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Department of Economics

Digital Economy:

A Study of Information, Policy, and Market Behavior

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Declaration of Authorship

I hereby declare that the thesis submitted for examination for the Doctor of Philosophy degree at City St George's, University of London, represents my own original work, except where specific acknowledgment is made to the contributions of others.

I am grateful to my supervisors, Dr Xiaogang Che and Professor Giulia Iori, for their constructive comments and feedback on Chapters Two to Four. The data collection for Chapters Three and Four particularly benefited from the work of Dr Xiaogang Che.

This thesis, in whole or in part, has not been submitted for any other academic qualification at this or any other institution.

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Hantao Jiao
London, 15 Oct 2025

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When I was an undergraduate, during my Advanced Mathematics class, I first learned that my lecturer held a PhD in mathematics. At that moment, the idea of a PhD shifted from something unattainable to something within reach. My biggest dream then was to ask a question so difficult that even this man, standing at the pinnacle of knowledge, would be challenged. Yet he answered every one of my questions, and under his guidance, I – who had nearly failed high school math – became one of the top students in advanced mathematics. Back then, I never imagined that one day I would pursue a PhD myself. Later, through a series of coincidences, with the help of Professor Chen and Harbin Institute of Technology, I somehow found myself on the path to a doctorate.

Before starting my PhD, I was told it would be a journey that reshapes one's worldview, breaks down and rebuilds the self. I thought I would transform into the person I had envisioned - disciplined, well-planned, and accomplished. In reality, I did break, but I hardly changed, except that I learned to accept the simple truth of being an ordinary person.

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I sincerely hope that the final version of my thesis, once submitted after my defense, will mark a meaningful chapter in my life. Years from now, when I look back, I hope I will feel content and proud.

Abstract

This thesis investigates the mechanisms addressing information asymmetry in the digital economy, focusing on the interactions between policy, technology, and market behavior in the online used car market. It comprises three essays that integrate theoretical synthesis with empirical identification to explore how trust is constructed in digital marketplaces.

The first essay reviews the literature on signaling, disclosure, and certification, establishing a theoretical framework for understanding how digital platforms reshape traditional solutions to adverse selection. It highlights the pivotal role of platform governance in facilitating credible information exchange. The second essay employs a difference-in-differences strategy to analyze the market response to Volkswagen's court-mandated Zero Emission Vehicle (ZEV) investment plan. The results indicate a significant 13.5% increase in the final auction prices of Volkswagen used cars following the announcement, with no corresponding change in transaction volume. This finding suggests that non-voluntary CSR initiatives can effectively enhance consumer perceived quality and willingness to pay. The third essay investigates the impact of buyer information acquisition through eBay's WeGoLook inspection service. The analysis reveals that the introduction of the service increased final prices by approximately 12% and reduced the marginal value of seller-provided photos. Furthermore, the policy induced a strategic supply-side response, where sellers increased voluntary disclosure to mitigate the threat of third-party verification.

This body of research contributes to information economics and platform design by demonstrating that credible signals, ranging from institutional mandates to technological enablers, are indispensable for mitigating moral hazard and enhancing market efficiency in the digital age.

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Chapter 1

Thesis Introduction

1.1 Background, Motivation, and Research Questions

1.1.1 The Rise of Information and Trust Challenges in the Digital Economy

Information asymmetry has long been recognized as a central cause of market inefficiency, shaping how individuals, firms, and institutions interact under uncertainty. Since Akerlof's (1970) seminal "market for lemons," economists have shown that when one party holds superior information about a product's quality, adverse selection can occur, driving high-quality goods out of the market and reducing welfare. This theoretical insight remains highly relevant in today's digital economy, where the production and exchange of information are more extensive than ever, yet its credibility and interpretability are often uncertain.

The transformation of traditional markets into digital platforms has amplified both the opportunities and challenges of information exchange. Online marketplaces such as *eBay Motors*, *AutoTrader*, and *CarGurus* have revolutionized how buyers and sellers interact, enabling millions of vehicle transactions annually through standardized listings, reputation systems, and digital payment mechanisms. According to Market.us (2024), the global used car market reached approximately $1.7 trillion in 2023, with more than one-third of transactions involving online intermediation [1].This shift has reduced many conventional frictions, including search costs, geographic constraints, and opaque pricing. However, it has also introduced new challenges, such as misinformation, manipulation of reputation, and information overload. These dynamics have intensified following events such as the Volkswagen Dieselgate scandal and the growing scrutiny over platform accountability in data-driven

1. Market.us, "Used Car Market Size, Share | CAGR of 6.2%," 2024, https://market.us/report/used-car-market/, accessed October 15, 2025.

markets, highlighting that trust remains the cornerstone of digital market efficiency.

At the same time, regulatory and societal expectations of corporate behavior have evolved. Firms are increasingly required to demonstrate transparency, ethical responsibility, and environmental commitment. Corporate social responsibility (CSR), once a voluntary practice, is now embedded in regulatory and consumer frameworks. However, the credibility of such commitments, particularly when they are mandated by law rather than driven by genuine goodwill, remains a subject of debate. These developments illustrate that the modern economy's efficiency depends not merely on the *availability* of information, but on its *credibility* and *verifiability*, themes that resonate across domains from digital platforms to corporate governance.

1.1.2 Motivation and Research Gap

While the economics of information has produced a rich body of theory, ranging from signaling and unraveling to certification mechanisms, much of this literature was developed in the context of traditional face-to-face markets. In recent years, scholars have begun to explore how digital transformation reshapes these mechanisms (Einav, Farronato, and Levin 2016; Tadelis 2016). Yet several critical gaps remain.

First, existing studies tend to examine individual mechanisms in isolation, such as warranties, reviews, or certification, without integrating them into a broader framework that captures the interaction between digital platforms, institutional credibility, and consumer behavior. Second, empirical research on how mandated or externally enforced actions, such as legal CSR requirements, affect market outcomes remains limited, especially in secondary markets where consumer perceptions evolve dynamically. Third, while many studies emphasize seller-side signaling, far less attention has been paid to the role of *buyer information acquisition*, particularly how new technologies and third-party services alter equilibrium transparency and trust.

This dissertation aims to fill these gaps by investigating how different information mechanisms, including market-based, institutional, and technological mechanisms, shape outcomes in markets characterized by asymmetric information. Using the used car market as a common empirical setting, it explores how digitalization, regulation, and innovation collectively influence information credibility, consumer trust, and welfare.

1.1.3 Research Questions and Objectives

This dissertation addresses three central research questions:

1. **How do digital platforms transform the mechanisms that mitigate information asymmetry in the used car market?**
   This question motivates a comprehensive theoretical and empirical review of market-based and institutional solutions to asymmetric information, focusing on how digitalization reshapes classical mechanisms such as signaling, disclosure, and certification.

2. **Do consumers respond to legally mandated corporate social responsibility (CSR) actions, and how do such disclosures affect market outcomes?**
   This question examines the causal impact of a non-voluntary CSR initiative, Volkswagen's 2017 Zero Emission Vehicle (ZEV) investment plan, on consumer willingness to pay and brand equity in the secondary car market.

3. **How does buyer information acquisition, facilitated by digital platform innovations, interact with seller disclosure to influence equilibrium transparency?**
   This question analyzes the introduction of eBay's WeGoLook inspection service to uncover the micro-level mechanisms through which buyers' and sellers' behaviors jointly shape market efficiency.

Together, these essays provide an integrated understanding of how information asymmetry evolves in digital markets and how institutions, firms, and technologies can collectively improve transparency and welfare.

1.2 Overview of the Three Essays

1.2.1 Overview

The dissertation consists of three standalone yet conceptually interrelated essays. Each examines a distinct dimension of information asymmetry, namely theoretical mechanisms, institutional credibility, and technological design, using the used car market as a unifying empirical and conceptual context. The first essay lays the theoretical foundation through a synthesis of the literature on information asymmetry and digital platforms. The second provides causal evidence on how institutional CSR initiatives shape market perceptions and pricing behavior. The third analyzes buyer information acquisition as a complementary mechanism to seller disclosure in online markets.

1.2.2 Chapter 1: Addressing Information Asymmetry in the Used Car Market

The first essay develops an information governance framework for analyzing how asymmetric information is mitigated in markets for complex goods. It organizes the mechanisms examined in the information economics literature (Akerlof 1970; Spence 1973; Grossman 1981; Rothschild and Stiglitz 1976; Lizzeri 1999; Bakos 1997) into three categories distinguished by their primary source of credibility: market-based mechanisms that operate through decentralized incentives (signaling, disclosure, reputation), institutional mechanisms that enforce credibility through formal authority (mandatory disclosure, quality standards, regulated certification), and technological mechanisms that scale information transmission through digital infrastructure (platform design, algorithmic ranking, feedback aggregation). The chapter's primary contribution lies not in this taxonomy but in the analysis of how mechanisms across categories interact. It argues that these interactions, rather than the properties of individual mechanisms, determine the structure of information governance in modern markets.

Methodologically, the essay combines theoretical synthesis with a structured review of empirical evidence to characterize three pairwise interactions: institutional rules discipline market-based signals by constraining misrepresentation, digital platforms amplify market information while altering its incentive compatibility, and platform architectures embed institutional enforcement while introducing governance tensions. The analysis progressively identifies two empirical gaps that motivate the subsequent chapters. First, while the literature establishes that institutional mandates constrain strategic manipulation, the conditions under which non-voluntary institutional signals causally influence consumer willingness to pay in secondary markets remain unresolved. Second, while digital platforms reduce the cost of accessing observable information, a residual verification gap persists for latent quality, and whether buyer-initiated verification can complement or substitute for seller-provided signals remains an open empirical question. These gaps provide the theoretical foundation for the causal analyses developed in Chapters 3 and 4.

1.2.3 Chapter 2: How Does Corporate Social Responsibility Affect Market Outcomes?

The second essay explores the effects of legally mandated CSR actions on consumer behavior and market equilibrium. Using the U.S. court-mandated Volkswagen Zero Emission Vehicle (ZEV) investment plan following the Dieselgate scandal as a quasi-natural experiment, the study assesses whether consumers reward transparent and verifiable CSR efforts despite their non-voluntary origin.

Employing a difference-in-differences framework with eBay Motors auction data, the analy-

sis identifies a 13.5% increase in final auction prices for Volkswagen used cars after the CSR announcement, with no significant change in transaction volumes or bidder participation. These findings suggest that the observed price increase reflects a demand-side response, characterized by an enhanced willingness to pay, rather than supply constraints. The chapter further demonstrates that this effect is strongest in environmentally conscious regions, highlighting the importance of local values in shaping CSR effectiveness. Conceptually, it reframes CSR as a credibility signal that restores brand trust even when driven by regulatory compulsion rather than voluntary motives.

1.2.4 Chapter 3: Information Acquisition in Online Marketplaces

The third essay examines the interaction between buyer information acquisition and seller disclosure in digital markets. It exploits the introduction of eBay's *WeGoLook* inspection service, which enabled buyers to commission third-party vehicle assessments prior to bidding. The study tests whether access to independent inspections changes equilibrium prices, price dispersion, and seller behavior.

Using a event study approach, the results indicate that the inspection service increased average transaction prices and reduced price variance, implying more precise quality information and improved matching efficiency. The analysis also finds that sellers respond strategically: those in treated markets adjust the number of listing photos and information detail, suggesting substitution and complementarity between seller disclosure and buyer inspection. The findings provide empirical evidence for a key theoretical insight that information acquisition and disclosure are jointly determined, and they offer practical guidance for platform design aimed at enhancing transparency and trust.

1.3 Overall Contribution and Broader Implications

This dissertation makes several interrelated contributions to the fields of information economics, market design, and digital platform governance.

First, it extends classical theories of information asymmetry into the context of digital marketplaces. By linking Akerlof (1970)'s adverse selection model, Spence (1973)'s signaling framework, and Grossman (1981)'s disclosure theory with platform governance and technological mechanisms, the dissertation demonstrates how information asymmetry evolves in data-rich, reputation-mediated environments.

Second, it provides empirical evidence on how credible information mechanisms, whether

market-driven, institutional, or technological, enhance trust and improve market efficiency. Chapter 3's causal identification of CSR-induced demand shifts and Chapter 4's analysis of buyer information acquisition both reveal how transparency and verification reshape price formation and consumer behavior.

Third, the dissertation contributes to policy and managerial discussions on digital market governance. It highlights the importance of credible, verifiable, and standardized information mechanisms for sustaining trust. For regulators, this implies the need for stronger disclosure mandates and oversight of corporate environmental claims. For platforms, it highlights the importance of designing effective information architectures. Reputation systems, third-party inspections, and adaptive algorithms should help users interpret quality signals more accurately and make better-informed decisions.

Taken together, these contributions underscore that addressing information asymmetry in the digital era requires more than simply increasing data availability. The efficiency and fairness of markets depend on institutional and technological designs that make information *credible*, *verifiable*, and *interpretable*. As digital markets continue to expand into new domains, the insights from this dissertation provide a foundation for developing transparent and trustworthy market systems capable of balancing innovation with accountability.

Chapter 2

Information Governance in Markets with Asymmetric Information: Market, Institutional, and Technological Mechanisms

Abstract

This chapter develops an information governance framework for analyzing how asymmetric information is mitigated in markets for complex goods. It organizes the mechanisms through which information is produced, transmitted, and verified into three categories distinguished by their primary source of credibility: market-based mechanisms that operate through decentralized incentives, institutional mechanisms that enforce credibility through formal authority, and technological mechanisms that scale information transmission through digital infrastructure. The central argument is that these mechanisms function as complements rather than substitutes, and that the effectiveness of any single mechanism depends on its interaction with the others. The chapter synthesizes theoretical and empirical evidence from the information economics literature to characterize the pairwise interactions between mechanism categories and to identify two empirical gaps that motivate the subsequent chapters: the causal effect of non-voluntary institutional signals on consumer beliefs in secondary markets, and the role of platform-enabled buyer-initiated verification in resolving residual quality uncertainty in digitally mediated markets.

Keywords: Information asymmetry, information governance, market mechanisms, institutional disclosure, digital platforms, mechanism interaction, used car market

2.1 Introduction

The market for complex consumer goods has been transformed by two parallel developments. On the demand side, online platforms have become the primary venue through which buyers access product information and conduct transactions. The U.S. used car market illustrates this shift. In 2024, approximately 37.4 million used vehicles sold (Cox Automotive 2025). Meanwhile, a growing share is mediated through digital marketplaces such as eBay Motors, which generates over USD 10 billion in annual gross merchandise value in its parts and accessories category alone (eBay Inc. 2022). On the supply side, regulatory and judicial interventions increasingly compel firms to produce information about social, environmental, and ethical dimensions of their conduct, ranging from mandatory CSR disclosure regimes adopted in the European Union to court-mandated environmental investments imposed on individual firms in the aftermath of corporate misconduct. Both developments respond to the same underlying friction: the asymmetric information that has structured economic exchange since Akerlof (1970) first demonstrated how unobservable quality can unravel markets entirely.

Yet the diversity of mechanisms that have emerged to address this friction raises a question that the existing literature has not directly confronted. Are seller warranties, consumer reviews, regulatory mandates, platform certification programs, and third-party inspection services substitutes for one another, each independently reducing information asymmetry through its own channel? Or are they complements, whose effectiveness depends on joint operation within a shared information environment? The answer matters not only for theoretical understanding but for policy. If these mechanisms substitute, regulatory intervention in one domain may simply crowd out market-based provision in another. If they complement, the failure of one mechanism may critically depend on the simultaneous breakdown of those that surround it.

The economic literature on information asymmetry has evolved through three broad phases that this review brings into a unified framework. The foundational phase, following Akerlof (1970), Spence (1973), and Rothschild and Stiglitz (1976), established the theoretical machinery of signaling, screening, and disclosure as decentralized responses to asymmetric information. A second phase, beginning in the 1980s and consolidated by Grossman (1981), Milgrom (1981a), and Shapiro (1983), refined this machinery through the analysis of voluntary disclosure, certification, and reputation, and incorporated institutional features such as licensing and minimum quality standards (Leland 1979; Shapiro 1986). The most recent phase, prompted by the rise of digitally mediated markets, has documented how online platforms reshape information production, aggregation, and verification (Bakos 1997; Dellarocas 2003; Einav, Farronato, and Levin 2016; Tadelis 2016; Goldfarb and Tucker 2019). This evolution reflects a paradigm shift from studying information mechanisms in isolation

to analyzing how they interact within increasingly complex environments, where regulatory authority and digital infrastructure have become integral to the production and credibility of market information.

This chapter focuses on quality-relevant information mechanisms in markets for complex consumer goods, particularly those mediated by digital platforms. It draws primarily on theoretical and empirical contributions from information economics, industrial organization, and platform economics published over the past four decades. Closely related literatures, including financial market disclosure, auction theory beyond consumer markets, and macroeconomic information frictions, are referenced where relevant but not systematically reviewed. The empirical evidence discussed concentrates on contexts most relevant to used car markets and online auction platforms. Studies based on hypothetical or laboratory settings are cited where they identify causal mechanisms not observable in field data, but field-based identification strategies receive analytical priority throughout.

Existing reviews of this literature concentrate on individual mechanism types. Dranove and Jin (2010) survey quality disclosure and certification; Tadelis (2016) examines reputation systems on online platforms; Einav, Farronato, and Levin (2016) characterize the design of peer-to-peer markets; and Goldfarb and Tucker (2019) review the broader economics of digital markets. Each provides a comprehensive treatment of its specific domain, but none develops a framework that systematically relates mechanisms across these domains to one another. This chapter addresses that gap.

The contribution is threefold. First, the chapter proposes a unified taxonomy that organizes information mechanisms into three categories distinguished by their primary source of credibility, market-based mechanisms operating through decentralized incentives, institutional mechanisms operating through formal authority, and technological mechanisms operating through digital infrastructure. The classification rests on the dominant source of credibility in each context, a criterion that resolves ambiguity in cases where mechanisms straddle traditional categories, such as platform-administered certification or algorithmically aggregated reputation. Second, the chapter develops a systematic analysis of pairwise interactions between mechanism categories: how institutional rules discipline market signals, how digital platforms amplify market information while altering its incentive properties, and how platform architectures embed institutional enforcement while introducing new conflicts of interest. This interaction-based view yields predictions that cannot be derived from studying mechanisms in isolation. Third, the chapter explicitly bridges theoretical synthesis and empirical analysis, deriving from the framework two specific predictions that motivate the empirical chapters of this thesis.

Four findings emerge from the synthesis developed in this chapter. First, no single mechanism category fully resolves information asymmetry on its own. Market-based mechanisms are limited by the verifiability and interpretability of seller-produced signals; institutional mechanisms by the trade-off between signal precision and market participation; and technological mechanisms by reputation manipulation, algorithmic opacity, and the strategic overproduction of non-diagnostic content. Second, digital transformation has not eliminated information asymmetry but restructured it. The binding constraint in modern markets has shifted from information access to information verification. Third, the three mechanism categories are complements rather than substitutes, and their interactions exhibit consistent patterns of both complementarity and tension that operate across diverse market settings. Fourth, two specific empirical questions emerge as underexplored within this framework: the causal effect of non-voluntary institutional signals on consumer beliefs in secondary markets, and the role of platform-enabled buyer-initiated verification in resolving the residual quality uncertainty that persists in digitally mediated markets.

These findings rest on substantial empirical consensus regarding the existence of adverse selection (Akerlof 1970; Lewis 2011; Jin and Kato 2006), the reputational discipline imposed by digital feedback systems (Resnick *et al.* 2006; Cabral and Hortaçsu 2010; Luca 2011), and the welfare effects of mandatory disclosure in specific contexts (Jin and Leslie 2003; Mathios 2000). They also acknowledge ongoing disagreement on several questions, including the magnitude and persistence of mandatory disclosure effects (Dranove *et al.* 2003; Christensen, Hail, and Leuz 2021), the welfare implications of platform-mediated reputation systems relative to traditional institutional oversight (Tadelis 2016), and the conditions under which non-voluntary corporate actions translate into credible market signals (Bénabou and Tirole 2010; List and Momeni 2021). The framework developed here clarifies why these debates persist by showing that the answers depend not on properties of any single mechanism but on how mechanisms interact within specific market contexts.

The chapter proceeds as follows. Section 2.2 establishes the conceptual foundations, formalizing the information problem in markets for complex goods and introducing the three-category taxonomy that organizes the analysis. Section 2.3 examines market-based mechanisms in a deliberate sequence from seller-initiated signaling and disclosure through buyer-initiated screening and search to third-party certification, identifying the structural limitations that motivate the introduction of institutional and technological alternatives. Section 2.4 analyzes institutional mechanisms and develops the case of CSR disclosure as a prominent instance of institutional signaling, distinguishing voluntary from mandatory and non-voluntary regimes. Section 2.5 turns to technological mechanisms and platform design, examining how digital infrastructures restructure information production, aggregation, and verification while introducing characteristic distortions. Section 2.6 develops the interaction framework that

constitutes the chapter's primary analytical contribution, characterizing the pairwise relationships between mechanism categories and tracing how interventions in one category propagate through the others. Section 2.7 draws out the implications for the empirical chapters of this thesis, identifying the two research gaps that motivate the analyses in Chapters 3 and 4. Section 2.8 concludes, and Sections 2.9 and 2.10 discuss directions for future research and the limitations of the analysis.

2.2 Conceptual Foundations

2.2.1 The Information Problem in Markets for Complex Goods

Markets for complex goods are governed by a fundamental informational friction: sellers possess private knowledge about product quality that buyers cannot observe or verify ex ante. The welfare consequences of this asymmetry are well established. Adverse selection depresses average quality and crowds out mutually beneficial trades (Akerlof 1970), while moral hazard attenuates incentives for quality provision post-contracting (Holmström 1979). Consequently, in equilibrium, high-quality agents are forced to either incur dissipative signaling costs or exit the market entirely (Spence 1973; Rothschild and Stiglitz 1976). Rather than isolated market failures, these distortions represent a pervasive structural feature of exchange under incomplete information that ultimately necessitates institutional or market-based interventions (Stiglitz 2000).

These informational frictions generate demand for mechanisms that facilitate the production, transmission, and verification of quality-relevant information. Such mechanisms, which this paper terms *information mechanisms*, constitute the micro-foundations through which dispersed private information becomes observable and actionable. The central question is not whether such mechanisms exist, but how they differ in their sources of credibility, how they interact, and under what conditions they succeed or fail. The remainder of this section develops a taxonomy that organizes the literature along these dimensions and structures the analysis in subsequent sections.

