsidised ICEV category, whose estimate is centred near zero with wide confidence intervals spanning both sides.

6. Robustness checks

We assess robustness along six dimensions: bandwidth sensitivity (R1), polynomial order (R2), placebo cutoff tests (R3), pre-trend test (R4), McCrary density test (R5), and total vehicle falsification (R6).

Bandwidth sensitivity (R1). Table 14 shows that varying the bandwidth from 13 to 52 weeks yields share β estimates in the range -24.1 to -37.3 percentage points, all statistically significant. The preferred 26-week estimate lies within this range.

Table 14. Bandwidth sensitivity (EV share as dependent variable)

Bandwidth	N obs.	Beta	SE	p-value	95% CI
13 wks	18	-27.04	2.36	8.12e-8	[-31.67, -22.41]
20 wks	32	-28.87	2.43	4.69e-11	[-33.63, -24.12]
26 wks	44	-24.1	5.07	3.00e-4	[-30.48, -10.62]
34 wks	60	-30.90	9.85	0.00294	[-50.20, -11.60]
40 wks	72	-37.26	10.88	0.00112	[-58.58, -15.94]
52 wks	96	-35.07	8.47	8.52e-5	[-51.68, -18.46]

Notes: N obs. reflects the number of weekly observations within each bandwidth after excluding the 8-week bunching window (weeks -8 to 0). All estimates significant at $p < 0.001$. Month fixed effects included throughout.

Figure 11 plots the beta estimates across bandwidths from 13 to 52 weeks with 95% confidence intervals, showing that while point estimates vary in magnitude, all remain negative and statistically significant, and the preferred 26-week estimate lies comfortably within the range.

Polynomial order (R2). Table 15 shows that poly-1 ($\beta = -24.1$ pp), poly-2 ($\beta = -25.7$ pp), and poly-3 ($\beta = -32.0$ pp) all produce significant estimates. With only 44 observations in the bandwidth, higher-order polynomials risk overfitting; poly-1 is retained as the main specification consistent with Hausman and Rapson (2018).

Table 15. Polynomial order sensitivity

Poly order	N obs.	Beta	SE	95% CI	p-value	AIC	BIC
1	44	-24.1	2.98	[-30.0, -18.3]	3.1e-9	150.5	173.7
2	44	-25.7	3.03	[-31.7, -19.8]	1.4e-9	151.7	176.7
3	44	-32.0	3.80	[-39.5, -24.6]	2.1e-9	148.1	174.8

Notes: AIC and BIC reported. Poly-1 preferred given $n = 44$ observations and overfitting risk.

Placebo cutoff tests (R3). Table 16 shows that applying the RDiT specification at three fictitious cutoff dates yields near-zero and insignificant coefficients, confirming that the December 2023 discontinuity is specific to the policy change. The December 2022 placebo yields a marginally significant coefficient (-6.80 , $p = 0.03$) but is small relative to the true effect and may reflect genuine market fluctuations at that date. Figure 11 plots these placebo estimates graphically, confirming that only the true December 2023 cutoff produces an economically and statistically significant discontinuity.

Table 16. Placebo cutoff tests

Cutoff	Real?	Beta	SE	p-value	95% CI
Jun 2022	Placebo	+1.89	12.70	0.88	[−22.99, +26.77]
Dec 2022	Placebo	−6.80	3.03	0.03	[−12.73, −0.86]
Jun 2023	Placebo	−17.26	10.49	0.11	[−37.81, +3.29]
Dec 2023 (REAL)	Real	−24.10	2.98	< 0.001	[−30.00, −18.30]

Notes: *** $p < 0.001$; * $p < 0.05$. Only the real December 2023 cutoff produces a large, highly significant effect.

Placebo Cutoff Tests — BEV Market Share

Only the true Dec 2023 cutoff should show a large significant effect.

