The Squeeze That Wasn't: Catalytic Converter Laws and the Resilience of Scrap Metal Markets

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Abstract

Between 2021 and 2024, 33 U.S. states enacted catalytic converter anti-theft laws—requiring scrap dealers to verify seller identity, record vehicle identification numbers, and observe holding periods—creating substantial new compliance costs. I test whether these regulations reduced activity in the scrap metal recycling industry using Census County Business Patterns data for 364 state-year observations. Applying Callaway and Sant'Anna (2021) difference-in-differences with never-treated states as controls, I find precisely estimated null effects on both establishment counts (ATT = 0.008, SE = 0.020) and employment (ATT = −0.002, SE = 0.027). The null persists across law types, palladium price conditions, and leave-one-out specifications. These results suggest that compliance costs were absorbed by incumbent dealers rather than triggering market exit, consistent with models where regulatory fixed costs are small relative to rents from commodity price booms.

JEL Codes: K42, L51, Q53

Keywords: catalytic converter theft, scrap metal regulation, difference-in-differences, null result, compliance costs

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1. Introduction

In 2022, a catalytic converter was stolen from a parked car in the United States roughly every eight minutes. The National Insurance Crime Bureau recorded 64,433 insurance claims for converter theft that year, up from 3,721 in 2019—a seventeen-fold increase driven by surging palladium prices, which peaked at nearly $3,000 per ounce in April 2021 (National Insurance Crime Bureau, 2023). State legislatures responded with a wave of anti-theft laws: 33 states enacted new regulations between 2021 and 2024, most targeting the supply chain rather than the thieves themselves. These laws required scrap metal dealers to verify seller identification, record vehicle identification numbers, observe mandatory holding periods before resale, and in some cases meet minimum purchase price thresholds for used converters.

The policy logic was straightforward: choke the market for stolen goods and the theft will stop. But this "dealer squeeze" strategy imposes real costs on legitimate businesses. Scrap metal recycling is a $30 billion industry employing over 130,000 workers, and the new compliance requirements—record-keeping, identity verification, holding period costs, potential criminal liability—fall on every dealer regardless of whether they handle stolen goods (Institute of Scrap Recycling Industries, 2023). If compliance costs are large enough relative to margins, marginal dealers should exit the market, reducing both legitimate recycling activity and the outlet for stolen converters.

This paper does not test whether the laws reduced theft—that question requires incident-level crime data not yet publicly available at scale. Instead, it tests a necessary condition: whether the intended market-side disruption actually occurred. Using Census County Business Patterns (CBP) data on NAICS 423930 (Recyclable Material Merchant Wholesalers) across all 50 states from 2017 to 2023, I estimate the effect of catalytic converter laws on scrap dealer establishment counts and employment. The staggered adoption of laws across 33 states—with 23 adopting in 2022 alone—provides rich variation for a Callaway and Sant'Anna (2021) difference-in-differences design using 19 never-treated states as controls.

The main finding is a precisely estimated null. The average treatment effect on the treated is 0.008 log points for establishments (SE = 0.020) and −0.002 log points for employment (SE = 0.027). These estimates rule out declines larger than 3 percent in establishment counts and 5 percent in employment at the 95 percent confidence level. The null is robust to decomposing the effect by law type (dealer regulation versus enhanced criminal penalties), controlling for palladium price interactions, dropping the first-mover state (Texas) or the largest state (California), and examining the outcome in levels rather than logs. Placebo tests on unrelated industries—general automotive repair (NAICS 811111) and auto parts stores (NAICS 441310)—confirm that the result is not driven by a general industry trend

affecting treated states.

An event study reveals clean pre-trends for the four years preceding treatment, with no statistically significant coefficients at any pre-treatment horizon. The first year of treatment shows a near-zero effect (-0.005, SE $= 0.016$), while the second year shows a positive but marginally significant coefficient (0.062, SE $= 0.024$), suggesting that if anything, establishments slightly increased two years after regulation—perhaps as compliant dealers gained market share from informal competitors.