2.2.2 A Taxonomy of Information Mechanisms

The theoretical literature has developed a rich set of mechanisms for mitigating information asymmetry, including signaling and screening (Spence 1973; Rothschild and Stiglitz 1976), voluntary disclosure (Grossman 1981; Milgrom 1981a), certification (Lizzeri 1999), reputation (Shapiro 1983), and consumer search (Stigler 1961; Bakos 1997). These mechanisms are typically studied in isolation. This paper organizes them into a unified framework based on their underlying source of information production and enforcement, distinguishing three categories:

- *Market-based mechanisms* rely on decentralized incentives and voluntary actions by economic agents to generate and transmit information. Signaling, screening, voluntary disclosure, and reputation formation operate through this channel. Credibility derives from the cost structure facing individual agents.

- *Institutional mechanisms* rely on formal rules, regulatory frameworks, and externally imposed requirements to mandate information provision and verification. Minimum quality standards, mandatory disclosure, and regulated certification fall within this category. Credibility derives from legal authority and enforcement capacity.

- *Technological mechanisms* rely on digital infrastructures, including online platforms, algorithmic systems, and data architectures, to aggregate, process, and disseminate information at scale. Credibility derives from the design of information systems and the governance rules embedded within them.

This classification rests on the *dominant source of credibility and enforcement* in each context, a criterion that resolves cases where mechanisms straddle categories. Certification, for instance, can emerge as a market-based intermediary activity or as part of a regulatory framework; reputation may arise organically through repeated transactions or be embedded in platform architectures; and corporate disclosure may function as a voluntary signal or a mandated institutional requirement. In each case, the taxonomy classifies according to the primary source of credibility that sustains the mechanism's effectiveness.

A central argument of this paper is that these three categories are not substitutes but complements. Market-based incentives generate information, institutional structures enforce and standardize it, and technological systems scale and transform its transmission. Rather than operating independently, they jointly constitute what this paper terms *information governance*: the composite set of mechanisms through which information asymmetry is managed in a given market. The effectiveness of any single mechanism therefore depends critically on its interaction with the others. This proposition is developed in Section 2.6.

Table 2.2.1 illustrates the distribution of information mechanisms across representative market settings. Two patterns are noteworthy. First, no single mechanism category operates alone in any market; all settings rely on combinations of market-based, institutional, and technological mechanisms, consistent with the complementarity argument developed below. Second, the online used car market activates all three mechanism categories simultaneously, making it a particularly rich setting for studying the interactions that constitute the core analytical contribution of this chapter.

Table 2.2.2 lists the principal works cited in this chapter, organized by the thematic categories that correspond to the chapter's section structure. Some papers appear under multiple themes when they contribute to more than one strand of the literature. Continued on the next page.

Table 2.2.1. Information Mechanisms across Market Settings

Mechanism	Used Car Market		Restaurants	Financial
	Traditional	Online (eBay)		
Market-based mechanisms				
Signaling: warranties	X	X	X	X
Signaling: advertising and p	X	X	X	X
Voluntary disclos	X	X	X	X
Reputation (word-of-mout	X	X	X	X
Consumer searc	X	X	X	X
Third-party certification	X	X		X
Institutional mechanisms				
Minimum quality standards	X	X	X	X
Mandatory disclosure	X	X	X	X
Regulated certification				X
CSR disclosure	X	X		X
Technological mechanisms				
Platform-mediated search		X		X
Digital reputation systems		X	X	
Platform certification and guarantees		X		
Buyer-initiated inspection		X		

Notes: An "X" indicates that the mechanism is active in the corresponding market setting.

Table 2.2.2. Literature Index by Thematic Category

Theme	Key References
Conceptual foundations (Section 2.2)	
Asymmetric information and market failure	Akerlof (1970); Spence (1973); Rothschild and Stiglitz (1976); Holmström (1979); Stiglitz (2000)
Market-based mechanisms (Section 2.3)	
Signaling: foundational theory	Spence (1973); Connelly *et al.* (2011); Spence (2002)
Signaling: warranties and advertising	Spence (1977); Cooper and Ross (1985); Boulding and Kirmani (1993); Nelson (1970); Milgrom and Roberts (1986); Kihlstrom and Riordan (1984); Ippolito (1990); Lutz (1989)
Signaling: price and reputation	Wolinsky (1983); Klein and Leffler (1981); Shapiro (1983); Kreps and Wilson (1982); Milgrom and Roberts (1982); Tadelis (2002); Board and Meyer-ter-Vehn (2013); Kim (2017)
Voluntary disclosure and unraveling	Grossman (1981); Milgrom (1981a); Grossman and Hart (1980); Jovanovic (1982); Board (2009); Levin, Peck, and Ye (2009); Faure-Grimaud, Peyrache, and Quesada (2009)
Voluntary disclosure: empirical	Jin and Kato (2006); Lewis (2011)
Screening	Rothschild and Stiglitz (1976); Stiglitz (1975)
Consumer search and information goods	Stigler (1961); Diamond (1971); Nelson (1970); Darby and Karni (1973); Bakos (1997); Brynjolfsson and Smith (2000); Kroft and Pope (2014); Goldfarb and Tucker (2019)
Third-party certification	Lizzeri (1999); Albano and Lizzeri (2001); Biglaiser (1993); Farhi, Lerner, and Tirole (2013); Stahl and Strausz (2017); Ali *et al.* (2022); Pollrich and Strausz (2024); Marinovic, Skrzypacz, and Varas (2018); Dranove and Jin (2010)
Certification: conflicts of interest	Bolton, Freixas, and Shapiro (2012); Mathis, McAndrews, and Rochet (2009)
Reputation manipulation	Mayzlin, Dover, and Chevalier (2014); Luca and Zervas (2016); Bolton, Greiner, and Ockenfels (2013)

Table 2.2.3. Literature Index by Thematic Category (Continued from Table 2.2.2)

Theme	Key References
Institutional mechanisms (Section 2.4)	
Quality standards and licensing	Leland (1979); Ronnen (1991); Shapiro (1986)
Mandatory disclosure: theory and evidence	Grossman (1981); Jovanovic (1982); Board (2009); Jin and Leslie (2003); Mathios (2000); Dranove *et al.* (2003)
Mandated certification	Dranove and Jin (2010); Cho, Frankel, and Martin (2024)
CSR: economic perspective and voluntary	Kitzmueller and Shimshack (2012); Baron (2001); Du, Bhattacharya, and Sen (2011); Sen, Bhattacharya, and Korschun (2006); Cheng, Ioannou, and Serafeim (2014); Godfrey, Merrill, and Hansen (2009); Turban and Greening (1997)
CSR: greenwashing and credibility	Laufer (2003); Lyon and Maxwell (2011); Christensen, Hail, and Leuz (2021); Hoogervorst (2013)
CSR: mandatory and non-voluntary	Christensen, Hail, and Leuz (2021); Wang, Cao, and Ye (2018); Bénabou and Tirole (2010); List and Momeni (2021)
Technological mechanisms (Section 2.5)	
Platforms and search costs	Bakos (1997); Brynjolfsson and Smith (2000); Kroft and Pope (2014); Goldfarb and Tucker (2019)
Platform design and governance	Einav, Farronato, and Levin (2016); Tadelis and Zettelmeyer (2015); Elfenbein, Fisman, and McManus (2015a); Hui *et al.* (2016)

Table 2.2.4. Literature Index by Thematic Category (Continued from Table 2.2.3)

Theme	Key References
Technological mechanisms (Section 2.5, continued)	
Digital reputation systems: theory	Dellarocas (2003); Tadelis (2016)
Digital reputation systems: empirical	Resnick *et al.* (2006); Cabral and Hortaçsu (2010); Luca (2011); Bolton, Greiner, and Ockenfels (2013)
Digital distortions and manipulation	Mayzlin, Dover, and Chevalier (2014); Luca and Zervas (2016); Bolton, Greiner, and Ockenfels (2013); Tadelis (2016)
Verification gap and product uncertainty	Lewis (2011); Dimoka, Hong, and Pavlou (2012); Peterson and Schneider (2017); Jin and Kato (2006)
Mechanism interaction (Section 2.6)	
Digital transformation of information	Goldfarb and Tucker (2019); Dellarocas (2003); Tadelis (2016)
Market × Institutional	Grossman (1981); Dranove and Jin (2010); Jin and Leslie (2003); Mathios (2000); Board (2009); Leland (1979); Farhi, Lerner, and Tirole (2013)
Market × Technological	Goldfarb and Tucker (2019); Dellarocas (2003); Tadelis (2016); Mayzlin, Dover, and Chevalier (2014); Bolton, Greiner, and Ockenfels (2013)
Institutional × Technological	Dellarocas (2003); Christensen, Hail, and Leuz (2021); Cho, Frankel, and Martin (2024); Tadelis (2016); Dranove and Jin (2010); Pollrich and Strausz (2024)

2.3 Market-Based Information Mechanisms

Market-based mechanisms constitute the classical foundation of the information economics literature. They rely on decentralized incentives to induce privately informed agents to produce, transmit, or verify quality-relevant information without external intervention. Participation is voluntary and self-enforcing: agents engage in information provision when doing so is individually rational given prevailing cost structures and competitive pressures.

This section examines these mechanisms in a deliberate sequence. It begins with seller-initiated mechanisms, specifically signaling and voluntary disclosure, through which informed agents convey private information. It then turns to buyer-initiated mechanisms, namely screening and consumer search, through which uninformed agents acquire information. Finally, it examines third-party certification, where an independent intermediary bridges the gap between the two sides. This progression reveals a common theme: each mechanism addresses a specific dimension of the information problem but is subject to characteristic limitations that the next mechanism partially resolves. Section 2.3.5 synthesizes these limitations and establishes why market-based incentives alone cannot fully resolve information asymmetry, motivating the institutional and technological mechanisms discussed in Sections 2.4 and 2.5.

2.3.1 Signaling

Signaling enables informed agents to convey private information through observable and costly actions. Credibility requires that the cost of the signal be differentially borne across types, so that low-quality agents cannot profitably mimic high-quality ones (Spence 1973). When this condition holds, separating equilibria arise in which signals reliably reveal quality.[1]

The mechanism manifests through several instruments, each exploiting a distinct cost asymmetry. Warranties function as credible signals because high-quality sellers face lower expected costs of honoring commitments (Spence 1977; Cooper and Ross 1985), and experimental evidence confirms that consumers treat them as quality cues (Boulding and Kirmani 1993).[2] Advertising expenditures can serve the same role when only high-quality sellers can recover sunk costs through repeat purchases (Nelson 1970; Milgrom and Roberts 1986). Reputation extends the logic to multi-period settings: the prospect of future rents disciplines current behavior, provided that transaction histories are sufficiently precise and widely disseminated (Shapiro 1983; Board and Meyer-ter-Vehn 2013; Kim 2017).[3] What unifies these

1. For a systematic review of signaling applications across disciplines, see Connelly *et al.* (2011); for a retrospective on the mechanism's implications for market design, see Spence (2002).

2. For related theoretical contributions on warranty signaling, see Grossman (1981) and Lutz (1989).

3. For foundational theoretical contributions on reputation mechanisms, see Kreps and Wilson (1982), Milgrom and Roberts (1982), and Tadelis (2002).

instruments is that credibility derives from the seller's cost structure rather than from any external verification. This property simultaneously defines the mechanism's scope and its boundary.

That boundary is reached when cost differentials are small, when signals are difficult to interpret in isolation, or when multiple signals interact in ways that confound inference. Price, for instance, may reflect demand conditions or strategic positioning rather than quality, reducing its reliability as a standalone indicator (Wolinsky 1983; Milgrom and Roberts 1986). More fundamentally, credible signaling requires expenditure on actions with no direct productive value, generating deadweight costs relative to first-best allocations (Spence 1973). In practice, sellers combine multiple signals to construct composite quality claims, and whether these bundles remain informative depends on buyers' ability to interpret them jointly, a challenge that intensifies in information-rich digital environments (Section 2.5.3).

2.3.2 Voluntary Disclosure and Unraveling

Voluntary disclosure provides an alternative channel through which sellers convey quality information without relying on differentially costly signals. The foundational result, the unraveling theorem of Grossman (1981) and Milgrom (1981a), shows that when disclosure is costless and verifiable, rational buyer skepticism drives all sellers except the lowest-quality type to disclose. The mechanism operates through inference rather than cost: buyers penalize silence by attributing low quality to non-disclosing sellers, and this adverse inference sustains disclosure in equilibrium.

Unraveling breaks down when its two premises fail. Disclosure costs generate partial equilibria in which only sellers above a quality threshold choose to reveal information (Grossman and Hart 1980; Jovanovic 1982), with the threshold depending on competitive conditions (Board 2009) and buyer demand for information (Faure-Grimaud, Peyrache, and Quesada 2009). When verification is imperfect, sellers may engage in strategic manipulation, selectively omitting unfavorable attributes or misrepresenting quality dimensions. Jin and Kato (2006) document this pattern on eBay, showing that seller-claimed quality ratings systematically exceed independently certified assessments and that platform reputation premiums are insufficient to compensate buyers for the resulting losses.

Digital platforms reduce the cost of disclosure but do not necessarily improve its credibility. Lewis (2011) demonstrates that additional photograph disclosure in eBay used car auctions is associated with significantly higher final prices, consistent with buyers rewarding transparency. The same study documents, however, that the marginal return to disclosure declines as photographs accumulate, suggesting that buyers discount information whose accuracy they cannot independently assess. This finding exposes a structural limitation of

voluntary disclosure: reducing the cost of producing information does not resolve the problem of verifying it. The verification dimension connects directly to the technological mechanisms examined in Section 2.5 and to the empirical analysis of buyer-initiated inspection in Chapter 4.

2.3.3 Screening and Consumer Search

While signaling and disclosure are initiated by the informed party, screening and search allow the uninformed side to acquire information actively. Rothschild and Stiglitz (1976) show that an uninformed party can elicit private information by designing menus of contracts that induce self-selection, achieving separation through endogenous choice rather than costly signaling. In consumer markets, however, screening by buyers is less prevalent because sellers typically hold the informational advantage, making seller-initiated signaling the more natural mechanism (Stiglitz 1975). Screening logic nonetheless reappears in platform settings, where differentiated listing formats, tiered verification services, and premium seller programs function as menu designs that induce higher-quality sellers to self-select into more transparent options. This connection is developed in Section 2.5.

Consumer search addresses information asymmetry more directly by allowing buyers to acquire information prior to purchase. The foundational insight is that search frictions sustain price dispersion and prevent competitive outcomes (Stigler 1961; Diamond 1971); digital technologies reduce these frictions substantially, enabling buyers to compare observable attributes across large numbers of alternatives (Bakos 1997; Kroft and Pope 2014; Goldfarb and Tucker 2019).

Search, however, confronts a fundamental boundary. Following the distinction between search, experience, and credence goods (Nelson 1970; Darby and Karni 1973), goods whose quality depends on experience or expert assessment cannot be fully evaluated through prepurchase comparison. Observable attributes may be compared at low cost, but latent quality, the dimension most susceptible to adverse selection, remains unresolved. Seller-provided information about unobservable dimensions may then lack credibility and function as cheap talk (Lewis 2011). This residual information gap motivates demand for third-party verification, which the next subsection examines.

2.3.4 Third-Party Certification

Certification addresses a limitation that is shared across seller-initiated and buyer-initiated mechanisms: neither side can credibly resolve uncertainty about latent quality without external verification. An independent intermediary whose assessment is non-partisan can resolve buyer uncertainty more effectively than any seller-initiated signal, provided the intermediary

itself has adequate incentives for accuracy (Lizzeri 1999; Dranove and Jin 2010).

The theoretical literature identifies two channels through which certification operates. The first is informational: certifiers collect and disclose quality information through strategically designed mechanisms. A key finding is that profit-maximizing certifiers may restrict information revelation to extract rents, for instance by disclosing only whether a product meets a minimum threshold rather than revealing precise quality (Lizzeri 1999). When quality is endogenous, however, certification can improve allocative efficiency by providing sellers with incentives to invest in quality (Albano and Lizzeri 2001). More recent work examines how fee design (Ali *et al.* 2022; Pollrich and Strausz 2024) and dynamic interaction with reputation formation (Marinovic, Skrzypacz, and Varas 2018) shape the welfare properties of certification. The second channel is reputational: intermediaries validate quality through their own reputational stake, investing in expertise to earn profits from repeated interaction (Biglaiser 1993). The common thread is that credibility derives from the intermediary's independence and incentive structure, not from the seller's cost of signaling.

Two structural constraints limit the effectiveness of certification. First, intermediaries compensated by sellers face conflicts of interest that may bias assessments. Bolton, Freixas, and Shapiro (2012) and Mathis, McAndrews, and Rochet (2009) demonstrate that under issuer-pays compensation, reputational concerns are insufficient to deter inflated assessments, particularly when the certifier's portfolio contains a large share of opaque assets. This finding parallels the voluntary disclosure problem identified above: the informed party's influence over information production undermines credibility. Second, comprehensive certification is costly, restricting its applicability to markets where the cost of third-party assessment is small relative to transaction value. Together, these constraints motivate the search for scalable, lower-cost verification mechanisms, a role increasingly fulfilled by platform-integrated inspection services, as examined in Chapter 4.

2.3.5 Limitations of Market-Based Mechanisms

The preceding subsections reveal a common pattern: each market-based mechanism resolves one dimension of the information problem while leaving others unaddressed. Signaling conveys quality through costly actions, but credibility fails when cost differentials are small or when signals proliferate beyond buyers' processing capacity (Dranove and Jin 2010; Tadelis 2016). Voluntary disclosure transmits information at lower cost, but breaks down when verification is imperfect and sellers can strategically manipulate or omit (Lewis 2011; Jin and Kato 2006). Search enables buyers to compare observable attributes, but cannot resolve uncertainty over latent quality dimensions (Nelson 1970). Certification introduces independent verification, but is constrained by cost and by the conflicts of interest inherent in issuer-pays compensation (Bolton, Freixas, and Shapiro 2012; Mathis, McAndrews, and Rochet 2009).

Reputation systems, which extend the signaling logic to repeated interactions, are susceptible to manipulation through fake reviews, retaliatory feedback, and identity cycling in anonymous or transaction-sparse settings (Mayzlin, Dover, and Chevalier 2014; Bolton, Greiner, and Ockenfels 2013).

These limitations are not idiosyncratic but structural. They reflect the fact that decentralized market incentives, by definition, cannot compel information provision, enforce verification standards, or guarantee the accuracy of aggregated information at scale. When the credibility of information depends on external enforcement or on infrastructures that individual agents cannot provide, market-based mechanisms reach their boundary. This is precisely the condition that characterizes high-volume, anonymous, and digitally-mediated markets such as the used car market studied in this thesis.

Two dimensions of this boundary are particularly relevant for the empirical analysis that follows. First, no market-based mechanism examined here can generate credible verification of latent quality at low cost and at scale. This is precisely the problem addressed by the platform-enabled buyer-initiated inspection analyzed in Chapter 4. Second, the credibility of seller-provided signals depends on institutional structures that constrain misrepresentation, yet the conditions under which institutional mandates causally influence consumer beliefs remain empirically underexplored. This question is examined in Chapter 3. These gaps motivate the turn to institutional and technological mechanisms in the following sections.

2.4 Institutional Mechanisms and Regulatory Signals

Institutional mechanisms differ from market-based mechanisms in their source of credibility. Whereas market-based mechanisms depend on agents' private incentives to generate and transmit information, institutional mechanisms operate through formal authority: mandating disclosure, standardizing reporting formats, and enforcing compliance through penalties. Information produced under institutional mandates is less susceptible to strategic manipulation because it is subject to external verification rather than self-enforcement. This distinction is consequential: as established in Section 2.3.5, market-based mechanisms break down precisely when verification is imperfect and sellers can strategically distort information. Institutional interventions address this limitation by constraining the information environment from outside the market.

This section develops the role of institutions as information devices and examines CSR disclosure as a prominent application. The analysis is organized around a single question: under what conditions do institutional mandates enhance the credibility of information beyond what decentralized incentives can sustain?

2.4.1 Institutions as Information Devices

Institutional mechanisms mitigate information asymmetry through three principal forms: minimum quality standards, mandatory disclosure requirements, and institutionally mandated certification. Each constrains the information environment differently, but all share a common logic: they reduce the discretion available to informed parties over information provision.

Minimum quality standards and licensing operate by restricting market entry, thereby improving average quality without requiring buyers to assess individual sellers. Leland (1979) models licensing as a supply truncation mechanism that removes the lower tail of the quality distribution, preventing adverse selection from displacing high-quality providers. Subsequent work refines this analysis. Ronnen (1991) shows that minimum standards in vertically differentiated markets compress quality differentiation and intensify price competition between firms, while Shapiro (1986) demonstrates that excessively stringent standards generate welfare losses through overinvestment, forcing consumers with low demand for quality to subsidize unnecessarily high levels of service. The common insight is that quality standards trade off inclusiveness against average quality: they strengthen the informational content of market participation at the cost of reduced market coverage.

Mandatory disclosure requirements address information asymmetry by eliminating sellers' discretion over information provision. The theoretical motivation follows from the limits of voluntary unraveling. While costless and verifiable disclosure yields full revelation in equilibrium (Grossman 1981), this result breaks down when disclosure is costly (Jovanovic 1982) or when competitive forces induce firms to remain silent in order to soften price competition (Board 2009). Mandatory disclosure restores information transmission by compelling revelation, strengthening competition and increasing consumer surplus. Empirical evidence supports this mechanism: Jin and Leslie (2003) show that mandatory disclosure of restaurant hygiene grades improved food safety and reduced illness rates, while Mathios (2000) document that nutrition labeling significantly altered consumer choices by forcing disclosure of previously withheld attributes. However, as the literature cautions, mandatory disclosure can also generate unintended consequences; if the mandated metrics imperfectly capture quality, they may encourage "gaming" or adverse selection behavior by sellers that ultimately reduces consumer welfare (Dranove *et al.* 2003).

Institutionally mandated certification occupies an intermediate position between market-based and institutional mechanisms. Certification functions as a market device when participation is voluntary, but acquires institutional force when disclosure and verification are legally required (Dranove and Jin 2010). In this case, institutional mandates can overcome the selection biases that limit voluntary mechanisms by establishing a credible foundation

for market signals. Cho, Frankel, and Martin (2024) provide evidence of this dynamic from mandatory odometer record-keeping laws in the used car market. Crucially, rather than dictating advertising content, the regulation legally enforced the reliability of the underlying odometer signal. They show that this enforceable verification improved market outcomes through two distinct channels: it raised average car prices across the board by mitigating adverse selection, and it incentivized sellers to voluntarily disclose mileage in their advertisements, which successfully reduced search costs and accelerated transactions.