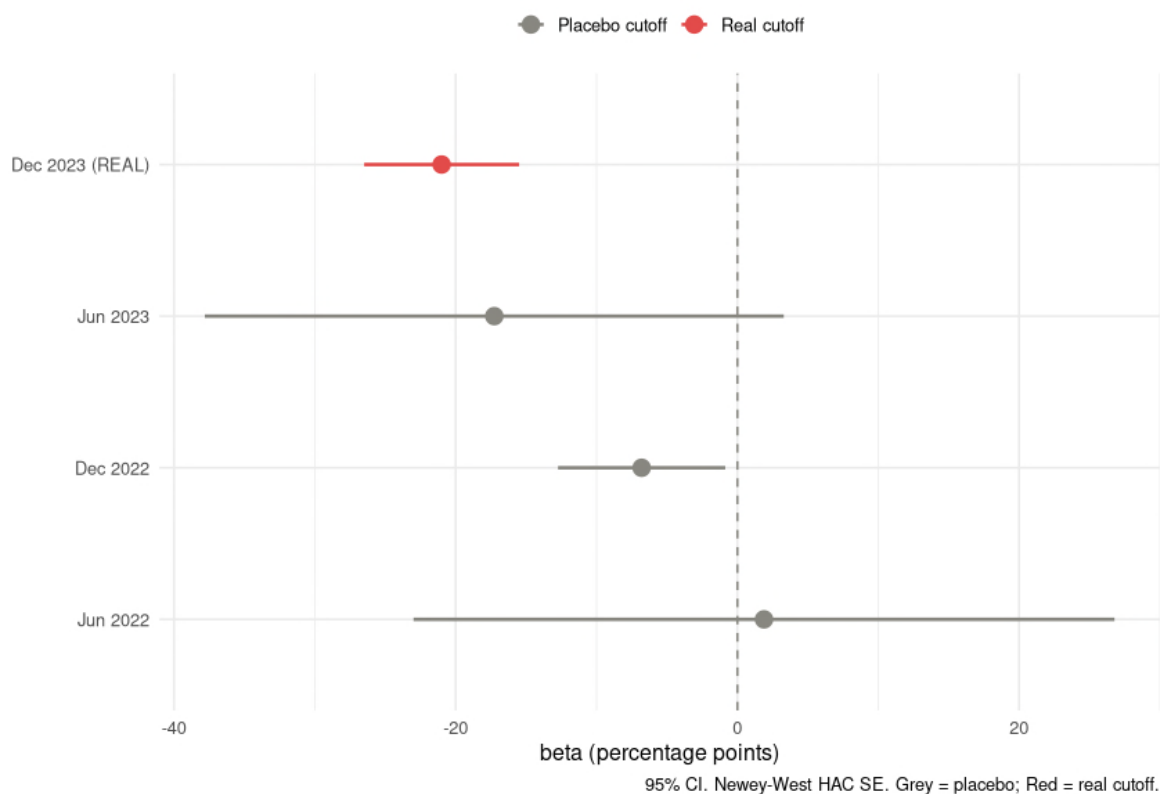


Figure 11. Placebo cutoff tests - RDIT estimates at fictitious cutoff dates.

Pre-trend test (R4). Share outcome: $\beta = -6.22$; $SE = 8.23$; $p = 0.47$. Count outcome:

$\beta = -671.4$; $SE = 615.9$; $p = 0.3$. Both confirm flat pre-trends, validating the RDIT design.

McCrary density test (R5). $T = -0.58$; $p = 0.56$. No evidence of manipulation of the running variable, as expected given that calendar time cannot be manipulated by market participants.

Total vehicle falsification (R6). $\beta = -2,185$; $p < 0.05$. Total market registrations declined at the cutoff, confirming the use of BEV market share as the preferred outcome to control for aggregate market trends. This is not a failure of identification - it motivates the share specification.

7. Discussion and conclusion

This paper provides causal evidence on the consequences of removing New Zealand's Clean Car Discount using a Regression Discontinuity in Time design. The large, immediate, and permanent reduction in BEV market share –24 percentage points at the cutoff, stabilising at 16.6–19.3 pp over 24 months - indicates that the Clean Car Discount was a fundamental structural driver of EV adoption in New Zealand. The implied own-price elasticity of –8.2 is substantially higher than estimates from larger, more mature markets, consistent with a nascent market dominated by marginal buyers for whom the subsidy was decisive. Anticipation bunching (28.8% excess demand in the final eight weeks) confirms forward-looking consumer behaviour, but the static price effect dominates in the long run. New vehicles, mass-market buyers, and high-income households were most affected; ICEV registrations were unaffected, suggesting market exit rather than fuel-type substitution.

These findings extend the thin cross-country literature on EV subsidy removal reviewed in Section 2. The implied elasticity of –8.2 is roughly 2.5 times the German estimate of –3.16 (Haan et al., 2025) and well outside the US range of –3 to –5 (Clinton and Steinberg, 2019), while the permanence of the demand decline over 24 months goes beyond what either Fournel (2025) or Lundberg et al. (2026) are able to establish for Ontario and Sweden respectively. Taken together,

the New Zealand evidence suggests that the smaller and more nascent a market is, the more disruptive subsidy withdrawal becomes - a pattern consistent with the theoretical prediction that marginal buyers dominate early-stage EV markets (Rapson and Muehlegger, 2023).

The heterogeneity results point to price, not infrastructure or geography, as the binding constraint on post-removal demand. The decline was steepest for mass-market vehicles and flattened sharply moving up the price distribution (-15.4 pp for mass-market models versus -1.5 pp for premium models), consistent with the subsidy representing a proportionally larger share of the purchase price for lower-priced vehicles. High-income households registered the largest absolute decline, while the more muted mid-income response is consistent with some substitution toward used BEV imports - a segment whose demand proved statistically insensitive to the subsidy's removal, unlike the new-vehicle market. By contrast, neither the split analysis nor the interaction models found robust evidence that charging infrastructure density moderated the demand response, suggesting that range anxiety and charging access were not the binding constraints on adoption in this setting; financial cost was.

These results carry several implications for the design and sequencing of EV subsidy programmes. First, market maturity matters: in nascent EV markets, purchase subsidies are a powerful and non-redundant lever for adoption, and their removal is correspondingly more disruptive. Premature phase-out risks a structural demand collapse that may be difficult to reverse. Second, the bunching evidence suggests that even abrupt announced phase-outs partially concentrate demand; however, the subsequent permanent demand decline implies that brought-forward purchases represented accelerated future buyers rather than newly attracted ones. Gradual phase-down may therefore produce smoother market adjustment than abrupt discontinuation.

Third, subsidy targeting matters: mass-market and lower-income buyers are more price-sensitive, and removal bears most heavily on these groups.

Two limitations warrant note. First, the total-vehicle falsification test (Section 6, R6) confirms that broader macroeconomic conditions also depressed registrations around the cutoff; while the market-share specification is designed to net out this confound, we cannot fully rule out residual macro-level demand shocks specific to late 2023 being entangled with the estimated BEV effect. Second, the 24-month post-removal window, while longer than comparable studies, cannot establish whether the demand decline would eventually reverse over a longer horizon as vehicle prices fall or new lower-cost BEV models enter the New Zealand market. Future work extending the post-period and quantifying the cost-effectiveness of the CCD relative to the New Zealand Emissions Trading Scheme, would help clarify whether subsidy removal was a net-beneficial policy shift, complementing the demand-side evidence presented here.

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