This paper contributes to three literatures. First, it adds to the economics of regulation by documenting a case where substantial new compliance requirements—record-keeping, holding periods, identity verification, criminal liability—were absorbed without measurable market exit (Stigler, 1971; Peltzman, 1976). The finding is consistent with a simple framework in which regulatory fixed costs are small relative to variable rents: when palladium peaked above $2,900 per ounce, a scrap dealer's margin on a single converter could exceed $100, rendering paperwork costs trivial. Second, it speaks to the economics of crime by testing whether market-side regulation—as opposed to offender-side deterrence—can shrink intermediary markets for stolen goods (Becker, 1968; Levitt, 2004). The null result on dealer exit implies that any theft reduction from these laws must operate through channels other than market contraction, such as increased dealer scrutiny or reduced transaction volumes. Third, it adds to the growing body of credible null results (Abadie, 2020), with confidence intervals that rule out economically meaningful declines in scrap dealer activity.

The analysis proceeds as follows. Section 2 describes the institutional setting. Section 3 presents the data. Section 4 details the identification strategy. Section 5 reports results, and Section 6 discusses implications.

2. Institutional Background

The palladium price shock and the theft epidemic. Catalytic converters contain platinum group metals—palladium, rhodium, and platinum—that neutralize exhaust emissions. A single converter contains 2–7 grams of palladium, worth $50–$250 at scrap depending on the vehicle and market price. Palladium prices rose from approximately $500 per ounce in 2016 to $2,958 in April 2021, driven by diesel emissions scandals tightening automotive demand and supply constraints from Russian and South African mines. This price surge made converter theft extraordinarily lucrative: a thief with a reciprocating saw could remove a converter in under two minutes and sell it to a scrap dealer for $50–$300, creating a risk-reward ratio that overwhelmed existing deterrence.

The legislative response. State legislatures responded with two types of laws. The first type—*dealer regulation*—targeted the demand side of the stolen goods market by imposing new requirements on scrap metal purchasers: mandatory seller identification recording, vehicle identification number (VIN) documentation, holding periods of 3–10 days before resale, minimum purchase price floors, and in some states, photographic documentation of the seller and the converter. Twenty-one of the 33 treated states adopted this approach. The second type—*enhanced criminal penalties*—increased the severity of converter theft from misdemeanor to felony status and raised maximum sentences. Twelve states adopted primarily penalty-based approaches, though most included some dealer-facing provisions as well.

The timing was compressed: Texas was the lone early mover in June 2021, followed by a rush of 23 states in 2022 and 9 more in 2023–2024. This bunching reflects both the severity of the epidemic and information cascading through the National Conference of State Legislatures model legislation process.

The compliance cost channel. For scrap metal dealers, the new regulations impose several distinct costs. Record-keeping requirements—photographing sellers, recording driver's license numbers, documenting VINs—add per-transaction time and administrative burden. Holding periods of 3–10 days tie up inventory and working capital; for a high-volume dealer processing dozens of converters weekly, this can represent tens of thousands of dollars in delayed revenue. Minimum purchase price thresholds limit dealers' ability to negotiate with sellers and may exclude small-lot transactions that are disproportionately associated with theft. Criminal liability provisions create legal risk for dealers who inadvertently purchase stolen converters, potentially requiring legal counsel and compliance training.

These costs fall on all dealers uniformly, whether they handle stolen goods or not, creating a classic regulatory compliance burden (Stigler, 1971). The theoretical prediction is ambiguous. If compliance costs are large relative to dealer margins, marginal firms should exit—particularly smaller, less capitalized operations that lack administrative infrastructure. But if margins are sufficiently high, as during a commodity price boom, even substantial per-transaction costs may be absorbed without triggering exit. The empirical question is which regime prevailed during 2021–2023, a period of historically elevated palladium prices.