Across these settings, institutional mechanisms share a common economic logic: they constrain the information environment in ways that enhance the reliability of observable signals beyond what decentralized incentives alone can sustain. The preceding discussion also reveals a consistent set of tensions. Minimum quality standards improve average quality but reduce market coverage and may induce overinvestment. Mandatory disclosure strengthens information transmission but can be gamed when mandated metrics imperfectly capture underlying quality (Dranove *et al.* 2003). Mandated certification overcomes voluntary selection biases but depends critically on the reliability of the underlying signals it verifies. In each case, the welfare consequences of institutional intervention depend not only on whether information is produced but on whether enforcement is credible, disclosed information is accessible and interpretable, and market participants attribute signals to genuine quality differences rather than regulatory compliance alone. These dimensions structure the analysis of CSR disclosure that follows.

2.4.2 CSR Disclosure and Signal Credibility

Corporate social responsibility (CSR) disclosure provides a compelling context for examining how institutional design shapes signal credibility. From an information economics perspective, CSR communicates information about dimensions of firm behavior and latent quality that are not directly observable through standard market outcomes (Kitzmueller and Shimshack 2012). However, because these disclosures often pertain to environmental externalities and long-term, intangible commitments, they are particularly susceptible to strategic distortion (Christensen, Hail, and Leuz 2021). Consequently, the effectiveness and credibility of CSR as a quality signal vary fundamentally depending on the institutional regime under which it is produced—specifically, the contrast between voluntary disclosure driven by decentralized market incentives and mandatory reporting imposed by regulatory authorities (Dranove and Jin 2010; Christensen, Hail, and Leuz 2021).

Voluntary CSR disclosure is driven by firm incentives and may serve strategic purposes such as pre-empting regulation (Baron 2001) or differentiating products in markets where consumers value ethical attributes (Kitzmueller and Shimshack 2012). Because disclosure

remains under firm control, it is inherently subject to strategic distortion. When disclosure costs are low relative to reputational benefits, firms may engage in selective reporting, emphasizing favorable outcomes while omitting unfavorable information (Du, Bhattacharya, and Sen 2011). In its more severe form, this strategic distortion manifests as "greenwashing" (Laufer 2003; Lyon and Maxwell 2011) or symbolic compliance, where reported commitments are used to legitimize corporate actions without corresponding substantive changes to underlying business practices (Christensen, Hail, and Leuz 2021). Furthermore, even when genuine, the informational content of voluntary CSR is limited by low stakeholder awareness and the heterogeneous attributions stakeholders make regarding the firm's true motives (Sen, Bhattacharya, and Korschun 2006). Voluntary CSR therefore constitutes an imperfect signal whose credibility is constrained by the same forces that limit voluntary disclosure more generally: the informed party retains complete control over information production.

Mandatory CSR disclosure restricts managerial discretion by imposing externally defined reporting requirements. Christensen, Hail, and Leuz (2021) document that such institutional mandates can enhance comparability and mitigate selective omission, while Wang, Cao, and Ye (2018) demonstrate that these mandates can generate positive spillover effects, improving overall financial reporting quality beyond the specific disclosures directly targeted by regulation. However, the credibility of these disclosures is not guaranteed by the mandate alone. Firms may resort to symbolic compliance, utilizing "boilerplate" language to satisfy formal requirements without revealing substantive, firm-specific information (Hoogervorst 2013; Christensen, Hail, and Leuz 2021). Furthermore, the signaling value of mandatory disclosure remains critically contingent on stakeholders' attributions of the underlying corporate motives. Stakeholder responses are significantly attenuated when corporate actions are attributed merely to regulatory compliance or instrumental profit-seeking rather than genuine quality improvement (Bénabou and Tirole 2010). In fact, if the CSR initiative is perceived merely as an instrumental tool, it can even backfire by providing a "moral license" that ultimately exacerbates detrimental or counterproductive behaviors (List and Momeni 2021).

A distinct and analytically important case arises when CSR actions are imposed through external legal or judicial mandates rather than chosen voluntarily. Such non-voluntary CSR differs fundamentally from both voluntary CSR and mandatory disclosure in its informational properties. While mandatory disclosure regimes force the reporting of endogenously chosen activities, non-voluntary CSR mandates the activities themselves. Because these actions are not endogenously chosen by firms, they introduce exogenous variation that mitigates two selection concerns inherent in voluntary settings: the self-selection into disclosure and the strategic choice of which activities to disclose. This limits the scope for strategic manipulation (Christensen, Hail, and Leuz 2021). However, whether such non-voluntary ac-

tions nonetheless influence consumer beliefs depends critically on stakeholder attributions. As Sen, Bhattacharya, and Korschun (2006) demonstrate, positive consumer responses hinge on whether stakeholders attribute the corporate action to a genuine concern for quality and social improvement. When actions are externally imposed, their signaling value risks being discounted if consumers attribute the behavior merely to legal compliance or instrumental motives rather than intrinsic prosocial commitment (Bénabou and Tirole 2010).

This question constitutes a gap in the existing literature. While the theoretical framework predicts that institutional mandates enhance signal credibility by constraining strategic manipulation, the conditions under which non-voluntary institutional signals causally influence consumer willingness to pay in secondary markets remain empirically unresolved. This gap motivates Chapter 3, which exploits a court-mandated CSR intervention as an exogenous institutional signal and identifies its causal effect on consumer willingness to pay in the used car market.

2.5 Technological Mechanisms and Platform Design

Technological mechanisms constitute the third category of information governance. They differ from market-based mechanisms in that their operation does not depend primarily on agent incentives, and from institutional mechanisms in that they do not rely on legal authority. Instead, they function through digital infrastructures that alter the conditions under which all other information mechanisms operate. While Sections 2.3 and 2.4 examined mechanisms that generate and enforce information respectively, this section examines how platforms restructure the information environment itself, simultaneously expanding the scope of information exchange and introducing new forms of distortion.

The analysis proceeds in three steps. It first examines how platforms function not merely as passive intermediaries but as active designers of the information environment. It then analyzes how digital reputation systems transform the aggregation and transmission of quality-relevant information. Finally, it identifies the characteristic distortions that digital environments introduce, which in turn define the residual information problems that motivate the empirical analysis in Chapter 4.

2.5.1 Platforms as Information Designers

The foundational observation in the platform literature is that digital marketplaces significantly reduce buyer search costs by lowering the marginal cost of acquiring both price and product information, thereby enabling simultaneous comparison across a large number of sellers (Bakos 1997). While early economic models predicted that this frictionless search would eliminate price dispersion, empirical evidence reveals a more nuanced reality. Bryn-

jolfsson and Smith (2000) document that although online retailers exhibit lower average prices than their offline counterparts, substantial price dispersion persists. As highlighted by Goldfarb and Tucker (2019), this persistence occurs because sellers respond strategically by endogenously manipulating the search process and differentiating their services to sustain margins. Extending this logic to local matching markets, Kroft and Pope (2014) show that platforms crowd out traditional search channels and improve matching efficiency, for instance by reducing housing vacancies, even when aggregate market effects remain limited.

More consequentially for the information governance framework developed here, platforms shape market outcomes not only by reducing search costs but by actively designing the informational environment in which transactions occur. As Einav, Farronato, and Levin (2016) emphasize, creating efficient trade between large numbers of fragmented buyers and sellers requires platforms to solve core market design problems, such as developing search and matching algorithms, establishing pricing mechanisms, and designing reputation systems that elicit dispersed information while keeping transaction costs low. In this capacity, platforms govern which signals are produced, how they are aggregated, and which are made salient to buyers. For instance, Goldfarb and Tucker (2019) note that a platform's choice of search and recommendation algorithms endogenously shifts consumer attention and significantly alters sales distributions. Similarly, the very architecture of a platform's feedback mechanism dictates whether the reputation signals produced are informative or strategically distorted by fear of retaliation (Bolton, Greiner, and Ockenfels 2013) . Furthermore, platform-mandated disclosure policies, such as the provision of standardized quality reports, act as direct matching mechanisms that structure bidder participation and intensify competition (Tadelis and Zettelmeyer 2015). These design choices therefore affect not only the sheer availability of information but also its fundamental comparability, credibility, and interpretability. In this sense, platforms function as active **information architects** rather than passive intermediaries. They structure the underlying conditions under which market participants form beliefs, assess quality, and ultimately make economic decisions.

Platform governance extends beyond information display to direct interventions that fundamentally alter the reliability of quality signals. Through entry restrictions, seller verification programs, and platform-administered certification, platforms can actively segment sellers based on observable quality indicators. Crucially, the efficacy of such centralized endorsement is deeply intertwined with both market structure and existing decentralized signals. Elfenbein, Fisman, and McManus (2015a) demonstrate that platform-sponsored certification (such as eBay's Top-Rated Seller program) not only generates substantial demand and price premiums, but also acts as a direct substitute for organic reputation—disproportionately benefiting newer sellers who lack established feedback histories. Furthermore, they show that this centralized certification provides the greatest value in highly competitive markets

where unobserved quality concerns are most severe. Beyond certification, platforms can provide direct institutional guarantees. Hui *et al.* (2016) provide evidence from the eBay Buyer Protection program, demonstrating that platform-wide guarantees increase market efficiency and total welfare not merely by reducing buyer risk exposure, but by actively mitigating moral hazard (incentivizing higher seller quality) and adverse selection (accelerating the exit of low-quality sellers). These interventions represent a qualitative shift in market design. Rather than relying exclusively on sellers to organically produce credible information, platforms manufacture credibility directly through the institutional features embedded in their architecture. Among the most consequential of these features are digital reputation systems, which aggregate dispersed transaction histories into publicly observable quality signals at a scale that pre-digital markets could not sustain.

2.5.2 Digital Reputation and Information Aggregation

Section 2.3.1 examined reputation as a market-based mechanism traditionally sustained by repeated bilateral interactions. Digital reputation systems fundamentally transform this mechanism by altering the scale, structure, and strategic properties of feedback information. Rather than relying on localized, relationship-based knowledge or informal word-of-mouth, digital platforms engineer large-scale information networks that aggregate decentralized transaction histories into publicly observable metrics (Dellarocas 2003). These metrics function effectively across vast, anonymous markets where direct pre-purchase experience is unavailable (Tadelis 2016). Importantly, by establishing a public repository of past performance, these systems effectively transform isolated, one-off exchanges into a repeated game framework, thereby mitigating both moral hazard and adverse selection even among completely anonymous traders (Cabral and Hortaçsu 2010; Einav, Farronato, and Levin 2016).

Whether these theoretical properties translate into measurable market outcomes has been extensively tested empirically, with evidence confirming both the pricing power and the disciplinary force of online reputation systems. Overcoming the endogeneity concerns inherent in observational data, Resnick *et al.* (2006) utilize a controlled field experiment, selling identical items under both established and new seller identities, to demonstrate that established reputations command a significant, causal price premium in online auctions. Complementing this static price effect, Cabral and Hortaçsu (2010) exploit panel data from eBay to document the dynamic incentive properties of observable reputation. They show that a seller's first negative feedback not only triggers a sharp decline in sales growth but also accelerates the arrival rate of subsequent negative ratings. This reflects a fundamental moral hazard mechanism whereby sellers dynamically reduce their effort once their pristine record is tarnished. Beyond centralized auction platforms, the economic impact of digitized word-of-mouth extends to decentralized offline markets. Luca (2011) demonstrates that consumer ratings on Yelp have substantial, causal effects on restaurant revenues. Collectively, these

findings confirm that digitally aggregated reputation not only resolves information asymmetry but fundamentally reshapes market demand, pricing behavior, and firm incentives at scale.

What distinguishes digital reputation from its traditional market-based predecessor is not merely its unprecedented scale, but the fundamental reality that platform design actively dictates the informational content of feedback. While crowdsourced reputation signals are theoretically insulated from the "cheap talk" problems of seller-initiated claims, empirical evidence demonstrates that they remain highly vulnerable to strategic manipulation, such as promotional review fraud and seller retaliation (Dellarocas 2003; Luca and Zervas 2016). Consequently, the informativeness and credibility of these signals depend critically on the architectural design of the feedback system. As Bolton, Greiner, and Ockenfels (2013) demonstrate in their analysis of eBay, implementing simultaneous (rather than sequential) feedback reporting drastically reduces strategic reciprocity and the fear of retaliation. This institutional design choice mitigates reputation inflation, substantially improving the dispersion and accuracy of ratings. More broadly, platforms engineer these large-scale information networks through two primary design channels: *aggregation*, which condenses dispersed individual experiences into reliable summary statistics that buyers can readily process, and *visibility*, which determines which signals are made most salient in the decision-making environment (Dellarocas 2003). By actively structuring both channels, platforms transform dispersed, noisy private experiences into publicly interpretable signals, thereby fundamentally reshaping how market beliefs about quality are formed. These design choices, however, cannot fully eliminate the informational frictions that persist in digital markets, a point to which Section 2.5.3 now turns.

2.5.3 Limits and Distortions in Digital Information Environments

Despite the informational benefits documented above, digital environments introduce characteristic distortions that generate new forms of information asymmetry rather than merely reducing existing ones.

The most direct distortion arises from the strategic manipulation of reputation systems. Because ratings directly impact revenues, sellers possess strong incentives to artificially influence their scores. Empirically, Mayzlin, Dover, and Chevalier (2014) and Luca and Zervas (2016) document that firms routinely post fabricated positive reviews for themselves and negative ones for competitors, significantly diluting the informational value of the system. Furthermore, bilateral feedback designs compound this issue by enabling reciprocity. Bolton, Greiner, and Ockenfels (2013) demonstrate that the mere threat of retaliation deters buyers from reporting negative experiences, leading to systematic underreporting of poor quality

and a pervasive upward bias in reputation scores. Because these manipulations masquerade as genuine feedback, they inherently undermine the credibility of the entire signaling mechanism.

A qualitatively distinct distortion arises from the near-zero cost of information replication in digital environments. As the marginal cost of signaling plummets, the separating properties of traditional signals deteriorate. Low-quality sellers can costlessly mimic high-quality ones by flooding the market with non-diagnostic claims, thereby diluting the informational value of the signaling environment (Tadelis 2016; Goldfarb and Tucker 2019). This phenomenon diverges fundamentally from classical adverse selection, where market friction stems not from an absence of information, but from the strategic overproduction of noisy signals that overwhelms buyers' assessment capacity.

Together, these distortions engender a residual verification gap. While digital platforms drastically reduce search costs for observable attributes, they struggle to resolve *product uncertainty* regarding latent quality, the primary driver of adverse selection in durable goods markets (Dimoka, Hong, and Pavlou 2012; Peterson and Schneider 2017). Because aggregated reputation is an imperfect substitute for direct inspection, and unverified seller disclosures are highly vulnerable to strategic misrepresentation (Jin and Kato 2006), the fundamental market friction has shifted decisively from information access to information verification (Lewis 2011; Goldfarb and Tucker 2019).

This verification gap motivates the design of mechanisms that enable direct quality assessment, bypassing the limitations of digitally mediated signals. One such mechanism is buyer-initiated inspection, where buyers commission independent third-party assessments of specific listings prior to purchase. Whether such mechanisms can substitute for or complement seller-provided signals, and how sellers respond strategically to the availability of independent verification, remain open empirical questions. These questions are addressed in Chapter 4, which exploits the introduction of the WeGoLook inspection service on eBay Motors as a quasi-natural experiment in platform-enabled buyer-initiated information acquisition.

2.6 Interaction and Transformation of Mechanisms

The preceding sections examined market-based, institutional, and technological mechanisms as analytically distinct approaches to mitigating information asymmetry. This separation is useful for exposition but incomplete as a description of how information governance operates in practice. In modern markets, these mechanisms rarely function independently. They interact in systematic ways that jointly determine the production, credibility, and transmission of information. The effectiveness of any single mechanism depends critically on how it

is complemented, constrained, or amplified by the others.

Understanding these interactions requires first recognizing how digital transformation has altered the environment in which all three mechanism types operate. Digital technologies have reduced the marginal cost of information production and transmission to near zero, enabled rapid updating of information, and expanded the scale at which dispersed signals can be aggregated (Goldfarb and Tucker 2019; Dellarocas 2003). As a consequence, the binding constraint in digitally mediated markets has shifted from information scarcity to information abundance. The central challenge is no longer whether agents can access information, but whether available information is credible, interpretable, and verifiable (Lewis 2011; Bolton, Greiner, and Ockenfels 2013). This transformation does not eliminate asymmetric information but restructures it, and in doing so, reshapes how market-based, institutional, and technological mechanisms relate to one another. Dynamic information environments strengthen mechanisms that rely on continuous updating, such as reputation systems, while weakening static signals that lose informativeness when they can be cheaply replicated (Goldfarb and Tucker 2019; Mayzlin, Dover, and Chevalier 2014).

This section develops three propositions that characterize the pairwise interactions between mechanism categories, then draws out their implications for the empirical analysis that follows.

2.6.1 Market and Institutional Mechanisms

The central proposition governing the interaction between market and institutional mechanisms is that *institutional interventions discipline rather than displace market-based information transmission.* Market-based mechanisms such as signaling and voluntary disclosure rely on the assumption that revealed information is credible and interpretable. As established in Section 2.3.5, however, these mechanisms break down when disclosure is unverifiable or when signals can be strategically manipulated (Grossman 1981; Dranove and Jin 2010). Institutional interventions address this limitation by introducing mandatory disclosure rules, liability regimes, and standardized certification requirements that constrain misrepresentation (Jin and Leslie 2003; Mathios 2000). By imposing penalties for false disclosure and standardizing information formats, they transform signals that would otherwise constitute cheap talk into costly-to-falsify claims. Voluntary disclosure becomes more informative when legal requirements enforce accuracy, and signaling becomes more credible when backed by regulatory oversight. Board (2009) demonstrate this complementarity directly: when competitive pressures undermine voluntary unraveling, mandatory disclosure can restore information transmission and increase consumer surplus.

The interaction is, however, subject to diminishing and potentially negative returns. In-

stitutional rules do not eliminate strategic behavior but reallocate it within a constrained incentive environment. Excessively stringent requirements may discourage market participation or induce evasion. Leland (1979) shows that overly restrictive licensing can reduce market entry and limit supply, while Farhi, Lerner, and Tirole (2013) demonstrate that mandating full transparency may deter sellers from engaging with certification programs due to the stigma of disclosed rejections. These findings imply a trade-off between the precision of institutional signals and the breadth of market participation. The interaction between market and institutional mechanisms is therefore not uniformly efficiency-enhancing; it depends on the calibration of institutional rules relative to the incentive structures they seek to constrain.

2.6.2 Market and Technological Mechanisms

The central proposition governing the interaction between market and technological mechanisms is that *digital platforms amplify the reach and efficiency of market-based signals while simultaneously altering their incentive compatibility.* Market-based mechanisms such as signaling, reputation, and search depend on the cost, observability, and interpretability of information. Digital technologies alter all three conditions by reducing the cost of signal production, increasing the visibility of information, and enabling large-scale aggregation of dispersed signals (Goldfarb and Tucker 2019).

The amplification channel operates primarily through reputation. Digital systems aggregate transaction histories into publicly observable and standardized metrics, extending reputation beyond localized networks to large-scale anonymous markets (Dellarocas 2003; Tadelis 2016). Algorithmic ranking further determines signal visibility, influencing which information reaches buyers and how it shapes decisions. Nosko and Tadelis (2015) show that incorporating reputation metrics into search-ranking algorithms improves matching efficiency and buyer retention, illustrating how platform design can enhance the performance of market-based signals.

The distortion channel operates through the same cost reductions that enable amplification. Lower signaling costs weaken the separating properties of costly signals, enabling low-quality sellers to mimic high-quality signals at reduced cost or to flood the information environment with non-diagnostic content (Mayzlin, Dover, and Chevalier 2014; Tadelis 2016). Sellers may further optimize for algorithmic visibility rather than underlying quality, distorting the relationship between observed signals and true quality. Bilateral feedback systems can generate strategic reciprocity and reputation inflation, compressing rating distributions and reducing their informativeness (Horton and Golden 2015; Bolton, Greiner, and Ockenfels 2013). Algorithmic ranking may prioritize signals based on platform objectives such as engagement or revenue rather than informational accuracy, creating a misalignment between visibility

and quality.

The net effect is therefore ambiguous: technological mechanisms expand the scale of market-based information systems while altering the conditions under which those systems remain incentive-compatible. Whether amplification dominates distortion in a given market depends on the specific design choices made by platform operators.

2.6.3 Institutional and Technological Mechanisms

The central proposition governing the interaction between institutional and technological mechanisms is that *digital platforms transform regulatory enforcement from centralized, ex post processes to embedded, continuous governance.* Traditional institutional mechanisms rely on periodic monitoring and ex post verification, which are costly and limited in coverage. Digital technologies alter these constraints by embedding disclosure requirements and verification rules directly into platform architectures, enabling real-time monitoring and scalable enforcement (Dellarocas 2003).

The primary channel operates through the integration of institutional rules into digital systems. Platforms can standardize information formats, mandate required disclosure fields, and cross-validate inputs using integrated data sources, thereby reducing both the cost and the discretion associated with information provision. Christensen, Hail, and Leuz (2021) emphasize that the effectiveness of mandatory disclosure regimes depends critically on enforcement capacity; embedding regulatory rules within technological infrastructures provides precisely this capacity. Cho, Frankel, and Martin (2024) illustrate this mechanism empirically: public enforcement under the Truth in Mileage Act creates a reliable data infrastructure that digital platforms can leverage to verify information at scale, substantially reducing the scope for strategic misrepresentation.

The interaction is bidirectional. Institutional rules shape platform design by defining the requirements that platforms must encode and enforce. Disclosure mandates, liability regimes, and data governance regulations constrain how platforms structure their information environments. In this sense, technological systems are not neutral intermediaries but institutional artifacts whose design reflects regulatory objectives and legal constraints. At the same time, embedding institutional functions within profit-maximizing platforms introduces governance tensions. Platform operators act as de facto regulators, simultaneously determining the rules of information provision and controlling the mechanisms through which information is aggregated and presented (Tadelis 2016). This dual role creates conflicts of interest that echo the certification literature on biased information provision (Dranove and Jin 2010; Pollrich and Strausz 2024). The opacity of algorithmic enforcement further complicates accountability, raising concerns about the effective delegation of public regulatory

authority to private actors.

Across the three interactions examined above, a consistent pattern emerges: each pairwise relationship involves both complementarity and tension. Institutional rules enhance the credibility of market signals but may suppress participation. Technology amplifies the reach of market information but weakens its incentive properties. Platforms embed institutional enforcement but introduce conflicts of interest. These effects do not operate in isolation. In the digitally mediated used car market studied in this thesis, a seller's information environment is simultaneously shaped by market incentives, institutional constraints, and platform architecture, and buyer beliefs are formed by jointly processing signals from all three sources. An intervention that alters one mechanism type therefore propagates through the others: a platform design change that improves verification simultaneously affects the returns to seller signaling and the enforcement value of disclosure mandates.