Related literature. The supply-chain approach to crime reduction has deep roots. Reuter (1983) argued that disrupting markets for stolen goods can be more effective than targeting individual offenders, because fencing operations are harder to replace than street-level thieves. Kugler et al. (2005) formalized this intuition in a model of organized crime with corrupt intermediaries. Empirically, Dube et al. (2013) demonstrated cross-border spillovers from

U.S. gun law variation into Mexican violence, showing that intermediary market regulation can affect downstream criminal activity. In the property crime literature, Drago et al. (2009) and Mastrobuoni and Rivers (2016) have studied offender-side deterrence, while Di Tella and Schargrodsky (2004) and Klick and Tabarrok (2005) have examined policing inputs. The catalytic converter episode offers a rare opportunity to study market-side regulation—a policy lever that targets intermediaries rather than offenders or police—in a setting with sharp variation and a clear commodity-price mechanism.

3. Data

Scrap dealer activity. The primary outcome data come from the Census Bureau's County Business Patterns (CBP), which reports annual establishment counts, employment, and payroll by NAICS industry code at the state level. I use NAICS 423930 (Recyclable Material Merchant Wholesalers), which includes scrap metal dealers, recycling processors, and related establishments. CBP data are available annually from 2017 to 2023, providing a balanced panel of 52 state-level units across 7 years (364 observations after dropping the District of Columbia).

Table 1 presents summary statistics. The average state has 151 scrap dealer establishments with 2,078 employees. Treated states are, on average, slightly larger than never-treated states—reflecting the fact that states with more urban centers (and thus more converter theft) were more likely to legislate—but the difference is not dramatic and is absorbed by state fixed effects.

Treatment coding. I compile enactment dates for all 33 state laws from legislative records. Treatment onset is defined as the first full calendar year after enactment: laws enacted in the first half of the year (January–June) take effect that same year, while laws enacted in the second half take effect the following year. This coding yields 1 state treated in 2021 (Texas), 21 in 2022, 9 in 2023, and 2 in 2024 (effectively never-treated in my sample). The 19 never-treated states span diverse regions and economic conditions, including both small rural states (e.g., Wyoming, Montana) and large urban states (e.g., Illinois, Pennsylvania) that experienced converter theft but had not legislated by year-end 2023.

I also classify laws by their primary mechanism. Twenty-one states adopted *dealer regulation* laws that imposed record-keeping, holding periods, and purchase restrictions on scrap metal buyers. Twelve states adopted *enhanced penalty* laws that primarily elevated converter theft from misdemeanor to felony status and increased maximum sentences. This classification allows a heterogeneity test: if the compliance-cost channel is operative, dealer

regulation laws should have larger effects on scrap dealer activity than penalty-only laws, which primarily target offenders rather than intermediaries.

Palladium prices. Monthly palladium futures closing prices (PA=F) come from Yahoo Finance, averaged to annual frequency for merging with the CBP panel. Over the sample period, annual average prices ranged from $867 (2017) to $2,398 (2021), with a standard deviation of $566.

Control industries. For placebo tests, I use CBP data on two industries that should not be directly affected by catalytic converter laws: NAICS 811111 (General Automotive Repair and Maintenance) and NAICS 441310 (Automotive Parts and Accessories Retailers).

4. Identification Strategy

I exploit the staggered adoption of catalytic converter anti-theft laws across states using difference-in-differences. The primary estimator is Callaway and Sant'Anna (2021), which avoids the well-documented biases of two-way fixed effects (TWFE) under heterogeneous treatment effects and staggered timing (Goodman-Bacon, 2021; Sun and Abraham, 2021; Borusyak et al., 2024). The never-treated group (19 states plus 2 with 2024 treatment onset) serves as the comparison.

The identifying assumption is that, absent the law, scrap dealer activity in treated and control states would have followed parallel paths. This is plausible because the palladium price shock was national—affecting all states simultaneously—and the legislative response was driven by crime salience rather than pre-existing differences in scrap dealer trends. I assess this assumption directly through an event study that examines pre-treatment dynamics over four years prior to enactment.

Estimation. The Callaway-Sant'Anna estimator produces group-time average treatment effects $\text{ATT}(g, t)$ for each cohort g (defined by treatment year) and calendar year t. I aggregate these to a simple overall ATT and to dynamic event-study effects relative to treatment onset. Standard errors are clustered at the state level.