This propagation logic connects directly to the empirical chapters that follow. Chapter 3 analyzes a court-mandated institutional signal and traces its effect on consumer beliefs in a market where platform infrastructure and market incentives jointly condition how that signal is interpreted. Chapter 4 analyzes a platform-enabled verification technology and examines how it reshapes both buyer behavior and seller disclosure strategy, effects that depend on the institutional and market context in which the technology operates. Together, the two chapters provide causal evidence on how institutional and technological interventions propagate within the information governance framework developed in this chapter.

2.7 Implications for This Thesis

The framework developed in this chapter organizes the mechanisms through which asymmetric information is mitigated into three complementary categories: market-based mechanisms that generate information through decentralized incentives, institutional mechanisms that enforce credibility through formal authority, and technological mechanisms that scale and transform information transmission through digital infrastructure. A central finding of the review is that the effectiveness of any single mechanism depends on its interaction with the others, and that information governance in modern markets is best understood as the product of these interactions rather than the outcome of any mechanism operating alone.

The review has progressively identified two empirical gaps that follow directly from this framework.

The first gap concerns the causal effect of institutional signals on consumer beliefs. The literature establishes that mandatory disclosure can improve information quality and that institutional mandates constrain the strategic manipulation inherent in voluntary disclosure

(Section 2.4). The analysis of CSR disclosure further shows that non-voluntary institutional actions, imposed through legal mandates rather than chosen by firms, generate exogenous variation that mitigates the selection concerns inherent in voluntary settings. What remains empirically unresolved is whether such non-voluntary institutional signals causally influence consumer willingness to pay in secondary markets, where buyers must interpret institutional actions through the lens of market incentives and platform-mediated information environments. This gap motivates Chapter 3, which exploits the court-mandated Volkswagen Zero Emission Vehicle investment plan as an exogenous institutional signal and identifies its causal effect on consumer willingness to pay in the used car market.

The second gap concerns buyer-initiated information acquisition in digitally mediated markets. The review of technological mechanisms (Section 2.5) identifies a residual verification gap: digital platforms reduce the cost of accessing observable information but do not resolve uncertainty about latent quality, the dimension most consequential for adverse selection in markets for complex goods. The review of market-based mechanisms (Section 2.3) further establishes that neither seller-initiated signals nor buyer search can credibly resolve this uncertainty without external verification. What remains empirically open is whether platform-enabled buyer-initiated verification can substitute for or complement seller-provided signals, and how sellers respond strategically to the availability of independent verification. This gap motivates Chapter 4, which exploits the introduction of the WeGoLook inspection service on eBay Motors as a quasi-natural experiment in buyer-initiated information acquisition, examining its effects on transaction prices, price dispersion, and seller disclosure behavior.

Together, the two empirical chapters extend the information governance framework from theoretical synthesis to causal empirical analysis. Chapter 3 tests how an institutional intervention propagates through market and technological channels to affect consumer beliefs. Chapter 4 tests how a technological intervention reshapes both buyer behavior and seller disclosure strategy within the existing institutional and market context. The two chapters therefore provide complementary evidence on different nodes of the interaction framework developed in Section 2.6.

2.8 Conclusion

This chapter has developed an information governance framework for analyzing how asymmetric information is mitigated in markets for complex goods. The framework rests on three propositions.

First, information mechanisms can be organized into three categories, market-based, institutional, and technological, distinguished by their primary source of credibility and enforcement. Market-based mechanisms generate information through decentralized incentives but

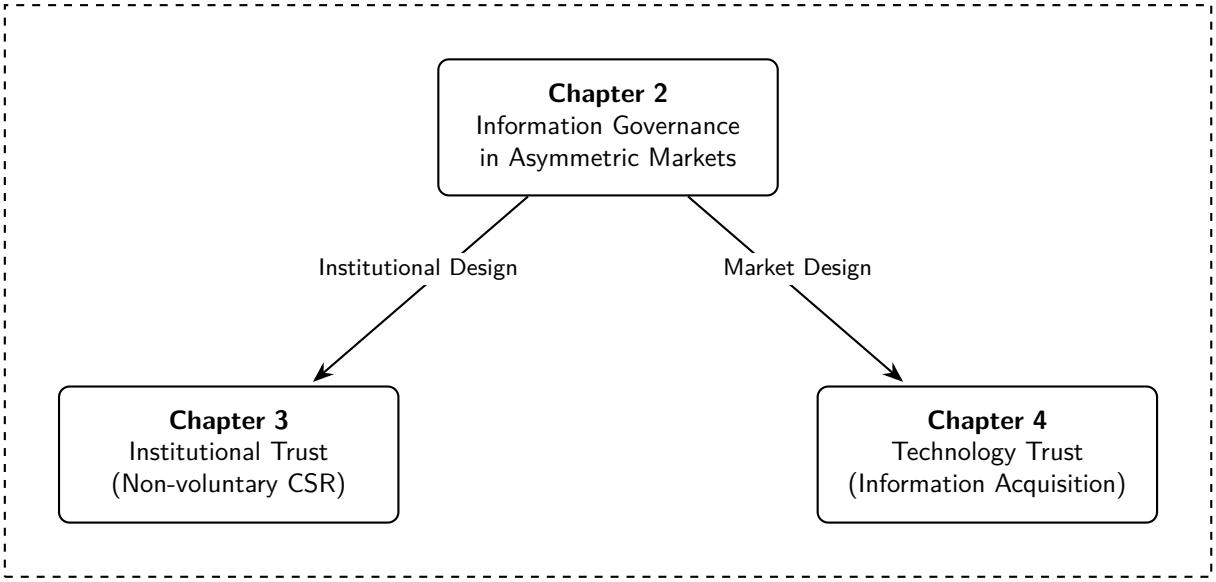

Figure 2.7.1. Thesis Structure: A Coherent Framework

are limited by the verifiability and interpretability of seller-produced signals. Institutional mechanisms enhance credibility through formal authority but face trade-offs between signal precision and market participation. Technological mechanisms scale information transmission through digital infrastructure but introduce new forms of distortion, including reputation manipulation and strategic information overproduction.

Second, these mechanisms are complements rather than substitutes. Institutional rules discipline market signals by constraining misrepresentation. Digital platforms amplify market information while altering its incentive properties. Platform architectures embed institutional enforcement while introducing governance tensions. The effectiveness of any single mechanism is contingent on the functioning of the others.

Third, the interaction between mechanisms generates empirical predictions that cannot be derived from studying any mechanism in isolation. The review has identified two such predictions, each corresponding to an unresolved empirical question: whether non-voluntary institutional signals causally affect consumer beliefs in secondary markets (Chapter 3), and whether platform-enabled buyer-initiated verification can resolve the residual quality uncertainty that persists in digitally mediated markets (Chapter 4).

The contribution of this chapter is not to introduce new theoretical mechanisms but to organize the existing literature into a framework that reveals the interdependence of information governance instruments and derives testable implications from that interdependence. The empirical chapters that follow provide the first causal tests of specific predictions generated

by this framework.

2.9 Future Research Directions

The framework developed in this chapter identifies several directions for future research that extend beyond the scope of the two empirical chapters.

A first direction concerns the dynamic interaction between mechanisms over time. The analysis in this chapter is largely comparative-static: it characterizes how mechanisms interact at a given point in time but does not model how these interactions evolve as markets, institutions, and technologies co-develop. In practice, the introduction of a new platform feature may trigger regulatory responses, which in turn alter market incentive structures. Tracing these dynamic feedback loops, whether through structural models or through longitudinal empirical designs that exploit sequential policy changes, would provide a richer understanding of how information governance systems evolve.

A second direction concerns heterogeneity in mechanism effectiveness across market contexts. The framework developed here draws on evidence from diverse markets, including insurance, restaurants, labor markets, and used cars. Whether the interaction patterns identified, particularly the complementarity between institutional enforcement and technological scaling, hold uniformly across these settings, or whether they depend on market-specific characteristics such as transaction frequency, product complexity, or buyer sophistication, remains an open empirical question. Comparative studies across market settings would help establish the boundary conditions of the framework.

A third direction concerns the welfare implications of platform governance. The review has identified that platforms increasingly function as de facto regulators, embedding institutional rules while pursuing private objectives. The welfare consequences of this shift, specifically whether platform-mediated governance improves or distorts the overall information environment relative to traditional institutional oversight, are not well understood. This question requires analytical tools that integrate platform incentives, regulatory objectives, and consumer welfare within a unified framework, and empirical strategies that can distinguish platform-induced information improvements from platform-induced distortions.

A fourth direction concerns the role of emerging technologies. Algorithmic verification, machine learning-based quality prediction, and blockchain-based provenance systems have the potential to alter the information governance landscape in ways that the current framework does not fully capture. Whether these technologies function as extensions of the technological mechanisms analyzed here, or whether they introduce qualitatively new channels of information production and verification that require an expanded taxonomy, is a question

that will become increasingly relevant as these tools are adopted in consumer markets.

2.10 Limitations

The framework developed in this chapter is subject to several limitations that should be acknowledged.

First, the taxonomy of information mechanisms is an analytical simplification. Classifying mechanisms by their dominant source of credibility and enforcement is useful for organizing the literature and generating testable predictions, but it inevitably involves boundary judgments. Some mechanisms, particularly platform-administered certification and algorithmically generated reputation, straddle the categories in ways that resist clean classification. The framework addresses these cases by classifying according to the dominant credibility source, but this resolution is context-dependent rather than definitive.

Second, the review focuses on information mechanisms that operate on the supply side of information, that is, mechanisms that govern how information is produced, transmitted, and verified. It devotes less attention to the demand side: how buyers process, interpret, and act on the information they receive. Behavioral considerations, including limited attention, cognitive biases in the interpretation of quality signals, and heterogeneity in buyer sophistication, may affect the effectiveness of information mechanisms in ways that the framework does not fully capture. Integrating insights from behavioral economics into the information governance framework would strengthen its predictive power, particularly in consumer markets where information abundance may exceed processing capacity.

Third, the interaction analysis developed in Section 2.6 characterizes pairwise interactions between mechanism categories but does not formally model the joint equilibrium properties of all three operating simultaneously. The closing discussion of that section acknowledges this limitation. While the two empirical chapters provide causal evidence on specific interactions within the framework, a comprehensive empirical test of the full interaction structure, examining how all three mechanism types respond to a single exogenous shock, remains beyond the scope of this thesis.

Fourth, the empirical evidence reviewed in this chapter is drawn predominantly from developed-market settings with well-established legal systems and digital infrastructures. The applicability of the framework to markets with weaker institutional enforcement, lower digital penetration, or different competitive structures has not been assessed. Extending the analysis to such settings may reveal interaction patterns that differ from those identified here, particularly with respect to the complementarity between institutional and technological mechanisms.

Despite these limitations, the framework provides a structured basis for analyzing how information asymmetry is managed across different market environments and for deriving testable predictions about the consequences of institutional and technological interventions. The empirical chapters that follow test two such predictions in the context of the used car market.

Chapter 3

How Does Corporate Social Responsibility Affect Market Outcomes? Evidence From Used Car Market

Abstract

I investigate whether consumers respond to a non-voluntary corporate social responsibility (CSR) practice. I examine the effect of a socially responsible investment plan on used car prices in short-run equilibrium by exploiting an investment plan disclosed by Volkswagen in March 2017. This investment plan, mandated by a decree of the U.S. District Court, aims to promote the adoption of zero-emission vehicle technology in the U.S., representing an exogenous CSR action driven by legal obligation rather than profit motives. Using a difference-in-difference approach, I find a significant increase in final auction price by 13.5 percent for Volkswagen cars compared to other brands, suggesting an increased consumer willingness to pay. However, there is no significant change in short-term transaction volumes following the plan. I interpret the price effect as a result of enhanced quality perception due to the CSR initiative, which boosts consumer willingness to pay. Additionally, I conduct several robustness checks to confirm the reliability of my findings. (JEL D12, D22, D44, L81)

Keywords: Corporate social responsibility, perceived value, consumer willingness to pay, zero-emission technology

3.1 Introduction

Corporate social responsibility (CSR) has become increasingly central to contemporary business practices, reflecting a broader recognition of the correlation between corporate behavior and social welfare. [1] A survey conducted by the Governance & Accountability Institute (G&A) reveals a significant increase in sustainability reporting among major U.S. companies. In 2023, an impressive 99% of S&P 500 firms and 87% of mid-cap Russell 1000 companies published a sustainability report, compared to 98% and 82% respectively the previous year[2]. This growth underscores the rising importance of sustainability practices in the corporate sector, reflecting a broader commitment to environmental, social, and governance (ESG) criteria. As companies increasingly embrace accountability and ethical conduct, there remains a gap in understanding the role of CSR in shaping consumer behavior and market dynamics. Exploring how and to what extent CSR initiatives influence consumer purchasing behavior is crucial for deepening our understanding of firm-consumer interactions. This insight can help firms make more informed managerial decisions and assist policymakers in crafting regulations that foster a business environment conducive to CSR.

This paper investigates the causal impact of a *non-voluntary* CSR action on market outcomes and consumer behavior in the secondary automobile market. The analysis centers on Volkswagen's Zero Emission Vehicle (ZEV) Investment Plan, a court-mandated environmental program introduced after the 2015 Dieselgate emissions scandal. Under the Partial Consent Decree approved by the U.S. District Court for the Northern District of California, Volkswagen was required to invest $2 billion over ten years to promote zero-emission vehicle technology in California and across the United States. The plan, released publicly on March 8, 2017, includes major commitments to charging-infrastructure development, educational outreach, and accessibility programs. A subsequent national version was announced one month later. Because the California plan explicitly referenced the upcoming nationwide investment, the March 8 release date serves as the event point in this study. [3] The timing and nature of this announcement offer a unique quasi-experiment for examining how compulsory CSR influences consumer willingness to pay (WTP) in a short-run market equilibrium.

The ZEV investment plan was mandated by judicial decree, designed to offset environmental harm from Volkswagen's diesel emissions. Its implementation was legally independent of the firm's profit-maximizing decisions or concurrent commercial strategies, thereby mit-

1. For instance, Microsoft has provided high-speed internet access to over 63 million people in underserved areas worldwide since 2017. In China, the technology company Tencent has raised over $4.6 billion in donations through its charity platform, with contributions from more than 800 million users, supporting over 130,000 charity projects.

2. Governance & Accountability Institute, Inc., "2024 Sustainability Reporting in Focus," accessed August 20, 2025, https://www.ga-institute.com/research/ga-research-directory/sustainability-reporting-trends/2024-sustainability-reporting-in-focus/.

3. In Section 3.5, I test the robustness of the main results to the release date.

igating endogeneity concerns common to voluntary CSR actions. Because the plan does not alter the physical quality of vehicles already in circulation, any market response can be interpreted as a change in consumer perception rather than a mechanical improvement in product quality. Moreover, the large financial scale of the investment and extensive media coverage ensure that consumers were broadly aware of the disclosure, enabling the estimation of behavioral responses at the aggregate level. These characteristics allow the ZEV plan to serve as a credible and exogenous shock to consumer beliefs about Volkswagen's environmental responsibility.

I compile detailed auction-level data from eBay Motors covering December 2016 to September 2017. Each observation corresponds to a specific vehicle listing and contains information on car characteristics, seller and buyer attributes, and auction settings. Using this dataset, I estimate a difference-in-differences (DiD) model comparing Volkswagen (treatment group) and non-Volkswagen (control group) vehicles before and after the March 2017 announcement. The short-run horizon of three months before and six months after the event ensures that supply conditions remain effectively fixed, allowing price variations to be attributed primarily to demand-side shifts in consumer valuation. The inclusion of comprehensive vehicle, auction, and participant controls, together with week, month, and location fixed effects, helps isolate the treatment effect of the CSR initiative.

The empirical analysis shows that the announcement of Volkswagen's Zero Emission Vehicle Investment Plan resulted in an average increase of approximately 13.5 percent in final auction prices for Volkswagen vehicles relative to comparable listings of other brands. In contrast, transaction volumes and bidder participation remained statistically unchanged, suggesting that the observed price rise was driven by higher consumer willingness to pay rather than by changes in market participation or supply conditions.

To interpret the observed price increase, I conduct a two-stage analysis. In the first stage, I interpret the price change within a short-run supply-demand framework to show how CSR-induced demand shifts translate into higher equilibrium prices. In the second stage, I examine how corporate social responsibility affects consumers' perceived quality and brand valuation, identifying the micro-level source of the demand shift.

In the short run, the supply of used cars is highly inelastic. Both dealerships and individual sellers face inventory and financial constraints that limit their ability to adjust supply in response to market fluctuations. As a result, price movements in the eBay auction market mainly reflect changes in consumer demand rather than supply-side adjustments. Following the announcement of Volkswagen's Zero Emission Vehicle investment plan, consumers demonstrated a higher willingness to pay for Volkswagen vehicles, which shifted the demand

curve upward and increased the short-run equilibrium price. The empirical evidence supports this interpretation: prices rose while transaction volumes and bidder participation remained stable. These findings indicate that the market response originated from demand-side adjustments triggered by Volkswagen's CSR disclosure rather than from changes in supply.

To understand the source of this demand shift, I decompose consumers' willingness to pay into two components. The first component reflects the valuation of a vehicle's physical attributes, such as age, mileage, and body type. The second component captures the premium associated with brand-related perceptions, including quality, trust, and social responsibility. Before the Dieselgate scandal, Volkswagen had built a strong environmental reputation in North America by promoting its diesel models as fuel-efficient and eco-friendly. This branding strategy strengthened consumers' association of Volkswagen with ecological responsibility. CSR initiatives can enhance this brand-related component by signaling a firm's long-term commitment to ethical and sustainable practices. Such actions improve perceived quality and help restore brand credibility. In Volkswagen's case, the ZEV plan served as a restorative signal of environmental commitment implemented under legal oversight. This initiative helped rebuild consumer confidence that had been weakened by Dieselgate. Overall, this conceptual framework connects the observed market-level price change to micro-level adjustments in perceived value, forming the foundation for the empirical strategy and the interpretation of results.

To validate the interpretation that CSR influenced perceived quality and brand valuation, I first exploit regional heterogeneity in environmental preferences across U.S. Census divisions. The estimated treatment effects are strongest in environmentally conscious regions, such as New England, the Middle Atlantic, and the South Atlantic, where public support for sustainability is historically high. By contrast, the Pacific division, which already possessed extensive zero-emission infrastructure, exhibits an insignificant response, suggesting diminishing marginal effects in markets that are already saturated with environmentally friendly options. These patterns provide initial evidence that the CSR announcement operates through an environmental reputation channel, influencing consumers who place greater weight on environmental attributes.

Building on this insight, the analysis examines whether the CSR-induced price premium varies with the environmental characteristics of vehicles. The effect is concentrated among vehicles with lower emissions proxies, such as smaller engines and non-SUV body types. A triple-difference specification shows that the price response is particularly pronounced for environmentally friendly vehicles within the mainstream segment. This pattern can be understood as a combination of two factors. First, consumers in the mainstream segment

are more likely to balance environmental attributes with other purchase considerations, unlike economy buyers who are primarily price-sensitive or performance buyers who prioritize power. Second, the marginal scope for perceived improvement is greatest in this segment: economy vehicles are already relatively efficient, leaving little room for perception gains, while performance vehicles are structurally high-emission, making CSR signals less credible. Together, these factors explain why the CSR announcement elicits the strongest response among mainstream environmentally friendly vehicles.

The empirical results are robust to a comprehensive set of sensitivity analyzes designed to validate identification and rule out alternative explanations. These tests consistently support the interpretation that the post-announcement price increase reflects a genuine demand-side response to Volkswagen's court-mandated CSR disclosure rather than confounding temporal, spatial, or behavioral factors.

First, using a Synthetic Difference-in-Differences (sDiD) estimator, I confirm that Volkswagen and the control brands exhibited nearly identical pre-treatment price trends, strengthening the comparability of the treatment and control groups. Second, to address potential anticipation or information leakage effects, I exclude observations around the event window and perform a placebo test with an artificially shifted release date. In all cases, the estimated treatment effect remains positive and statistically significant, indicating that the observed price increase is not driven by pre-announcement behavior. Third, an event study reveals no significant pre-trend and a short-lived price surge that peaks two months after the announcement, suggesting a temporary but meaningful shift in consumer perception. Fourth, the results remain stable when alternative model specifications are adopted, including month-by-seller and mileage-interacted fixed effects, which account for localized demand shocks and heterogeneous valuation of vehicle usage. Fifth, the findings remain robust to alternative sample constructions, including restricting the analysis to high-volume brands and excluding outliers in vehicle age and mileage, and are consistent across subsamples categorized by the country or region of brand origin. Additional robustness checks further confirm that the results are not driven by changes in seller strategies (e.g., photo quantity, shipping policies, or starting prices) or by demographic characteristics such as population or housing density at the seller's location.

This study provides causal evidence that even non-voluntary CSR initiatives can enhance consumer valuation in secondary markets. By combining a natural experiment with high-frequency transaction data, it demonstrates how court-mandated CSR actions influence market outcomes through perceived quality and brand equity. This study also yields policy insights which suggest that well-designed regulatory interventions can achieve environmental and social objectives while indirectly restoring consumer trust in the marketplace.

3.1.1 Literature Review

The findings contribute to three strands of literature: the economics of CSR and firm behavior, consumer perception and brand equity formation, and the micro-foundations of demand shifts in short-run equilibrium.

Corporate social responsibility. This paper contributes most directly to the empirical research on the impact of corporate social practices on market outcomes. On the demand side, many empirical studies report significant positive impact of corporate philanthropy (Sen, Bhattacharya, and Korschun 2006; Elfenbein, Fisman, and McManus 2012), corporate environmentalism (Casadesus-Masanell *et al.* 2009), corporate commitment to families, and CSR initiative (Du, Bhattacharya, and Sen 2011) on consumer's willingness to pay. On the supply side, the CSR may affect employee behavior, especially the desire of employees to be employed by a social responsible firms (List and Momeni 2021; Cassar and Meier 2021) or directly impact productivity (Tonin and Vlassopoulos 2015; Gubler, Larkin, and Pierce 2018; Hedblom, Hickman, and List 2019).