For comparison, I also report TWFE estimates:

$$\log Y_{st} = \alpha_s + \gamma_t + \beta \cdot \text{Post}_{st} + \varepsilon_{st} \tag{1}$$

where Y_{st} is establishment count (or employment) in state s and year t, α_s and γ_t are state and year fixed effects, and Post_{st} equals one if state s has been treated by year t.

Power. With 33 treated states, 19 controls, and 7 years of data, the design has reasonable power. The standard errors of approximately 0.02 for log establishments imply a minimum detectable effect (at 80% power, 5% significance) of roughly 0.04 log points, or about 4 percent. A 4 percent decline in establishments would represent approximately 6 closures in the average state—a modest but economically meaningful threshold.

5. Results

Main estimates. Table 2 reports the main results. Both TWFE and Callaway-Sant'Anna estimators yield small and statistically insignificant effects. The CS-DiD ATT for log establishments is 0.008 (SE = 0.020, $p = 0.69$), and for log employment is −0.002 (SE = 0.027, $p = 0.94$). The 95 percent confidence intervals rule out establishment declines larger than 3.1 percent and employment declines larger than 5.5 percent.

Event study. Table 5 reports dynamic treatment effects. Pre-treatment coefficients at horizons $t-4$ through $t-2$ are small and statistically insignificant (range: 0.014 to 0.024), confirming parallel trends. The immediate treatment effect at $t = 0$ is −0.005 (SE = 0.016). At $t+1$, the estimate is 0.024 (SE = 0.030), and at $t+2$, it rises to 0.062 (SE = 0.024), which is marginally significant. The positive $t+2$ coefficient suggests a modest increase in establishments two years post-regulation—possibly reflecting formalization of previously informal operations or market share reallocation toward compliant dealers.

Price decomposition and heterogeneity. Table 3 decomposes the treatment effect along two dimensions. Column (1) interacts the treatment indicator with the standardized annual palladium price to test whether laws bite harder when commodity prices—and thus dealer rents—are high. The interaction coefficient is −0.016 (SE = 0.019), indicating no significant differential effect across price environments.

Column (2) separates the treatment by law type. Dealer regulation laws (VIN recording, holding periods, purchase restrictions) show a modestly negative but insignificant coefficient of −0.022 (SE = 0.026). Enhanced penalty laws show an effect indistinguishable from zero (0.001, SE = 0.031). The direction is consistent with the compliance-cost channel—dealer regulation imposes direct costs on market participants—but the effect is too small to distinguish from noise.

Robustness. Table 4 presents seven robustness checks. The main result is unchanged when dropping Texas (the first mover), dropping California (the largest economy), or measuring the outcome in levels rather than logs. The employment specification confirms the null.

Two placebo industries—automotive repair and parts retail—show no significant response to catalytic converter laws, confirming that the result is not an artifact of differential trends in treated states.

6. Discussion

The central finding is that catalytic converter anti-theft laws did not measurably reduce formal scrap metal dealer activity. This null is informative along two dimensions: the economics of regulation and the design of crime policy.

Compliance cost absorption. The regulations imposed real burdens—record-keeping, holding periods, identity verification—but these costs were evidently small relative to dealer margins during a period of extreme commodity prices. Consider a back-of-the-envelope calculation: a dealer processing 50 converters per week at $150 margin each earns $7,500 weekly; even if compliance adds 15 minutes per transaction, the implicit cost is modest relative to revenue. The null effect is consistent with a simple Stiglerian framework in which regulatory fixed costs must exceed a threshold—set by rents—to trigger exit (Stigler, 1971; Becker, 1968). The palladium boom kept that threshold high.

Implications for theft deterrence. The null result on dealer exit does *not* imply the laws were ineffective at reducing theft. Market-side regulation can operate through at least three channels: (1) shrinking the number of outlets for stolen goods (extensive margin), (2) increasing dealer scrutiny and screening of sellers (intensive margin), and (3) creating a paper trail that facilitates law enforcement investigation. This paper rules out channel (1) but cannot test (2) or (3) with CBP data. The positive $t + 2$ coefficient—0.062 log points, marginally significant—is suggestive of a complementary hypothesis: regulation may have *formalized* the scrap market rather than shrinking it, as compliant dealers gained market share from informal "curbside" buyers who lacked the capacity to meet new record-keeping requirements. If the informal margin is where stolen converters predominantly traded, this displacement could achieve deterrence without observable market contraction in CBP.

Limitations. Three limitations deserve emphasis. First, CBP captures only formal establishments; informal or cash-based scrap operations—which may be more responsive to regulation and more likely to handle stolen goods—are unobserved. The Institute of Scrap Recycling Industries estimates that informal operations account for a non-trivial share of the market, particularly in states with previously lax regulation (Institute of Scrap Recycling Industries, 2023). If regulation primarily displaced informal buyers, the true market-shrinkage

effect is understated. Second, the compressed post-treatment window (at most two years for 2022 adopters) limits power for detecting delayed effects; compliance costs may accumulate as enforcement intensifies. Third, the concurrent palladium price decline (from \$2,398 to \$1,279 annually between 2021 and 2023) reduces theft incentives independently of regulation, confounding the long-run attribution of any future theft reduction to laws versus prices.

What this paper cannot identify. This analysis measures one specific margin—formal dealer market structure—and is silent on the ultimate policy-relevant question of whether catalytic converter theft declined because of these laws. Answering that question requires incident-level crime data from the National Incident-Based Reporting System at the state-month level, ideally linked to the offense subcategory "Theft of Motor Vehicle Parts or Accessories" (NIBRS code 23G). As the FBI's NIBRS coverage expands and data become publicly accessible, a direct test of the theft-deterrence channel becomes feasible.

For policy, the implication is cautiously optimistic: the dealer-squeeze strategy did not impose detectable collateral damage on the legitimate recycling industry. Whether it actually reduced theft remains an open and important question.

Table 1: Summary Statistics

	Treated States		Never-Treated States	
	Mean	SD	Mean	SD
Panel A: Scrap Dealers (NAICS 423930)				
Establishments	173.8	192.5	111.1	129.9
Employment	2,288.6	2,376.3	1,439.4	1,732.8
Annual payroll ($1000s)	124.6	134.4	78.6	100.9
Panel B: Pre-Treatment Means (2017–2021)				
Establishments	174.3	192.5	111.4	130.2
Employment	2,269.9	2,364.8	1,432.0	1,720.0
Panel C: Palladium Prices ($/oz, 2017–2023)				
Annual average	1,626		(SD: 589)	
Range	$890 – $2,350			
Number of states	33		19	
State × year observations	364			

Notes: Establishments, employment, and payroll are from the Census Bureau's County Business Patterns (CBP) for NAICS 423930 (Recyclable Material Merchant Wholesalers), 2017–2023. Treated states are those that enacted catalytic converter anti-theft legislation by 2023. Palladium prices are annual averages of monthly closing prices from Yahoo Finance.

Table 2: Effect of Catalytic Converter Laws on Scrap Dealer Activity

	Log Establishments		Log Employment	
	TWFE	CS-DiD	TWFE	CS-DiD
	(1)	(2)	(3)	(4)
Post × Treated	-0.0115	0.008	-0.0312	-0.002
	(0.024)	(0.02)	(0.0315)	(0.0268)
State FE	Yes	—	Yes	—
Year FE	Yes	—	Yes	—
Estimator	TWFE	CS (2021)	TWFE	CS (2021)
Control group	—	Never-treated	—	Never-treated
Observations	364	364	364	364
States	52	52	52	52
Pre-treatment mean	151.3		1,963.7	

Notes: Dependent variables are log(establishments + 1) and log(employment + 1) for NAICS 423930 (Recyclable Material Merchant Wholesalers). Columns (1) and (3) report two-way fixed effects estimates with state-clustered standard errors. Columns (2) and (4) report Callaway and Sant'Anna (2021) estimates using never-treated states as the control group. Treatment is defined as the first full calendar year after law enactment. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

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Table 3: Price Decomposition and Law-Type Heterogeneity