Consumer's response toward CSR. This paper also connects to consumers' response to CSR. Studies have presented how consumers' attitudes and purchase behavior respond to CSR, such as consumers' perceptions of the quality of the products provided by responsible companies(Elfenbein, Fisman, and McManus 2012; Besley and Ghatak 2007), purchase intention (Chang 2008; Folse, Niedrich, and Grau 2010; Hainmueller, Hiscox, and Sequeira 2015; Elfenbein, Fisman, and McManus 2019), willingness to pay (Haruvy and Leszczyc 2009; Elfenbein and McManus 2010; Leszczyc and Rothkopf 2010; Elfenbein, Fisman, and McManus 2012; Hainmueller, Hiscox, and Sequeira 2015), bidding behavior in an auction context (Haruvy and Popkowski Leszczyc 2018). Leszczyc and Rothkopf (2010) have shown that it is the higher bidding instead of increased bidder entry that results in significantly higher selling prices in auctions with proportional proceeds donated to charity. Similar to the work of Leszczyc and Rothkopf (2010), I investigated how consumers' willingness to pay is influenced by CSR when the market is in short-term equilibrium and both supply and demand are relatively stable.

Consumer perception. This paper contributes to the understanding of how consumers form perceptions of product quality. Brand equity refers to the additional utility or value that a product derives from its brand name, beyond its physical characteristics (Kamakura and Russell 1993; Park and Srinivasan 1994; Rangaswamy, Burke, and Oliva 1993). Accordingly, prior research suggests that brand equity can be inferred by isolating the portion of total utility that cannot be explained by the product's observable attributes.

The remainder of the paper is organized as follows. Section 3.2 provides the background

of the study and describes the data. Section 3.3 presents the empirical methodology and main results. Section 3.4 outlines the conceptual framework to interpret the observed price change. Section 3.5 discusses the robustness checks. Finally, Section 3.7 concludes the paper, and Section 3.8 highlights the study's limitations and suggests directions for future research.

3.2 Background and Data

3.2.1 Volkswagen Zero Emission Vehicle Investment Plan

The Volkswagen Zero Emission Vehicle investment plan was mandated by the U.S. District Court for the Northern District of California as part of the legal settlement following the Dieselgate emissions case. Its primary objective is to promote zero-emission vehicle infrastructure through investments in charging facilities, educational programs, and accessibility initiatives. On September 18, 2015, the Environmental Protection Agency (EPA) issued a notice to Volkswagen for violating the Clean Air Act. According to the EPA, Volkswagen had installed emission control software, known as a "defeat device," in its model year 2009–2015 2.0-liter diesel cars to circumvent emission standards.[4] As a result, on June 28, 2016, Volkswagen agreed to a settlement of up to $14.7 billion U.S. dollars to address issues related to diesel vehicles that misled customers. The majority of this amount, estimated at around $10 billion U.S. dollars, was allocated to compensate consumers who purchased or leased the affected vehicles in the primary market, which is not directly related to the used car market examined in this paper.

Before the Dieselgate scandal, Volkswagen had cultivated a strong reputation for environmental responsibility in North America, which makes the subsequent emissions violations particularly striking. The company actively promoted its "clean diesel" technology as an eco-friendly alternative to conventional gasoline engines. Marketing campaigns and media coverage emphasized fuel efficiency, reduced carbon emissions, and technological innovation, positioning Volkswagen as a leader in sustainable mobility. For instance, the *2009 Volkswagen Jetta TDI* was named the "Green Car of the Year" by *MotorTrend*[5], and by 2013 Volkswagen and Audi together accounted for 75% of clean diesel vehicle sales in the United States.[6] This sustained emphasis on environmental performance reinforced consumers' perception of Volkswagen as an environmentally responsible automaker, a perception that would later shape their response to the company's CSR-driven investment commitments.[7]

4. These vehicles emitted up to 40 times more nitrogen oxides than regulations allowed.

5. Source: https://www.motortrend.com/features/epcp-0811-2009-vw-jetta-tdi-clean-diesel

6. Source: Volkswagen Group of America CSR Report, March 12, 2014, available at https://media.vw.com/releases/226

7. For supporting evidence, see Table A.6 in the Appendix, which summarizes Volkswagen's major clean diesel promotional activities in North America before September 18, 2015.

As part of the court-mandated settlement, Volkswagen was required to invest $2 billion over ten years in "zero-emission vehicle infrastructure, education, and access activities," with the goal of promoting the adoption of zero-emission vehicle technology across California and other U.S. states. According to the settlement terms, Volkswagen must submit a series of National ZEV Investment Plans to the Environmental Protection Agency (EPA) for approval and to California regulators for state-specific spending.[8] Volkswagen unveiled its first $800 million "California ZEV Investment Plan: Cycle 1" on March 8, 2017, marking one of the largest such commitments to date. A separate $1.2 billion plan for investment outside California was later submitted to the Environmental Protection Agency.[9] These investments focus on infrastructure and educational initiatives rather than on Volkswagen's vehicle production activities, ensuring that their impact remains external to the used car market examined in this paper. The settlement structure also limits potential endogeneity concerns, as the mandated investments target public goods provision rather than profit-maximizing activities related to Volkswagen's automobile sales.

Due to its unprecedented scale and regulatory significance, the ZEV investment plan attracted extensive public and governmental attention. It was widely reported by official sources, including the United States Environmental Protection Agency,[10] state governments such as California[11] and North Carolina,[12] as well as Electrify America, the entity established by Volkswagen to implement the investment program.[13] Such official recognition enhanced the public credibility of the initiative, framing it as a genuine environmental remediation effort rather than a strategic marketing campaign.

Overall, the Volkswagen ZEV investment plan represents a legally mandated environmental remediation program focused on public infrastructure and education rather than vehicle manufacturing. Its design and implementation reduce concerns about endogenous firm behavior, making it a suitable and exogenous setting for examining how CSR-driven initiatives influence consumer perceptions and market outcomes in the used car market.

8. Plans are available at https://www.electrifyamerica.com/our-plan.
9. National ZEV Investment Plan, April 9, 2017.
10. https://www.epa.gov/enforcement/frequently-asked-questions-zero-emission-vehicle-investment, accessed August 23, 2024.
11. https://ww2.arb.ca.gov/our-work/programs/volkswagen-zero-emission-vehicle-zev-investment-commitment/about, accessed August 23, 2024.
12. https://www.deq.nc.gov/about/divisions/air-quality/motor-vehicles-and-air-quality/volkswagen-settlement/volkswagen-mitigation-plan/zero-emission-vehicle-infrastructure, accessed August 23, 2024.
13. https://www.electrifyamerica.com/our-plan/, accessed August 23, 2024.

3.2.2 eBay Car Auction Market

eBay is a world-leading online auction marketplace that achieved an annual gross merchandise volume of $83.4 billion in 2016. eBay Motors, a subsection of eBay dedicated specifically to buying and selling vehicles, is considered one of the most popular online marketplaces for secondhand cars.

eBay features auction-style listings, which are a variation of second-price auctions[14]. I keep auction listings that end up with auction formats in the sample. An auction listing offers various options for listing duration: 1, 3, 5, 7, and 10 days. At the end of an auction, the bidder with the highest price wins the item and pays the second highest bidding price or the starting price, whichever is higher. Sellers on eBay are required to provide information in a standardized format to disclose characteristics of the car listed, including age, mileage, make, body type, and engine type (diesel or gasoline). To increase the chances of a successful sale, sellers can customize their listings by offering free shipping, adding more pictures of the product [15], and providing a detailed description on the listing page.

In a nutshell, eBay, together with the release of the ZEV investment plan, have provided a proper context for conducting quasi-experimental research to examine the impact of the environmentally friendly policies. In the second-price auctions, it is typically a weakly dominant strategy for bidders to reveal their true valuation of the used car. Hence, I can exploit this mechanism and interpret the final auction price as a measure of consumers' willingness to pay in a short-run equilibrium. Additionally, the detailed documentation on eBay allows us to observe the bids of all participating bidders, as well as the characteristics of auctions, sellers, the winning bidder, and used cars themselves. With these informational advantages, I am able to control the impact of unobservable factors to a minimum.

3.2.3 Data and Summary Statistics

I collected data from eBay Motors on successfully sold used cars in the U.S. market between December 1, 2016 and September 30, 2017. Within my sample, I identified a "quasi-experiment" where sellers listed used cars manufactured by Volkswagen group (treatment group) and other manufacturers (control group), covering periods 3-month before and 6-month after the release of the ZEV investment plan. The selection of this time window ensures that I have sufficient in-sample time to observe the impact of the investment plan

14. eBay has expanded beyond its original auction-based model. Sellers now have various options for selling items, including fixed-price listings (known as "Buy it Now"), negotiation options ("Buy it Now" or "Best Offer"), or traditional auctions that are focused on in this paper.

15. When creating a listing of a product, it is essential to include at least one image with a minimum size of 500 pixels on its longest side.

while including as little noise as possible from before the investment plan was released.

For each listing in the sample, observed features of the used cars, including mileage traveled, car make, body type[16]; engine types for gasoline and diesel; car title for clean title and rebuilt title [17]; and year of production, which is used to calculate the age of the car. Additionally, observed multiple characteristics about the seller and those set up by the seller. Seller features include the feedback score and the seller's geographical location at the state level, as well as whether the seller is a dealer or a private seller. Characteristics set up by the seller include starting price; scheduled start and end dates; indicators for listing duration for 1, 3, 5, 7, and 10 days; an indicator for buyer shipping, if the seller provides free shipping; and the number of photos that demonstrate the used car, ranging from 1 to 24. Additionally, observed characteristics related to bidders, including the bidder's feedback score, final price, as well as all other bids submitted by participating bidders.

To narrow down potential confounding factors, I implemented several sample restrictions. First, I eliminate all listings with missing data for key variables, such as start price, car make, and dealership. Second, I include only auction-based transactions, and drop listings using selling methods like "buy it now", posted prices, or those who have a reserve price option. Third, I exclude listings for vehicles with special purposes, such as engineering vehicles, as well as car parts that are not functional vehicles. Finally, I drop cars produced before 1990 and cars with fewer than 100 sales to exclude vintage cars and collectible cars. There are 14606 observations remaining in my sample, and the summary statistics are presented in Table 3.2.1 [18].

On average, the used cars start with a low price at $1988.14 and end up with a relatively higher price at $7374.04. Among the auctions in the sample, only 9% of the shipping fees are paid by sellers. A typical seller uploads around 14 photos of his used car and it attracts approximately 9 bidders to attend the auction. The majority of sellers (57%) set the listing for 7 days. Dealers account for 47% of the listings, and the average seller feedback score is approximately 2474.73, indicating that the majority of sellers on eBay are experienced sellers. The average feedback score for the winning bidder is around 269.17. The sample is fairly balanced before and after the release of the ZEV investment proposal, and 71% of the auctions end after the release. Volkswagen cars take a relatively small share of 7% of the listings. During the sample period, diesel cars account for 5% of the share. The average car

16. Used cars have been classified into four different groups by their features: sedan and hatchback; coupe and convertible; SUV indicates sports utility vehicle; and VAN indicates van and mini trucks.

17. A car with a clear-title has no accidents officially reported by an insurance company, while a rebuilt-title is given to a car that has been repaired and has passed the (U.S) state government inspection.

18. See Table A.3.2 in the Appendix for a comprehensive list of car makes, along with their transaction volumes and corresponding market shares in the sample.

Table 3.2.1. Summary Statistics

Variable	Obs	Mean	S.D.	Min	Max
Auction listing characteristics					
Start price	14606	1988.14	5231.12	0	128000
Final price	14606	7374.04	9102.86	1	128000
Buyer shipping	14606	0.91	0.28	0	1
Number of pictures	14606	14.35	7.42	0	24
Number of bidders	14606	9.28	6.15	1	33
Listing duration (3 days)	14606	0.22	0.41	0	1
Listing duration (5 days)	14606	0.16	0.37	0	1
Listing duration (7 days)	14606	0.57	0.50	0	1
Listing duration (10 days)	14606	0.06	0.23	0	1
Release	14606	0.71	0.45	0	1
Volkswagen	14606	0.07	0.25	0	1
Seller and buyer characteristics					
Dealer	14606	0.47	0.50	0	1
Seller feedback score	14606	2474.73	4909.78	1	167401
Bidder feedback score	14606	269.17	1301.32	1	119765
Used car characteristics					
Diesel	14606	0.05	0.22	0	1
Car age (years)	14606	12.13	6.52	1	27
Mileage	14606	127133.88	830743.81	1	99999999
Clean	14606	0.84	0.37	0	1
Rebuilt	14606	0.16	0.37	0	1
Sedan and Hatchback	14606	0.40	0.49	0	1
Coupe and Convertible	14606	0.17	0.37	0	1
Suv	14606	0.24	0.43	0	1
Van	14606	0.18	0.39	0	1

Notes: All dummy variables are introduced below. *Buyer shipping* equals one if the buyer covers shipping costs, and zero otherwise. *Reserve price* equals one if the auction has an undisclosed threshold price, meaning the product will not be sold unless this price is met. Otherwise, it equals zero. *Listing duration* indicates how long an auction lasts, and it equals $i (i = 3, 5, 7, 10)$ if the auction lasts i days. *Release* is the event indicator, and it equals one if the auction listing ends after the introduction of the CSR, and zero otherwise. *Volkswagen* equals one if the used car in the auction listing is a Volkswagen car, and zero otherwise. *Dealer* equals one if the seller is a dealership, and zero otherwise. *Diesel* equals one if the car is a diesel engine vehicle, and zero if it is a gasoline vehicle. *Clean* and *Rebuilt* are binary variables indicating the title status of the car according to eBay. *Sedan and Hatchback*, *Coupe and Convertible*, *SUV* and *Van* are all car body type indicators, and they equal one if a used car belongs to that kind of body type.

year is approximately 12.13 years, and the average miles traveled is around 127133.88 miles. Most used cars in the sample have a clean title—84% have a clean title and 16% are rebuilt cars. I classify the listings into four groups by body types: Sedan and Hatchback (40%); Coupe and convertible (17%); SUV (24%); and Van (18%).

In Table A.3.4 of the appendix, I also display the summary statistics for the treatment group (Volkswagen cars) and control group (Non-Volkswagen cars) before and after the announcement of the ZEV invention. There is a slight difference in average start price before and after the release ($1976 and $1916), while the average final price increased by $334 after the release of the plan ($8067 and $8401). The mean characteristics for the car did not change significantly before and after the release. The mean age is around 12 years for both groups, and the mean traveled mileage is $122,155$ miles and $112,111$ miles, respectively. The feedback scores of sellers and bidders have increased – sellers from 1775 to 2028 and buyers from 243 to 271 – suggesting the market players have gained more experience within the sample period. The market share of Volkswagen increased from 4% to 5% after the publication of the investment plan. All other features of the auction listing are similar before and after the release shock.

3.3 Empirical Analyzes

In this section, I empirically examine the effect of the CSR initiative on price and quantity outcomes in the short-run equilibrium of the used car auction market.

3.3.1 The Impact on Transaction Price

I first examine the short-run equilibrium price effects of Volkswagen's ZEV investment plan disclosure on the online used car market. In durable goods markets such as automobiles, the short run typically spans several months to one year. At this time horizon, analyzing how external shocks influence used car prices allows for leveraging the relative stability of market fundamentals, thereby minimizing the confounding effects of changes in supply and demand conditions.

On the demand side, the used car market tends to remain in a dynamic but stable equilibrium, with no structural shifts occurring within a short period. Buyers in this market are often subject to financial constraints and face substantial search frictions (Hortaçsu, Martínez-Jerez, and Douglas 2009). Consequently, large-scale entry or exit of potential buyers (dealers) is unlikely to occur in the short run. On the supply side, inventory adjustments are restricted by multiple real-world frictions, making it difficult for most sellers to simultaneously alter their inventories in response to brand-specific shocks. Individual sellers face

constraints imposed by vehicle replacement cycles and transaction costs (Berkovec 1985)[19], while professional dealers operate under fixed logistical capacities and face menu costs when adjusting listing strategies, such as starting prices and promotional terms. As a result, aggregate supply at the brand level largely reflects existing vehicle registrations and persists as a predetermined stock (Stolyarov 2002).

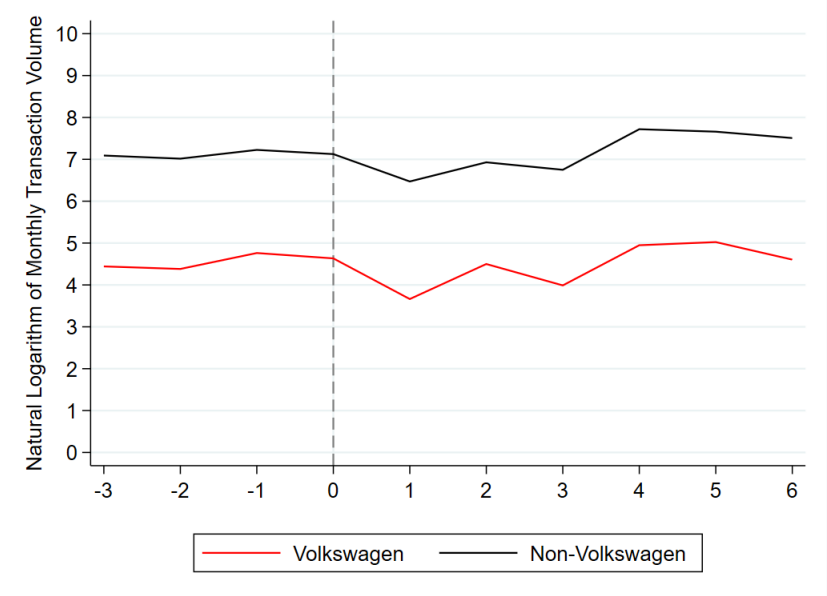

Figure 3.3.1. The Logarithm of Monthly Transactions

Figure 3.3.1 illustrates the short-run dynamics described above, showing monthly transaction volumes for both treatment and control groups before and after the CSR announcement. The vertical line at the origin marks the release of the investment plan in March 2017, and the horizontal axis measures the time elapsed between each auction's end date and the release date. The two broken lines, shown in red for Volkswagen-branded vehicles and in black for non-Volkswagen vehicles, represent the monthly sales volumes of the two groups. The figure reveals an almost perfectly parallel trend before and after the disclosure, suggesting that bidder switching between the two groups was minimal. Section 3.3.2 later presents additional evidence on the stability of bidder entry and bidding behavior.

This observed stability aligns with existing empirical evidence, highlighting that short-run price movements predominantly reflect demand-side shifts rather than supply adjustments. List (2004) shows that dealer-level supply elasticities on platforms such as eBay Motors rarely exceed 0.2 in the short run, as inventory replenishment is constrained by production cycles. Such inelasticity implies that short-run price responses to demand shocks, including

19. For related discussions on supply inelasticity in equilibrium, see Brancaccio, Kalouptsidi, and Papageorgiou (2025).

those triggered by corporate social responsibility disclosures, mainly reflect changes in consumer willingness to pay rather than adjustments on the supply side. In contrast, long-run adjustments, such as the gradual substitution of traditional vehicles with new energy models, typically unfold over several years and are driven by structural changes in the new car market, which subsequently spill over to the used car market. Focusing on short-run dynamics therefore helps to minimize potential confounding effects arising from brand-specific shifts in supply and demand.

Building on this understanding of short-run market rigidity, the following difference-in-differences specification formalizes the estimation strategy to quantify the CSR effect on prices. Specifically, the benchmark specification is formulated as follows.

$$\begin{aligned} ln(Price)_i \;=\; & \beta_0 \;+\; \beta_1 Release_i \;+\; \beta_2 Volkswagen_i \;+\; \beta_3 Release_i \times Volkswagen_i \\ & +\; Controls_i \;+\; \tau_m \;+\; \tau_w \;+\; \delta_s \;+\; \mu_j \;+ \epsilon_i; \end{aligned} \tag{3.1}$$

Each component of equation 3.1 is carefully defined to capture the relevant treatment, control, and interaction effects, as well as the observable characteristics that could influence auction prices. The Subscript i denotes an auction listing. The variable $Release_i$ is a dummy equal to one if the auction ends after the announcement of the ZEV investment plan on March 8, 2017, and zero otherwise. $Volkswagen_i$ is a dummy variable equal to one if the listed car belongs to the Volkswagen brand family (includes Volkswagen and Audi), and zero otherwise. This variable captures the distinction between the treatment group (Volkswagen vehicles) and the control group (non-Volkswagen vehicles). The interaction term $Release_i \times Volkswagen_i$ is the variable of interest, equal to one for Volkswagen cars auctioned after the disclosure of the CSR initiative. The ZEV investment plan represents a non-voluntary initiative by Volkswagen, as discussed in Section 3.2. The coefficient β_3 associated with this interaction term measures the change in price following the announcement of the ZEV investment plan, reflecting the effect of this non-voluntary CSR action on consumers' willingness to pay.

Importantly, the CSR initiative represents an exogenous event with respect to Volkswagen's profit-maximizing behavior, which reinforces the credibility of the causal interpretation. A systematic review of Volkswagen's public communications from 2009 to September 2015 reveals no evidence of any announced electric vehicle or zero-emission investment plans in the United States, indicating that the company's strategic focus before the Dieselgate scandal lay largely outside the U.S. market (see Appendix Table A.7.1 for details). According to the judicial document, the plan's primary objective was to promote zero-emission vehicle technology and public education. It operated independently of Volkswagen's commercial strategies for diesel and gasoline models. Moreover, Volkswagen's subsequent investment in

zero-emission infrastructure in the United States was unrelated to its core vehicle production activities and represented a non-voluntary initiative mandated by the U.S. District Court (see Appendix Table A.7.2 for details). Therefore, the event can reasonably be regarded as exogenous to Volkswagen's profit-maximizing behavior and unlikely to exert any direct influence on used-car sales.

To further isolate the effect of the CSR initiative, a comprehensive set of control variables is included, encompassing vehicle features, auction participants, and listing characteristics. Regarding vehicle characteristics, key controls are incorporated to ensure comparability between the treatment and control groups. Specifically, the natural logarithm of car age ($\ln(Car\ age)_i$) and the natural logarithm of mileage ($\ln(Mileage)_i$) are included, as these two factors primarily determine the market value of a used car. Engine type is controlled for using a dummy variable, $Diesel_i$, which equals one if the vehicle is diesel-powered and zero otherwise. Additional dummy variables capture car title status ($Clean$ or $Rebuilt$), accounting for buyers' differing attitudes toward vehicles that have undergone major repairs.