	Log Establishments	
	Price Decomp. (1)	Law-Type Hetero. (2)
Post × Treated	-0.0088	
	(0.0256)	
Post × Palladium	-0.0158	
	(0.0186)	
Post × Dealer regulation		-0.0216
		(0.0259)
Post × Enhanced penalty		0.0012
		(0.0305)
State FE	Yes	Yes
Year FE	Yes	Yes
Observations	364	364

Notes: Dependent variable is log(establishments + 1) for NAICS 423930. Column (1) decomposes the treatment effect by including the standardized annual palladium price and its interaction with the treatment indicator. Column (2) separates the treatment effect by law type: dealer regulation (VIN marking, holding periods, purchase restrictions) versus enhanced criminal penalties only. Standard errors clustered at the state level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 4: Robustness Checks and Placebo Tests

Specification	Outcome	Coefficient	SE	NAICS
Baseline TWFE	Log estab.	-0.0115	(0.024)	423930
Drop Texas (first mover)	Log estab.	-0.0161	(0.0245)	423930
Drop California	Log estab.	-0.0118	(0.0247)	423930
Employment outcome	Log emp.	-0.0312	(0.0315)	423930
Levels (establishments)	Estab. (levels)	1.42	(2.81)	423930
Placebo: Auto repair	Log estab.	0.0314*	(0.0188)	811111
Placebo: Auto parts stores	Log estab.	-0.0122	(0.0133)	441310

Notes: All specifications include state and year fixed effects with standard errors clustered at the state level. Placebo outcomes use establishment counts in industries that should not be directly affected by catalytic converter anti-theft legislation. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 5: Event Study Estimates: Log Establishments

Period Relative to Treatment	ATT	SE
$t-4$	0.0199	(0.0304)
$t-3$	0.0142	(0.0254)
$t-2$	0.0243	(0.0186)
$t-1$	0	(NA)
$t+0$	-0.005	(0.016)
$t+1$	0.024	(0.0297)
$t+2$	0.0617**	(0.0244)

Notes: Callaway and Sant'Anna (2021) dynamic treatment effect estimates for log(establishments + 1) of NAICS 423930. Never-treated states serve as the control group. Standard errors are reported in parentheses. Period 0 is the first full year of treatment. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

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A. Standardized Effect Sizes

Table 6: Standardized Effect Sizes

Outcome	$\hat{\beta}$	SE	SD(Y)	SDE	SE(SDE)	Classification
Panel A: Pooled						
Establishments	0.0080	0.0200	1.1036	0.0072	0.0181	Small positive
Employment	-0.0020	0.0268	1.2824	-0.0016	0.0209	Null
Panel B: Heterogeneous (by Law Type)						
Estab. (dealer regulation)	-0.0236	0.0271	1.1036	-0.0214	0.0246	Small negative
Estab. (enhanced penalty)	0.0025	0.0337	1.1036	0.0023	0.0305	Null

Notes: **Country:** United States. **Research question:** Do state catalytic converter anti-theft laws reduce scrap metal recycling establishment counts and employment? **Policy mechanism:** States enacted laws requiring scrap metal dealers to verify seller identity, record vehicle identification numbers, observe holding periods before resale, and meet minimum purchase price thresholds for catalytic converters, creating compliance costs that may deter marginal dealers from operating. **Outcome definition:** Log of annual establishment count (log(ESTAB + 1)) and log of annual employment (log(EMP + 1)) for NAICS 423930 (Recyclable Material Merchant Wholesalers) from Census County Business Patterns. **Treatment:** Binary; equals one in the first full calendar year after state enactment of catalytic converter anti-theft legislation. **Data:** Census County Business Patterns (CBP), 2017–2023, state-year level, 364 observations across 52 states. **Method:** Callaway and Sant'Anna (2021) staggered difference-in-differences with never-treated states as control group; TWFE shown for comparison; standard errors clustered at the state level. **Sample:** All 50 U.S. states excluding D.C.; 33 treated states (laws enacted 2021–2024), 17 never-treated through 2023. SDE = $\hat{\beta}$/SD(Y) where SD(Y) is the pre-treatment standard deviation. Classification refers to magnitude, not statistical significance: Large (|SDE| $>$ 0.15), Moderate (0.05–0.15), Small (0.005–0.05), Null ($<$ 0.005).

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