For the main auction participants, controls are included for both the winning bidder and the seller. A dealer dummy variable, $Dealer$, equals one if the seller operates as a dealership, thereby distinguishing professional sellers from individual ones. In addition, the feedback scores of both sellers and winning bidders are incorporated to capture variation in experience and reputation within the auction environment.[20]

A third group of controls captures the characteristics of the auction listing itself. These include the natural logarithm of the starting price, which serves as another important indicator of the vehicle's underlying value, and the natural logarithm of the number of pictures displayed on the auction page, reflecting the amount of information available to potential buyers. A buyer-shipping dummy variable is included, taking the value of one if the winning buyer bears the shipping cost, to account for differences in the additional services provided by sellers. To ensure comparability in the competitive environment across listings, the natural logarithm of the number of bidders is added as a control for auction competitiveness. Finally, a set of dummy variables indicating listing durations of $n = 3, 5, 7$, and 10 days is incorporated to equalize exposure time across listings and mitigate biases arising from differences in auction length.

Additionally, time, spatial, and brand fixed effects are incorporated to account for unob-

20. Because most sellers are relatively experienced platform users, their feedback scores tend to be higher and exhibit greater variance. To prevent the magnitude of these scores from exerting disproportionate influence on the results, the logarithmic form is used. In contrast, buyers' scores are typically lower and display limited variation, and preliminary analysis suggests that buyer feedback has little effect on the final auction price; thus, the non-logarithmic form is retained.

served heterogeneity that may simultaneously influence demand and supply. Specifically, month (τ_m) and week fixed effects (τ_w) are included to capture temporal variations. The week fixed effects absorb short-term behavioral fluctuations in market activity and cyclical patterns linked to weekly or biweekly pay cycles, short-term promotions, and potential weekend effects. The month fixed effects control for broader macroeconomic and seasonal factors, such as fuel price movements and other time-varying demand shocks. State fixed effects (δ_s) account for cross-state differences in demand structures, while car make fixed effects (μ_j) capture manufacturer-specific heterogeneity, including differences in brand reputation, perceived quality, and consumer loyalty. Standard errors are clustered at the car-make level. Subsection 3.5 presents robustness checks using alternative combinations of fixed effects.

The empirical strategy is further strengthened by sample restrictions and historical checks. First, the sample is limited to transactions completed through auctions rather than fixed-price or hybrid listings with undisclosed reserve prices. Second, the CSR announcement was not intended to stimulate sales of existing Volkswagen vehicles. This restriction allows for a cleaner identification of variations in buyers' willingness to pay associated with the CSR initiative.

Table 3.3.1 reports the estimation results for equation 3.1. Column (1) includes only $Release_i$, $Volkswagen_i$, their interaction term, the natural logarithm of the auction start price, and car-make fixed effects. Column (2) adds controls for all covariates, including used car characteristics, auction listing features, and both seller and buyer attributes, along with body type fixed effects. Column (3) further incorporates week and month fixed effects, while column (4) additionally includes seller (location) fixed effects.

The primary variable of interest is the interaction term, $Release_i \times Volkswagen_i$, which captures the effect of the CSR initiative release on consumers' willingness to pay for Volkswagen vehicles. Across all specifications, this coefficient remains positive and statistically significant at the 1% level, confirming the robustness of the results. In column (4), the interaction term suggests that the CSR initiative's release corresponds to a 13.5% increase in consumers' willingness to pay, after accounting for all covariates and fixed effects. Among the variables included in the regressions, key characteristics of used cars, such as car age and mileage, are negatively associated with the final auction price. In contrast, auction listing features determined by sellers, including the number of pictures and listing duration, show a positive relationship with the final price. Additional factors, such as a higher number of bidders, the seller operating as a dealership, and the presence of a diesel engine, are also associated with higher prices. Due to space constraints, the full estimates for all covariates are reported in Table A.3.1 in the Appendix.

Table 3.3.1. The Impacts of the CSR on Price in Short-term Equilibrium

Dep. var: ln(Price)	(1)	(2)	(3)	(4)
Release×Volkswagen	0.116***	0.126***	0.124***	0.135***
	(0.03)	(0.04)	(0.04)	(0.04)
Volkswagen	-0.129***	-0.539***	-0.542***	-0.555***
	(0.02)	(0.05)	(0.05)	(0.04)
Release	-0.028	0.024	0.067	0.017
	(0.03)	(0.01)	(0.23)	(0.23)
Car Make FE	Yes	Yes	Yes	Yes
Body type FE	No	Yes	Yes	Yes
Week FE	No	No	Yes	Yes
Month FE	No	No	Yes	Yes
Seller FE	No	No	No	Yes
R^2 (within)	0.11	0.71	0.71	0.73
N	14606	14606	14606	14606

Notes: *Release* is a dummy variable and reflects the CSR, which equals one if the auction listing ends after the introduction the Volkswagen ZEV investment plan (March 8, 2017); otherwise zero. *Volkswagen* is a dummy variable equaling one if the car is a Volkswagen car, and zero otherwise. Control variables are presented in Table A.3.1 of Appendix. Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

3.3.2 The Impact on Unit Sales and Bidder Entry

Having established that the CSR initiative significantly increased consumers' willingness to pay, I next investigate whether this effect translated into changes in transaction quantities and bidder behavior in the short-run equilibrium. I aggregate daily transactions by car make and use the aggregated daily sales for each car make as the outcome variable $ln(Daily\ Listing)$.

$$\begin{aligned} ln(Daily\ listing) \;=\; & \lambda_0 \;+\; \lambda_1 Release \;+\; \lambda_2 Volkswagen \;+\; \lambda_3 Release \times Volkswagen \\ & +\; AvgControls \;+\epsilon; \end{aligned} \tag{3.2}$$

The covariates ($AvgControls$) in equation 3.2 include daily average characteristics of the car, auction listing, seller, and buyer. Specifically, they consist of the natural logarithms of the number of photos, sellers' feedback scores, start price, car age, traveled mileage; number of participating bidders, and feedback score of the winning bidders; a dealership dummy; a buyer shipping dummy; a diesel engine dummy; and listing duration dummies. The coefficient of the interaction term, λ_3, captures the change in daily transaction volume for Volkswagen cars before and after the CSR initiative. As shown in Table 3.3.2, the coefficients are insignificant across specifications, suggesting minimal change in short-run transaction quantities.

To ensure these results are not driven by systematic changes in bidders' participation, I next examine bidder entry behavior. I perform regressions using both the number of bidders and the natural logarithm of the number of bidders as dependent variables. Table 3.3.3 reports the results. The coefficient of interest, $Release \times Volkswagen$, is not significant in either specification, indicating that bidders' entry decisions remained stable before and after the CSR initiative.

Together, these findings indicate that the CSR initiative raised consumers' willingness to pay without affecting short-run transaction volumes or bidder participation. This pattern suggests a demand-driven price adjustment under an inelastic short-run supply, implying that consumers' valuation of Volkswagen vehicles increased after the announcement. Building on these observations, the next section develops a conceptual framework to interpret this demand-side response and explore the mechanism through which corporate social responsibility influences consumers' willingness to pay.

Table 3.3.2. The Impact of CSR on Daily Transaction Quantity in Short-run Equilibrium

Dep. var: ln(Daily listing)	(1)	(2)	(3)	(4)
Release×Volkswagen	-0.175	-0.145	-0.144	-0.123
	(0.11)	(0.10)	(0.10)	(0.10)
Volkswagen	-2.541***	-2.575***	-2.576***	-2.553***
	(0.09)	(0.08)	(0.08)	(0.10)
Release	0.342***	0.756***	0.753***	0.711***
	(0.07)	(0.23)	(0.23)	(0.23)
Week FE	No	Yes	Yes	Yes
Month FE	No	Yes	Yes	Yes
Start price	No	No	Yes	Yes
Other controls	No	No	No	Yes
R^2 (within)	0.83	0.86	0.86	0.87
N	512	512	512	512

Notes: Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table 3.3.3. The Impact of CSR on Bidder Entry in Short-run Equilibrium

Dep. var: (1) Number of Bidders Dep. var: (2) ln(Number of Bidders)	(1)	(2)
Release×Volkswagen	-0.233	-0.005
	(0.17)	(0.02)
Volkswagen	-0.515***	-0.064***
	(0.12)	(0.01)
Release	0.015	-0.136
	(2.42)	(0.26)
Fixed Effects	Yes	Yes
R^2 (within)	0.44	0.46
N	14606	14606

Notes: The dependent variable in column (1) is the number of bidders in an auction listing. In column (2), the dependent variable is the natural logarithm of the number of bidders. Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

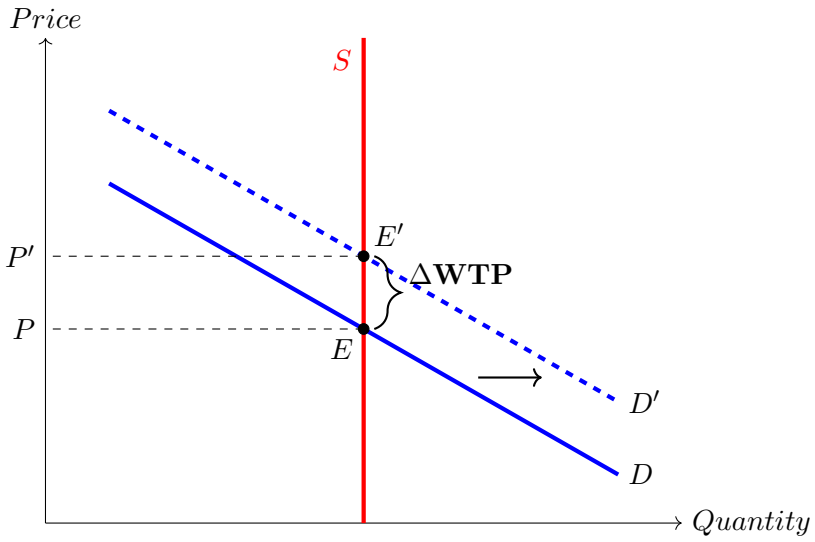

Figure 3.4.1. The effect of the CSR on the Volkswagen Vehicles in short-term equilibrium

3.4 Mechanism Analysis

The previous section provides evidence that the disclosure of Volkswagen's ZEV investment plan significantly increased auction prices, while transaction quantities and bidder participation remained stable. This pattern indicates that the price effect stems primarily from the demand side rather than supply adjustments or market participation changes. Understanding this mechanism clarifies how CSR actions are transmitted through consumer demand and influence market equilibrium outcomes.

To examine this mechanism, I conduct a two-stage analysis. First, I interpret the observed price increase within a short-run supply-demand framework, illustrating how CSR-induced demand shifts translate into higher equilibrium prices. Second, I analyze how corporate social responsibility (CSR) affects consumers' perceived quality and brand valuation, thereby identifying the micro-level source of the demand shift.

3.4.1 Willingness to Pay

To interpret the empirical results, I first analyze how changes in consumers' willingness to pay are reflected in the short-run equilibrium of the eBay auction market. Figure 3.4.1 illustrates this relationship within a standard supply–demand framework, where changes in final prices can be interpreted as movements along or shifts of the demand curve.

Previous research has shown that the supply of used cars is inelastic (Busse, Knittel, and Zettelmeyer 2013; Gillingham, Houde, and Van Benthem 2021). Within my sample period

(3 months before and 6 months after the event date), significant adjustments in supply are unlikely. In my sample, 47% of the cars are sold by dealerships, whose supply is largely fixed due to constraints like complex supply chains, inventory capacity, and financial limitations. Thus, fundamental changes in dealership supply during this short timeframe are impractical. For individual sellers, selling a used car, which is a durable good, requires careful financial consideration. Since most individual owners sell their cars for personal or financial reasons rather than as part of a continuous business activity, their listing decisions are largely independent of short-term market fluctuations. It is therefore unlikely that a large number of individual sellers on eBay would systematically adjust their buying or selling strategies in the short run. If such systematic adjustments had occurred, the nearly parallel monthly sales trends of Volkswagen and other brands shown in Figure 3.3.1 would not have been observed. Consequently, the supply of used cars remains relatively stable, reflecting the stock accumulated through past transactions.

This stability on the supply side, represented by the red vertical supply curve S in Figure 3.4.1, implies that any observed change in prices must originate from the demand side rather than from adjustments in supply. Under this condition, variations in final prices can be interpreted as shifts in consumer demand. Before the release of the investment plan, the short-run equilibrium is located at point E with an equilibrium price of P. Following the announcement, consumers exhibit a higher willingness to pay for Volkswagen vehicles, leading to an upward shift in the demand curve from D to D'. The new equilibrium moves from E to E', resulting in a higher equilibrium price, P'. In this framework, the price difference $(P' - P)$ provides a reliable measure of the increase in consumers' willingness to pay, ΔWTP. This interpretation aligns with the empirical evidence, which shows that prices increased while transaction quantities and bidder entry remained stable. The next subsection further examines the underlying mechanism behind this demand shift by analyzing how CSR actions influence consumers' valuation of the brand.

3.4.2 Quality Perception and CSR Impact

Having established that the observed price increase reflects a demand shift, I now explore the underlying cause of this shift. Specifically, I examine how CSR influences consumers' perceived quality and brand equity, thereby shaping their willingness to pay.

According to previous research, the utility of a brand is composed of both its physical attributes and its brand equity (Grover and Srinivasan 1992; Kamakura and Russell 1993; Rangaswamy, Burke, and Oliva 1993; Simon and Sullivan 1993), as illustrated in Equation 3.3. On the left-hand side, WTP_i indicates consumers' willingness to pay for a branded product i, which can be disentangled into two components. The first component is the

willingness to pay for the physical attributes of the product, $WTP_{\text{Physical}}(X_i)$, where X_i refers to characteristics such as car age, mileage, make, and body type. The second component, $WTP_{\text{Brand Equity}}(B_i)$, represents consumers' willingness to pay for the brand equity of product i, which depends on brand-related factors B_i.

$$WTP_i = WTP_{\text{Physical}}(X_i) + WTP_{\text{Brand Equity}}(B_i) \tag{3.3}$$

This mechanism is particularly plausible in the case of Volkswagen, whose brand image and product positioning have long emphasized environmental performance. Prior to the Dieselgate scandal, Volkswagen actively promoted its clean diesel technology as a fuel-efficient and environmentally friendly alternative to conventional gasoline engines. Vehicles such as the *Volkswagen Jetta TDI* were widely marketed for their low emissions and superior fuel economy, earning environmental awards and recognition from industry organizations. As a result, many consumers associated Volkswagen with advanced green technology and ecological responsibility. In this context, the company's subsequent investment in zero-emission vehicle infrastructure could have partially restored or reinforced these prior beliefs about its environmental commitment. Consequently, consumers may have interpreted the ZEV investment plan as credible evidence of quality improvement, thereby enhancing their willingness to pay for Volkswagen vehicles in the used car market.

Yoo, Donthu, and Lee (2000) identify perceived quality as a critical component of a company's brand equity. Additionally, Boulding and Kirmani (1993) demonstrate that a firm's actions can significantly shape consumers' perceptions of quality[21], as illustrated in Equation 3.4. In this study, I examine how Volkswagen's announcement of an investment plan—framed as a non-voluntary socially responsible behavior—affects consumers' perceptions of the quality of Volkswagen's used cars. By analyzing variations in consumer willingness to pay, I empirically assess how perceptions of quality, influenced by corporate social responsibility, impact consumer behavior, as detailed in Equation 3.5.

$$\begin{aligned} WTP_i = {} & WTP_{\text{Physical}}(X_i) + WTP_{\text{Perceived Quality}}(CSR_i) \\ & + WTP_{\text{Brand Equity}}(B_{(-1)}i) \end{aligned} \tag{3.4}$$

where WTP_i represents the total willingness to pay (WTP) for product i; $WTP_{\textbf{Physical}}(X_i)$ captures the portion attributed to physical attributes; $WTP_{\textbf{Perceived Quality}}(CSR_i)$ represents the component of WTP driven by perceived quality influenced by CSR actions (CSR_i corresponds to the investment plan in this study); and $WTP_{\textbf{Brand Equity}}(B_{(-1)i})$ represents residual brand equity unrelated to CSR effects, including reputation, loyalty, and past per-

21. Previous research (Besley and Ghatak 2007; Bénabou and Tirole 2010; Du, Bhattacharya, and Sen 2011) suggests that corporate responsible behavior can influence buyers' attitudes toward a firm's products, akin to the mechanism of corporate reputation.

formance.

$$\Delta WTP_i = \Delta WTP_{\text{CSR}_i} \tag{3.5}$$

where ΔWTP_i represents the change in willingness to pay for product i as a result of changes in the firm's CSR actions. $\Delta WTP_{\text{CSR}_i}$ captures the variation in willingness to pay specifically due to the impact of the CSR investment plan.

Overall, the findings suggest that Volkswagen's CSR disclosure primarily operated through a demand-side channel, elevating consumers' perceived quality and brand valuation without altering supply or market participation. In the following section, I test this interpretation using regional heterogeneity in environmental preferences across U.S. states and subsequently assess the robustness of the results under alternative model specifications.

3.4.3 Heterogeneous Effects Across Regions

The baseline results indicate that Volkswagen's announcement of the Zero Emission Vehicle investment plan led to a significant increase in the prices of Volkswagen vehicles relative to comparable vehicles from other manufacturers. One potential mechanism underlying this effect is that the announcement strengthened Volkswagen's environmental reputation, which in turn increased consumers' willingness to pay for vehicles perceived as environmentally friendly. If this interpretation is correct, the price response should be stronger in environmentally conscious states compared with states that are more reliant on traditional energy sources. This cross-state heterogeneity provides a natural setting for empirically testing the proposed mechanism..

To test this hypothesis, I use the regional classification system defined by the United States Census Bureau, which divides the country into four regions and nine divisions (U.S. Census Bureau, n.d.). This standardized and stable framework is widely adopted in federal data reporting and academic research, ensuring comparability across studies.[22] Following this standard, I divide the sample into nine regional groups and re-estimate Equation 3.1 separately for each division. Because most eBay Motors transactions occur within state borders, the seller's location serves as a reasonable proxy for both the transaction and consumer location. Although some cross-state transactions exist, their proportion is small. Moreover, the Census Bureau's divisions aggregate neighboring states with similar market structures, effectively capturing regional variations in environmental preferences and consumer attitudes

22. Due to its stability and general applicability, this classification has been extensively used across disciplines, including social sciences and economics (Bishop, Lee, and Zeager 2015; Mencarini *et al.* 2018), public health and policy (Jimenez *et al.* 2025; Hu *et al.* 2025), and cultural studies (Kittler, Sucher, and Nahikian-Nelms 2017).

toward CSR.

Table 3.4.1. Heterogeneous Effects – Regions and Districts

Dep. var: ln(Price)	New England (1)	Middle Atlantic (2)	East North Central (3)	West North Central (4)	South Atlantic (5)
Release×Volkswagen	0.209*	0.207**	-0.066	-0.547	0.192***
	(0.12)	(0.10)	(0.04)	(0.36)	(0.06)
Volkswagen	-0.553***	-0.687***	-0.679***	0.987	-0.821***
	(0.19)	(0.08)	(0.09)	(0.75)	(0.05)
Release	0.395	-0.527	-0.497**	-0.962	-0.046
	(0.30)	(0.53)	(0.21)	(0.66)	(0.13)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2 (within)	0.63	0.54	0.74	0.63	0.57
N	581	2654	3176	220	3136

Dep. var: ln(Price)	East South Central (6)	West South Central (7)	Mountain (8)	Pacific (9)
Release×Volkswagen	-0.223	-0.205	0.220	0.032
	(0.42)	(0.13)	(0.39)	(0.10)
Volkswagen	-1.555***	-1.244***	-0.451	-0.184**
	(0.43)	(0.17)	(0.33)	(0.07)
Release	-1.245*	-0.029	-0.681	-0.006
	(0.63)	(0.38)	(0.79)	(0.09)
Fixed Effects	Yes	Yes	Yes	Yes
R^2 (within)	0.55	0.54	0.57	0.78
N	267	632	338	3602

Notes: Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table 3.4.1 presents the regional estimation results. The coefficient of the interaction term $Release \times Volkswagen$ is positive and statistically significant in the New England, Middle Atlantic, and South Atlantic divisions, indicating stronger consumer responses in environmentally conscious areas. These regions include states such as Massachusetts, New York, Pennsylvania, and Florida, which have long histories of environmental advocacy and policy initiatives that promote clean energy. The higher awareness of environmental issues in these regions likely makes consumers more responsive to Volkswagen's zero-emission investment plan, thereby increasing their willingness to pay for its vehicles.

By contrast, the coefficient is insignificant in the Pacific division, which includes California. This region already had a mature zero-emission infrastructure, with more than $599 million in ZEV investments by 2017[23]. Consequently, the marginal impact of Volkswagen's additional commitment was limited. These results indicate that the investment plan primarily shifted consumer demand in regions where environmental awareness was increasing but not yet fully internalized, rather than in markets where such awareness and infrastructure were already saturated.

3.4.4 Heterogeneous Effects Across Vehicle Environmental Characteristics

The previous subsection shows that the CSR announcement generated stronger price responses in regions with higher levels of environmental awareness. This finding suggests that heterogeneous environmental preferences may play an important role in shaping consumer responses to Volkswagen's ZEV investment plan. To further examine this mechanism, this section investigates whether the CSR effect varies systematically with the environmental characteristics of vehicles.

To support this analysis, we extract information on engine capacity from the textual descriptions in the dataset. Among the 14,606 observations in the main sample, valid engine capacity information is successfully obtained for 10,903 observations. In addition, observations corresponding to vehicles equipped with turbocharged or other forced-induction engines are excluded in this subsection. While such technologies can improve fuel efficiency by enabling smaller engines to deliver higher performance, they are also associated with higher prices and enhanced performance characteristics. As a result, their inclusion may confound the interpretation of engine capacity as a proxy for environmental performance. Restricting the sample in this way allows for a cleaner identification of the environmental mechanism. It is important to note that this restriction is applied only in the mechanism analysis. The baseline specifications include the full sample to capture the overall market response to the

23. For further details, refer to the data source: California Surpasses Half-Billion Dollar Mark in Investments for Zero-Emission Vehicles, accessed September 2, 2024.

CSR announcement. In contrast, the objective here is to isolate variation in environmental attributes, for which a more refined sample definition is appropriate.

Building on this refined sample, certain technical attributes of vehicles are closely associated with environmental performance. In particular, body type and engine capacity are strongly correlated with fuel consumption and emissions. Larger vehicle types, especially sport utility vehicles (SUVs), vans, and mini trucks, tend to exhibit higher fuel consumption due to their weight and design characteristics. Engine capacity provides an additional proxy for environmental performance, as larger engines are typically associated with higher fuel consumption and emissions. Consistent with this classification, SUVs have significantly larger engines than non-SUV vehicles, averaging 4.0 liters compared with 3.2 liters for non-SUVs ($P < 0.01$). Combining these attributes therefore allows the analysis to approximate the environmental characteristics of vehicles.

Based on these considerations, vehicles are classified according to two attributes: body type and engine capacity. First, body types are divided into two broad categories. SUVs, vans, and mini trucks are grouped as large-body vehicles because they are generally heavier and tend to exhibit higher fuel consumption. All remaining body types, including sedans, hatchbacks, coupes, and convertibles, are grouped as passenger vehicles. These vehicles are typically smaller and lighter, and therefore tend to have lower average emissions.

Second, engine capacity is divided into terciles of the empirical distribution: *economy* ($1.0 - 3.0$ liters), *mainstream* ($3.1 - 4.0$ liters), and *performance* (above 4.0 liters). This classification balances economic interpretability and empirical tractability. In the sample, engine capacity ranges from 1.0 to 8.4 liters. A binary split would group together vehicles with substantially different environmental performance, thereby obscuring meaningful variation. Conversely, a finer partition would generate overly narrow categories that are difficult to interpret economically. The tercile-based classification therefore provides a parsimonious way to capture heterogeneity in environmental characteristics.

In the following analysis, vehicles in the lower two groups are classified as having relatively small engines, which are typically associated with lower fuel consumption and emissions. As discussed in Appendix A.5, additional evidence supports this classification and its relevance for capturing environmental heterogeneity.

Using these criteria, a vehicle is classified as a green vehicle if it satisfies two conditions simultaneously: it has a relatively small engine and it does not belong to the SUV category. Formally, the indicator variable $Green_i$ equals one if the vehicle belongs to the lower two engine-capacity groups and its body type is not an SUV, and zero otherwise. This defini-

tion captures vehicles that are more likely to exhibit environmentally friendly technological attributes while maintaining sufficient sample size for reliable estimation.

To examine whether the CSR effect is stronger for environmentally friendly vehicles, the analysis implements both subsample regressions and a difference-in-difference-in-differences (DDD) specification. The subsample approach estimates the baseline difference-in-differences model separately for green (passenger group) and non-green (SUV group) vehicles. If environmental preferences drive the observed price premium, the CSR announcement should lead to a larger price increase for green vehicles.

To further test this mechanism within a unified framework, the following DDD specification is estimated:

$$\begin{aligned} ln(Price)_i \;=\; & \beta_0 \;+\; \beta_1 Release_i \times Volkswagen_i \\ & +\; \beta_2 Release_i \times Volkswagen_i \times Green_i \\ & +\; Controls_i \;+\; \tau_m \;+\; \tau_w \;+\; \delta_s \;+\; \mu_j \;+\epsilon_i; \end{aligned} \tag{3.6}$$

where $Green_i$ indicates whether a vehicle is classified as environmentally friendly according to the criteria described above. The coefficient of interest is β_2, which captures whether the CSR-induced price effect differs between green and non-green vehicles. The specification includes the same set of control variables and fixed effects used in the baseline regressions, and standard errors are clustered at the manufacturer level.

The empirical results are reported in Table 3.4.2. In the subsample analysis, the estimated CSR effect is positive and statistically significant for green vehicles, while the corresponding coefficient for non-green vehicles is not statistically significant. This pattern indicates that the price response to the CSR announcement is concentrated among vehicles with more environmentally friendly characteristics.

The DDD specification provides additional evidence consistent with this mechanism. The interaction term $Green \times Release \times Volkswagen$ is positive and statistically significant in the specification that compares mainstream vehicles with performance vehicles, suggesting that the CSR announcement generated a stronger price response for environmentally friendly vehicles within this segment. One possible explanation is that consumers in the mainstream segment are more responsive to environmental signals. Compared with economy buyers, who are primarily price-sensitive, and performance buyers, who prioritize power and driving experience, mainstream consumers are more likely to trade off between environmental attributes and price. As a result, CSR-induced improvements in environmental

reputation have the largest impact in this segment. A complementary explanation is that the marginal impact of CSR signals depends on the scope for perceived environmental improvement. Economy vehicles are already relatively fuel-efficient, leaving limited room for further perception gains. Performance vehicles, by contrast, are structurally associated with high emissions. The mainstream segment lies between these extremes, where CSR signals can generate the largest perceived improvement.

Taken together, these findings support the interpretation that Volkswagen's environmental CSR initiative influenced consumer valuation through a reputational channel. The announcement appears to have strengthened the brand's environmental image, increasing willingness to pay particularly among consumers located in environmentally conscious regions and among consumers who prefer vehicles with environmentally friendly characteristics. This mechanism provides additional evidence that environmental CSR initiatives can affect market outcomes by interacting with heterogeneous consumer preferences in the automobile market.

Table 3.4.2. Heterogeneous Effects – Vehicle Environmental Characteristics

Dep. var: ln(Price)	Green	Non-green	Economy vs Performance	Mainstream vs Performance	Full
	(1)	(2)	(3)	(4)	(5)
Release×Volkswagen	0.103***	0.150			
	(0.03)	(0.13)			
Green×Release×Volkswagen			-0.178	0.239**	-0.136
			(0.13)	(0.10)	(0.13)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2 (within)	0.79	0.72	0.74	0.73	0.76
N	4739	6164	7569	6376	10903

Notes: *Green* equals one for vehicles with relatively small engines (economy or mainstream terciles) and non-SUV body types. Columns (1)–(2) report subsample estimates for green and non-green vehicles. Columns (3)–(5) report triple-difference specifications comparing economy versus performance, mainstream versus performance, and the full sample, respectively. All regressions include the full set of controls and fixed effects used in the baseline specification. Standard errors are clustered at the manufacturer level. ***, **, and * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

3.5 Robustness

This section evaluates the robustness of the empirical findings and validates the identification strategy through a series of complementary tests. First, I verify the comparability between the treatment and control groups using a Synthetic Difference-in-Differences (sDiD) estimator. I then assess the validity of the identifying assumption by testing whether consumers were aware of the CSR event prior to its nationwide release. Next, I explore the dynamic and temporal stability of the effects using an event study. I further test alternative model specifications, sample constructions, and control variables to ensure that the results are not driven by unobserved heterogeneity or specific data configurations.

3.5.1 Synthetic Difference-in-Differences Estimator

To verify that the main estimates are not driven by differences in brand characteristics or bidder switching across groups, I apply a Synthetic Difference-in-Differences (sDiD) estimator. This approach constructs a weighted combination of control brands that best match the pre-treatment price trend of Volkswagen (see Figure 3.5.1), thereby improving comparability between the treatment and control groups. The outcome variable is the monthly average transaction price for each brand, and key used-car characteristics (starting price, car age, mileage, and number of bidders) are included as covariates.

The results show that the Average Treatment Effect on the Treated (ATT) is 0.189 ($p = 0.005$), consistent with the main findings. Figure 3.5.2 plots the monthly average price of Volkswagen cars and the synthetic control group. The pre-treatment trends are nearly parallel, while a sharp post-announcement increase is observed for Volkswagen, confirming that the price effect arises from the CSR event rather than unobserved group differences.

3.5.2 Consumer Awareness of the CSR Event

On March 8, 2017, Volkswagen issued its initial investment plan, specifically tailored for California, with a clear statement of a separate nationwide version to follow. Approximately one month later, on April 9, 2017, Volkswagen released the subsequent investment plan in the series, known as the "National ZEV Investment Plan (Public Version)." A potential concern arises regarding the unresponsiveness of consumers outside California to the investment plan prior to the nationwide release. To address this concern, we exclude auction transactions occurring between the launch of the first and second investment plans and re-estimate main specification. The results in Column (1) of Table 3.5.1 show that the coefficient of the interaction term remains significant and positive at the one percent level.

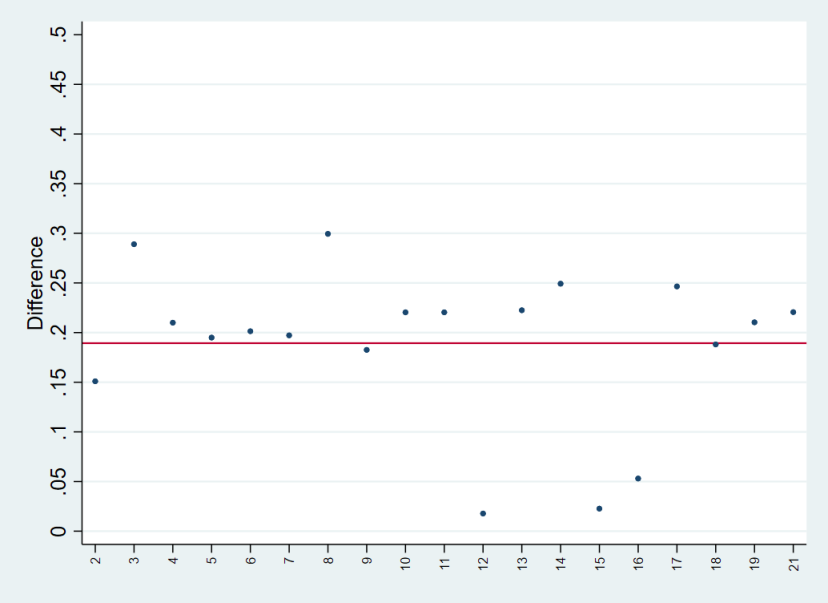

Figure 3.5.1. Composition of the synthetic group

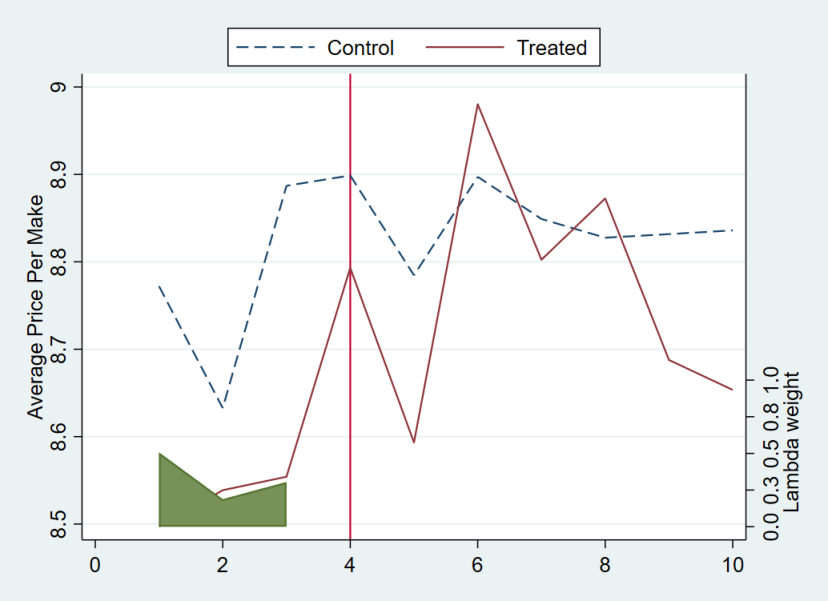

Figure 3.5.2. Synthetic Difference-in-Differences

There is a possibility that consumers might have been informed about the investment plan in advance, which could lead them to adjust their willingness to pay before the investment plan's official release. If this were the case, it would violate the parallel trends assumption and potentially undermine the validity of our results. To address this concern, we conduct three tests.

First, We exclude all transactions from the same month as the announcement of the investment plan. Second, we exclude transactions from one month before and one month after the announcement date. Applying the same specification to this adjusted sample, the results in columns (2) and (3) of Table 3.5.1 show patterns consistent with our previous findings. Third, we perform a placebo test by artificially moving the release date to one month earlier (February 8, 2017) and excluding auction listings ending after the actual release date and by. We then apply the same methodology used in the main specification to this artificial release date. The result, presented in column (4) of Table 3.5.1, shows that the coefficient of the interaction term is not significant, indicating no significant information leakage that would alter consumers' responses to the ZEV investment plan.

Table 3.5.1. Robustness I – Consumer Awareness of the CSR Event

	Gap	No Event Month	+/-1 Month	Placebo
Dep. var: ln(Price)	(1)	(2)	(3)	(4)
Release×Volkswagen	0.161***	0.155***	0.169***	0.009
	(0.03)	(0.04)	(0.04)	(0.03)
Volkswagen	-0.534***	-0.543***	-0.547***	-0.644***
	(0.04)	(0.04)	(0.04)	(0.05)
Release	-0.025	-0.023	-0.028	0.013
	(0.07)	(0.07)	(0.07)	(0.07)
Fixed Effects	Yes	Yes	Yes	Yes
R^2 (within)	0.73	0.73	0.73	0.73
N	12893	13319	11768	4166

Notes: Standard errors are clustered at the car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

3.5.3 Event Study and Temporal Robustness

To examine how the price effect evolved over time, I conduct an event study that estimates monthly treatment effects relative to the event month. The specification follows Equation 3.7.

$$ln(Price)_i = \beta_0 + \sum_{n=-3}^{6} B_n(D_n \times Volkswagen_i) + Controls_i + \tau + \delta + \mu + \epsilon_i; \quad (3.7)$$

The coefficient B_n measures the month-specific price difference between Volkswagen and the control group relative to the pre-event period. Consistent with the parallel trends assumption, no significant pre-trends are observed before the announcement. After the release, average prices rise significantly, peaking two months post-event, and gradually decline thereafter. Figure 3.5.3 illustrates this pattern, suggesting that the effect is short-lived, possibly reflecting a temporary boost in consumer perception and attention.

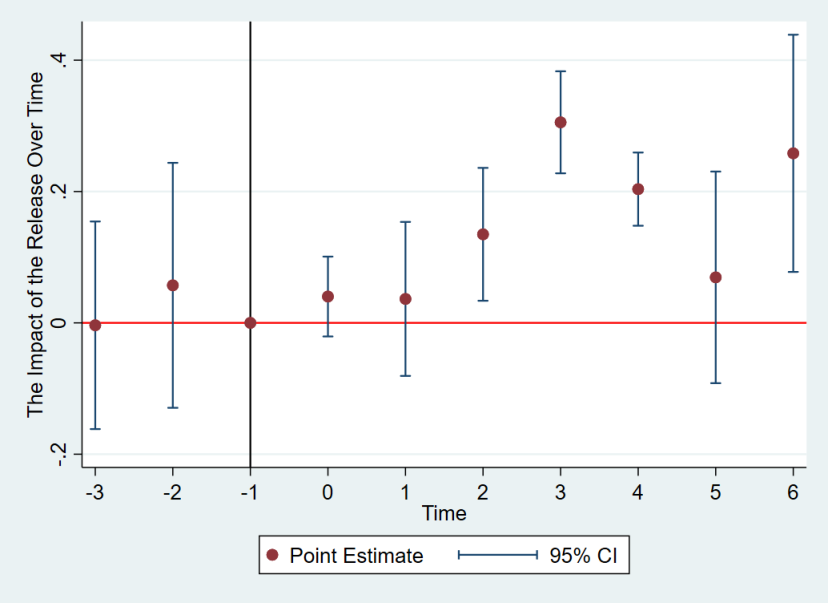

Figure 3.5.3. Dynamic Effects of the CSR Investment Plan

To assess temporal robustness, I re-estimate the model using narrower and wider time windows around the event date (from one month before to five months after). The estimated treatment effects in Table 3.5.2 remain positive and consistent in magnitude, supporting the stability of the findings across different sample horizons.

3.5.4 Alternative Specifications and Additional Controls

We re-estimate Equation 3.1 by incorporating additional fixed effects to capture more detailed temporal and spatial variations in consumer behavior. The baseline model already includes fixed effects for car make, body type, week, month, and seller location, ensuring that the estimated effects are identified within specific combinations of product characteris-

Table 3.5.2. Robustness II – Different Time Windows

	-1/+1	-2/+2	-3/+3	-3/+4	-3/+5
Dep. var: ln(Price)	(1)	(2)	(3)	(4)	(5)
Release×Volkswagen	0.057	0.063**	0.110***	0.136***	0.117***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)
Volkswagen	-0.640***	-0.590***	-0.574***	-0.568***	-0.571***
	(0.07)	(0.06)	(0.05)	(0.05)	(0.04)
Release	0.188	0.187	0.124	0.097	0.042
	(0.20)	(0.21)	(0.20)	(0.22)	(0.22)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2 (within)	0.75	0.74	0.73	0.73	0.73
N	3520	5825	8018	10412	12685

Notes: In column (1), I use a one-month window before and after the event, covering auctions from February 1 to April 30, 2017. In column (2), the window expands to two months before and after, from January 1 to May 30, 2017. Column (3) extends this to three months before and after, from December 1, 2016, to June 30, 2017. In column (4), the period includes three months before and four months after the event, from December 1, 2016, to July 30, 2017. Column (5) widens it to three months before and five months after, from December 1, 2016, to August 30, 2017. Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

tics and time–location variations.

To account for potential heterogeneity in regional market dynamics, we introduce month-by-seller fixed effects ($Month \times Seller$), which control for time-varying local shocks such as seasonal demand fluctuations, regional advertising campaigns, or local policy changes that may affect used car prices. This refinement ensures that the estimated treatment effect is not confounded by localized temporal patterns in consumer demand. In addition, we construct a composite fixed effect combining month, body type, and seller location interacted with mileage ($Month–Body–Seller \times Mileage$). Since mileage is one of the most salient indicators of vehicle quality and depreciation, consumer sensitivity to mileage can vary across markets and periods depending on income levels, usage intensity, and vehicle replacement cycles. Incorporating this interaction helps capture heterogeneous valuation patterns linked to both regional and temporal contexts.

As shown in Table 3.5.3, the coefficient of interest remains positive and statistically significant, though slightly smaller in magnitude. This outcome suggests that the main results are not driven by omitted temporal or spatial heterogeneity in consumer demand and that the estimated price effect robustly reflects shifts in willingness to pay induced by the CSR announcement.

3.5.5 Alternative Sample Compositions

A potential concern is that the baseline results may be affected by noise from brands with very limited transactions or by extreme observations in vehicle quality. Brands with few listings are often characterized by idiosyncratic pricing behavior or sparse bidding activity, which could distort the estimated treatment effect. To mitigate this issue, we first raise the threshold for brand inclusion from 100 to 200 unit sales, ensuring sufficient within-brand variation for reliable identification. We then restrict the sample to the ten best-selling brands (excluding Volkswagen), which account for the majority of transactions in the used car market. This restriction reduces the influence of smaller, niche brands whose pricing dynamics may not reflect typical market conditions. In addition, we exclude the top one percent of listings in terms of car mileage and car age, as these outliers likely correspond to vehicles with atypical depreciation patterns or unusually high maintenance costs that could bias price comparisons.

The results, reported in Panel B of Table 3.5.4, show that the coefficients of the interaction term remain positive and statistically significant at the one percent level across all subsamples. This consistency demonstrates that the estimated price premium is not driven by thinly traded brands or outlier vehicles, confirming the robustness and representativeness of

Table 3.5.3. Robustness III – Additional Source of Variations

Dep. var: ln(Price)	(1)	(2)
Release×Volkswagen	0.137***	0.093***
	(0.04)	(0.03)
Volkswagen	-0.532***	-0.546***
	(0.05)	(0.05)
Release	0.022	-0.023
	(0.25)	(0.20)
Car Make FE	Yes	Yes
Body type FE	Yes	Yes
Week FE	Yes	Yes
Month FE	Yes	Yes
Seller FE	Yes	Yes
Month×Seller FE	Yes	No
Month-Body-Seller×Mileage FE	No	Yes
R^2 (within)	0.74	0.78
N	14606	14606

Notes: This table, by incorporating different combinations of fixed effects, examines potential confounding factors that might influence consumers willingness to pay. Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

the main findings.

3.5.6 Seller strategies.

Concerns may arise that the impact of the investment policy release could be attributed to changes in seller behavior rather than shifts in consumer demand. For instance, sellers might attempt to capitalize on the announcement by modifying their strategies, such as adjusting photo postings, shipping policies, or starting price settings. To ensure the robustness of my results against these possibilities, I re-estimated the main regressions, including interaction terms between the policy release variable ($Release$) and seller strategy variables, such as the natural logarithm of the number of pictures ($ln(Numberofpictures)$), the dummy for buyer shipping ($Buyershipping$), and the natural logarithm of the starting price ($ln(Startprice)$). The results, shown in Table 3.5.5, reveal patterns consistent with the main findings, indicating that the observed effects are robust and not driven by changes in seller behavior.

3.5.7 Population density and housing density.

The investment plan focuses on promoting the adoption of ZEV technologies, with a key commitment to expanding electric vehicle charging infrastructure. I anticipate that population density may influence the availability of these charging facilities, potentially affecting consumers' expectations regarding the investment and introducing bias into the results.

To address this, I first re-estimate the main specification by incorporating the natural logarithm of population density and the interaction term $Release \times \ln(\text{population density})$. I then use housing density as an alternative measure, adding the natural logarithm of housing density and the interaction term $Release \times \ln(\text{house density})$ to the main specification. Additionally, I include all four density variables in the main specifications. The results, presented in Table 3.5.6, remain consistent, indicating that the findings are not biased by variations in population density or housing density.

3.6 Discussion

In this section, I interpret the findings in policy and managerial terms. The court-mandated nature of Volkswagen's ZEV investment plan, established under the 2016 U.S. District Court Consent Decree, illustrates how regulatory interventions can produce positive brand effects even in secondary markets. The empirical results show a 13.5% increase in consumers' willingness to pay for Volkswagen used cars following the announcement. This finding suggests that mandatory CSR initiatives can realign corporate incentives with environmental and

Table 3.5.4. Robustness IV – Composition of Control Group and Sample

Panel A: composition of control group				
	German	EU	Asian	US
Dep. var: ln(Price)	(1)	(2)	(3)	(4)
Release×Volkswagen	0.149**	0.138**	0.156***	0.197***
	(0.04)	(0.05)	(0.02)	(0.03)
Volkswagen	-0.303***	0.337***	-0.121***	-0.272***
	(0.03)	(0.06)	(0.04)	(0.07)
Release	-0.299	-0.438	-0.007	0.441
	(0.52)	(0.47)	(0.17)	(0.41)
Fixed Effects	Yes	Yes	Yes	Yes
R^2 (within)	0.69	0.71	0.72	0.74
N	3127	4169	5088	6353
Panel B: composition of the sample				
	Make>200	Top 10	Mileage Outlier	Age Outlier
	(5)	(6)	(7)	(8)
Release×Volkswagen	0.143***	0.132***	0.140***	0.132***
	(0.04)	(0.03)	(0.04)	(0.04)
Volkswagen	0.426***	0.103**	-0.551***	-0.539***
	(0.04)	(0.03)	(0.04)	(0.04)
Release	-0.009	0.027	0.004	0.073
	(0.25)	(0.30)	(0.23)	(0.23)
Fixed Effects	Yes	Yes	Yes	Yes
R^2 (within)	0.73	0.73	0.73	0.73
N	12961	10042	14460	14459

Notes: In columns (1) through (4) of Panel A, the control group is restricted to brands from Germany, European Union countries, Asian countries, and the U.S., respectively. In Panel B, column (5) includes only brands with at least 200 sales in the sample, while column (6) focuses on the 10 best-selling brands. Columns (7) and (8) exclude the top 1 percent of the sample in terms of car mileage and car age. Standard errors are clustered at the car-make level. Significance is indicated by ***, **, and * for the 1 percent, 5 percent, and 10 percent levels, respectively.

Table 3.5.5. Robustness V – Seller Strategies

Dep. var: ln(Price)	(1)	(2)	(3)
Release×Volkswagen	0.140***	0.134***	0.134***
	(0.04)	(0.04)	(0.04)
Volkswagen	-0.558***	-0.553***	-0.553***
	(0.04)	(0.04)	(0.04)
Release	-0.102	0.127	0.037
	(0.25)	(0.20)	(0.22)
Release×			
ln(Number of pictures)	0.050**		
	(0.02)		
Buyer shipping		-0.110	
		(0.07)	
ln(Start price)			-0.004
			(0.01)
Fixed Effects	Yes	Yes	Yes
R^2 (within)	0.73	0.73	0.73
N	14606	14606	14606

Notes: Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table 3.5.6. Robustness VI – Population Density and House Density

Dep. var: ln(Price)	(1)	(2)	(3)
Release×Volkswagen	0.133***	0.133***	0.135***
	(0.04)	(0.04)	(0.04)
Volkswagen	-0.553***	-0.554***	-0.552***
	(0.04)	(0.04)	(0.05)
Release	-0.116	-0.109	0.306
	(0.26)	(0.27)	(0.34)
ln(house density)	0.461***		2.544
	(0.10)		(22.24)
Release×ln(house density)	0.036*		0.463***
	(0.02)		(0.15)
ln(population density)		0.456***	-2.063
		(0.10)	(21.98)
Release×ln(population density)		0.027	-0.431***
		(0.02)	(0.15)
Fixed Effects	Yes	Yes	Yes
R^2 (within)	0.73	0.73	0.73
N	14606	14606	14606

Notes: Population data is sourced from the Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2019 (NST-EST2019-01), published by the U.S. Census Bureau's Population Division and released in December 2019. Housing unit data is also provided by the U.S. Census Bureau. Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

social objectives. The following subsections discuss the policy and managerial implications derived from these results.

3.6.1 Policy Insights

The findings highlight the policy relevance of mandated CSR as a tool for restoring public trust and aligning corporate incentives with social goals. The observed increase in willingness to pay demonstrates that well-designed, transparent regulatory frameworks can generate positive market responses even when compliance is compulsory. These results suggest that policymakers should view CSR not merely as a compliance requirement but as a mechanism to enhance accountability, credibility, and environmental performance through verifiable disclosure and consistent public oversight.

First, the ZEV plan's independence from profit-maximizing motives underscores the importance of transparent, legally binding CSR frameworks. Unlike voluntary CSR, which may be driven by strategic marketing or reputational goals, mandated CSR ensures accountability and verifiability of outcomes (Christensen, Hail, and Leuz 2021; Wang, Cao, and Ye 2018). Transparency is critical for such initiatives to restore public trust, especially when a firm's credibility has been damaged by misconduct. Policymakers should therefore develop regulations that require firms, especially those with a history of regulatory breaches, to disclose quantifiable social and environmental impacts associated with mandatory CSR initiatives. For example, Volkswagen's quarterly public reports on the progress of its ZEV infrastructure investment, published by its subsidiary Electrify America, detailed the number of charging stations built, their geographic distribution, and public education initiatives. Such transparent communication enhanced consumer perceptions of brand integrity and signaled a credible commitment to environmental remediation, consistent with the observed increase in willingness to pay. This aligns with evidence that credible disclosure mechanisms can mitigate reputation loss after corporate scandals (Kim, Park, and Wier 2014).

Second, the positive consumer response to the ZEV plan suggests that compulsory CSR efforts in environmental domains can reshape consumer preferences and elevate brand value even when firms act under regulatory constraints. Regulators could extend similar frameworks to industries characterized by high negative externalities, such as energy (Christensen, Hail, and Leuz 2021) and heavy manufacturing (Mbanyele *et al.* 2022), by requiring companies to allocate a fixed percentage of revenues to independently verified sustainability projects. For instance, the European Union's Corporate Sustainability Reporting Directive (CSRD) and India's Companies Act (2013), which mandates that large firms invest at least 2 percent of their profits in CSR activities, demonstrate how regulatory enforcement can institutionalize social responsibility. Similarly, California's Zero-Emission Vehicle (ZEV)

credit system links environmental compliance directly to tradable incentives, illustrating how market-based mechanisms can transform regulatory obligations into competitive advantages. In this context, the Volkswagen case highlights that well-designed, transparent, and enforceable CSR mandates can generate both private and social welfare gains, aligning corporate behavior with broader societal objectives.

3.6.2 Managerial Implications

The estimated 13.5% increase in willingness to pay for Volkswagen used cars demonstrates that credible CSR actions can strengthen brand equity and rebuild consumer trust, even when these actions are mandated by regulation rather than driven by voluntary corporate goodwill. This finding reinforces the view that CSR activities, whether voluntary or imposed, can generate reputational capital when they are perceived as authentic and transparent (Godfrey, Merrill, and Hansen 2009). Previous research suggests that CSR signals moral commitment and long-term orientation, helping restore confidence among consumers and other stakeholders (Klein and Dawar 2004). For managers, this evidence highlights the tangible economic value of well-communicated sustainability commitments, which can serve as risk-mitigating investments in brand credibility and customer loyalty (Brown *et al.* 2006; Bhattacharya, Korschun, and Sen 2009b).

Firms should therefore view CSR investments, such as those in electric vehicle charging networks, carbon reduction initiatives, or circular economy programs, as durable components of brand equity rather than discretionary costs. Empirical studies show that environmentally responsible actions can increase consumers' willingness to pay and foster positive brand associations, especially when linked to salient societal concerns like climate change or urban pollution (Casadesus-Masanell *et al.* 2009; Elfenbein, Fisman, and McManus 2012). Moreover, CSR communication strategies should emphasize localized and context-specific relevance. The heterogeneity results in Section 3.4.3 indicate that consumer responses were strongest in environmentally conscious regions, consistent with prior evidence that consumers' reactions to CSR initiatives vary depending on their underlying values and environmental awareness (Sen, Bhattacharya, and Korschun 2006). For instance, region-specific outreach quality campaigns or partnerships with local environmental organizations—can amplify perceived authenticity and magnify the return on CSR investments.

3.7 Conclusions

Firms, as corporate citizens, are increasingly expected to play a significant role in modern society, particularly by taking on greater social responsibilities. Corporate social responsi-

bility, whether voluntary or involuntary, can have a profound impact on a company's brand image and influence consumers' purchasing decisions. Despite its importance, quantifying the impact of CSR on consumer behavior—specifically how CSR influences consumers' willingness to pay—remains challenging. This study aims to address this question by exploring a quasi-experiment using used car data from eBay, making it one of the few attempts to empirically measure the effects of CSR on consumer behavior.

In this study, I examine the impact of Volkswagen Group's ZEV investment plan announcement on the short-run equilibrium price and unit sales of Volkswagen-branded used cars. My findings reveal that the introduction of the investment plan significantly increased the final auction price for Volkswagen used cars by 13.5% compared to other brands in the market. However, the daily transaction volume remained unaffected. In the context of short-run equilibrium, these results suggest that the price increase is driven by a change in consumers' willingness to pay in response to this corporate social initiative. I interpret this increase in willingness to pay as a reflection of consumers' valuation of brand equity associated with the firm's social behavior.

3.8 Limitations and Future Research

Despite extensive efforts to minimize potential limitations, several constraints remain due to data availability and identification challenges.

3.8.1 Data Limitation

The most important limitation arises from the lack of buyer-level identification in the dataset. Because eBay Motors transactions are anonymized, it is not possible to observe individual buyers' characteristics such as income, education, or environmental preferences. This limitation restricts the ability to identify heterogeneous consumer responses to the CSR initiative and may reduce the precision of the estimated demand-side effects. Moreover, without information on specific buyer identities, it is impossible to directly track individual bidding behavior or repeat purchases. As a result, in Section 3.3.2, buyer activity can only be inferred indirectly through aggregate indicators—such as the total number of bidders and transactions in treatment versus control groups—to assess whether systematic bidder switching occurred after the CSR announcement. A richer dataset that combines transaction records with consumer demographics would enable a more granular analysis of how CSR influences different consumer segments, following approaches such as Hainmueller, Hiscox, and Sequeira (2015) and Du, Bhattacharya, and Sen (2011).

3.8.2 Mechanism Limitation

The empirical design infers increased willingness to pay from observed price changes. However, the analysis cannot directly measure how consumers' perceptions or brand attitudes changed in response to the CSR disclosure. Existing literature highlights that CSR can operate through multiple channels—including trust restoration, reputational repair, moral compensation, and perceived fairness (Bénabou and Tirole 2010; Bhattacharya, Korschun, and Sen 2009a; Du, Bhattacharya, and Sen 2011). The present study focuses primarily on perceived quality as the transmission mechanism, without distinguishing the relative importance of these alternative pathways. Future work combining market data with consumer surveys, experimental evidence, or text analysis of online reviews could help disentangle these channels and provide a deeper understanding of the psychological mechanisms underlying CSR effects.

3.8.3 Welfare Analysis

The absence of buyer-level identification also limits the precision of welfare estimation. Without the ability to estimate individual demand curves or recover the full shape of the demand function, the welfare analysis in Section 3.6 relies on reduced-form approximations and back-of-the-envelope calculations. Moreover, the analysis cannot directly estimate demand or supply elasticities, which are critical for measuring welfare changes and surplus redistribution. Although the used car market exhibits empirical signs of inelastic short-run supply (Busse, Knittel, and Zettelmeyer 2013; Gillingham, Houde, and Van Benthem 2021), direct estimation of elasticity parameters using richer data would allow for a more precise quantification of welfare effects. Structural demand-supply modeling (e.g., as in Berry, Levinsohn, and Pakes (1995)) could provide a more rigorous welfare framework for future research.

3.8.4 External Validity

The data used in this study come exclusively from eBay Motors, which accurately reflects price formation and bidder behavior in online secondary markets. However, it may not capture dynamics in offline transactions, dealership-based markets, or peer-to-peer sales. As a result, the generalizability of the findings is limited. Consumer sensitivity to CSR initiatives might vary substantially across platforms or regions depending on transaction transparency, buyer protection policies, and local market conditions. Future studies could combine online and offline datasets or draw on administrative data from vehicle registration systems to test the robustness of these findings in broader market contexts.

3.8.5 Directions for Future Research

Building on these limitations, several avenues for future research are proposed.

1. Collecting buyer-level data or merging transaction records with external consumer information—such as customer survey about environmental attitudes or demographic profiles—would enable identification of heterogeneous CSR effects and a more precise estimation of individual willingness to pay.
2. Future work could develop a structural or semi-structural model of demand and supply to estimate elasticities explicitly and simulate welfare changes associated with CSR interventions.
3. Integrating data from offline market or other trading platforms would improve the external validity of the results and provide a more comprehensive picture of CSR effects across market environments.
4. Future research could examine the interaction between primary and secondary car markets. For instance, understanding whether new car sales recover faster after CSR disclosures, and how such recovery propagates to used car markets, could shed light on the dynamic feedback mechanisms linking corporate actions, consumer perception, and long-term brand recovery.

Chapter 4

Information Acquisition in Online Marketplaces: Evidence from WeGoLook Inspection Service on eBay

Abstract

This study investigates the impact of eBay Motors' inspection policy on the demand and supply sides of the used car market. In March 2016, eBay Motors and WeGoLook introduced an inspection service for all eBay car auction listings, allowing potential buyers to obtain a standard report with interior and exterior photos of a car for a small fee, aimed at increasing buyer confidence and verifying non-mechanical conditions. On the demand side, I observe that the policy positively affects buyers' willingness to pay, resulting in higher final auction prices. I also find a decrease in the price premium gained from sellers' information disclosure. Furthermore, the policy has a greater impact on professional dealers and low-quality cars in terms of increasing consumers' willingness to pay. On the supply side, I provide evidence of a decrease in moral hazard through an improvement in seller disclosure and other performance, with adverse selection being more likely reduced through improved product quality than changes in seller composition. (JEL: D82, L15, L81, M31)

Keywords: WeGoLook inspection services, information acquisition, eBay auctions, willingness to pay, adverse selection

4.1 Introduction

In most markets, buyers seek information about products to make their purchasing decisions regarding which sellers to buy and how much they are willing to pay. In response, sellers often disclose information about their products voluntarily to buyers (Jin and Leslie 2003; Lewis 2011; Tadelis and Zettelmeyer 2015), which mitigates adverse selection (Akerlof 1970). However, voluntary information disclosure is often incomplete due to, for example, selectively disclosing favorable news (Jin, Luca, and Martin 2021), intense competition among sellers (Jin 2005), or sellers' countersignaling motives (Bederson *et al.* 2018). It is less of a problem when buyers can acquire, rather than rely on sellers' disclosure of, information on the products at their discretion.

In this paper, I empirically investigate the role of buyer information acquisition in determining market prices and its ability to substitute for sellers' information disclosure, using transaction data from eBay Motors. In March 2016, eBay Motors introduced an on-site inspection service offered by a third-party provider, WeGoLook, that allows buyers to acquire information on the listings of interest before placing bids. By paying a small amount of fee[1], a WeGoLook user can obtain a standardized report of a used car on its non-mechanical conditions, including interior and exterior photos, photos of tire tread depth, damage verification, etc.

Sellers' information disclosure in this context can take the form of posting photos on eBay and the number of photos measures the degree of disclosure.

The introduction of the WeGoLook inspection service in eBay used car markets provides us with an excellent opportunity to examine how information acquisition affects online market outcomes. Markets of second-hand cars are typical examples of lemon markets by nature. In the U.S. used car market, more than half of the consumers are cross-state buyers[2], creating demand for on-site inspection services offered by WeGoLook. Furthermore, the introduction of WeGoLook on eBay Motors was not announced before its implementation, creating an exogenous shock that allows us to identify the effect of buyer information acquisition.

Despite its importance, there is very few empirical analysis on the role of buyer information acquisition in the industrial organization literature.[3] This is mainly due to the scarcity of

1. The current inspection service costs USD 99. See https://placeorder.wegolook.com/instant-inspections/auto for the WeGoLook service.

2. Smy ce: eBay News Team, https://www.ebayinc.com/stories/news/ebay-motors-and-wegolook-partner-to-provide-onsite-inspections-for-vehicles/ (accessed July, 2022).

3. There are extensive theoretical studies on information acquisition in auctions (Milgrom 1981a; Persico 2000; Miettinen 2013; Shi 2012; Hernando-Veciana 2009; Crémer, Spiegel, and Zheng 2009; Compte and Jehiel 2007; Kim and Koh 2022; Miettinen 2013) and information acquisition in asset markets (Van Nieuwerburgh and Veldkamp 2010; Goldstein and Yang 2015; He and Manela 2016). The list is far from complete.

proper data and empirical settings that allow a comparison before and after enabling buyer information acquisition. Understanding the role of information acquisition is economically important not only for the attention it attracts from theoretical research, but also for its implications for the inspection service provider, the market maker who implements the service and other instruments, and sellers who disclose information.

The empirical analysis reveals that the final price increases by approximately 12 percent after the introduction of the service, controlling for seller and time fixed effects. Given that the average final price in my sample is around USD 8289, the introduction of the buyer information acquisition service increases an average seller's revenue by about USD 986. The finding is consistent with previous theoretical studies. In particular, Persico (2000) shows that covert information acquisition by buyers increases auction revenue. Consider two buyers interested in the same listing using the inspection service. Since the WeGoLook report they receive must be similar, their willingness to pay tends to converge and the bidding competition between the two is more intense. This increases the final price and the seller's revenue. In the language of Persico (2000), buyers' bids are more correlated when they acquire information, which reduces their information rent and increases sellers' revenue.

Compared to information acquisition, information disclosure received much more attention in both empirical and theoretical research. The celebrated "linkage principle" states that when a seller discloses public information, buyers' willingness to pay converges and bids are more correlated, resulting in a more competitive environment, which increases seller revenue (and reduces buyers' information rent) (Milgrom and Weber 1982). Such intuition is closely aligned with that of information acquisition, illustrated by Persico (2000), suggesting the two information mechanisms may share a similar channel in mitigating adverse selection. As a common feature of online markets, eBay allows sellers to disclose information voluntarily by posting photos of their products, which has been shown to mitigate adverse selection and increase final price of the listing(Lewis 2011). While information disclosure by posting photos also significantly increases final prices in my setting, I find that the price premium of information disclosure decreases at every percentile on average 5 percent (USD 406) after the introduction of the inspection service. This is consistent with the above argument that information acquisition and information disclosure play a similar role in mitigating adverse selection in the online market. In response, sellers on average upload 2 (around 17.2 precent) more photos after introducing the service.

Previous empirical studies suggest that information disclosure can serve as a signaling device because it is initiated by the informed party (Jin, Luca, and Martin 2021; Bederson *et al.* 2018). This must not be the mechanism behind information acquisition because the latter is initiated by the uninformed party. Furthermore, potential buyers can observe in-

formation about several listings whenever the sellers choose to disclose, whereas a buyer can only acquire information on the listings she chooses. This implies that the information acquisition cannot affect the market through a "matching mechanism" as in Tadelis and Zettelmeyer (2015).

As mentioned, information acquisition is at buyers' discretion, unlike information disclosure, which is at sellers' discretion. What then follows is when buyers have fewer incentives to purchase information, facilitating acquisition may no longer be an effective information mechanism in removing the information asymmetry. Fixing the cost and the informativeness of a piece of information (e.g., the WeGoLook report), a buyer does not wish to purchase it if there is little uncertainty in the product quality. This is the case, for example, when a buyer is purchasing a brand new car or a rebuilt title car that is certified by an insurance company to be roadworthy. Indeed, I find that the introduction of the inspection service significantly increases the final price of clean title cars, whereas its effect on rebuilt title cars is insignificant. Since WeGoLook provides inspection services only on non-mechanical conditions of the car, potential buyers would be less interested in using the service if they are confident about both non-mechanical and mechanical conditions (rebuilt title).[4]

Similarly, the introduction of the service significantly increases the final price of cars sold by professional dealers but not for private sellers. Compared to dealers, private sellers have little reputation concerns and are less professional in eliminating mechanical problems and daily maintenance, exposing potential buyers to high risks that the inspection service can hardly remove.

In all the above findings, the coefficient for the interaction term between information disclosure by sellers, i.e., the number of photos posted, and information acquisition by buyers, i.e., whether the inspection service is introduced, is significant (and negative) only when the latter dummy variable is significant in itself. The former variable is always significantly positive in itself. These findings further support that information acquisition works through a similar channel as information disclosure by sellers. In addition, these findings also suggest that, compared to information disclosure, acquisition by buyers has limitations in mitigating adverse selection, e.g., it only applies to the clean title, or low-quality, cars. This is particularly interesting in comparison with Tadelis and Zettelmeyer (2015), which shows that information disclosure is more effective for unanticipated high- and low-quality cars. These findings jointly suggest that a combination of buyer information acquisition and seller disclosure can further improve market transparency than each alone.

4. Rebuilt title cars are those that have been repaired and certified to be roadworthy and that, to some extent, be considered new cars. Buyers are less interested in obtaining more information about the non-mechanical conditions of these cars.

Finally, my study examines the impact of the inspection policy on sellers' behavior and performance measures. The results show that there is a reduction in moral hazard as sellers provide more information about the products they sell. The analysis is then conducted at the sub-category level, revealing a change in vehicle quality and seller expertise. Moreover, the study finds evidence of an improvement in sellers' efforts with alternative measures. The reduction in adverse selection is likely due to the improved product quality rather than a higher market share of high-quality sellers. Overall, the policy has improved the transparency and efficiency of the market.

My work most directly contributes to the empirical literature on buyer information acquisition. To the best of my knowledge, this paper is the first attempt to empirically study the role of acquiring product-specific information by buyers and the interaction between information acquisition and disclosure by sellers.[5] Theoretical foundations of information acquisition include Milgrom (1981b), Grossman and Stiglitz (1980), and Persico (2000). The most closely related theoretical study is Persico (2000), which shows that information acquisition by buyers increases seller revenue. This is the first time in the literature, confirmed by the empirical analysis.

This paper contributes to the extant literature on seller information disclosure in markets. On the one hand, consistent with theoretical foundations of information asymmetry in markets (Grossman 1981; Grossman and Hart 1980; Milgrom 1981a), Lewis (2011) shows that credible information disclosure increases final prices of listings. On the other hand, information disclosure can improve market transparency through channels beyond what is documented in theoretical studies. According to Bederson *et al.* (2018) and Jin, Luca, and Martin (2021), disclosure can instead serve as a signaling mechanism and non-disclosure may sometimes signal high quality. Tadelis and Zettelmeyer (2015) instead illustrate that information disclosure can be effective by serving as a matching mechanism that sorts similar-minded buyers into the same auctions, which intensifies the competition and increases seller revenue.

I contribute to this literature by providing evidence that the underlying mechanism of information acquisition is similar to that of credible information disclosure as in Lewis (2011), but not the signaling or matching mechanisms. This is true because: (1) my analysis reveals that the price premium of information disclosure decreases after introducing the inspection service, and, (2) acquiring information about specific listings by the uninformed party can-

5. There is a strand of marketing literature on consumer information acquisition, which refers to consumers *searching* for price and product information (Murray 1991). This literature is connected more closely with the economics literature on consumer search (Stahl 1989). See an earlier discussion of the connection in Wilde (1980). There is another branch of literature in empirical finance focusing on the role of information acquisition in financial markets. See, for example, Larcker and Lys (1987) and Chen *et al.* (2022).

not improve market transparency through signaling (initiated by the informed party) or matching (relies on all buyers observe all information).

Previous empirical studies show that the degree of seller disclosure is affected by the competitive environment (Jin 2005), signaling and countersignaling motives z(Bederson *et al.* 2018; Jin, Luca, and Martin 2021), which are potentially why regulators had to mandate disclosure (Dranove and Jin 2010; Mathios 2000; Jin and Leslie 2003). I contribute to this branch of literature by showing that sellers disclose significantly more information when buyers can acquire information. The implication is that voluntary information disclosure can be encouraged by enabling buyer information acquisition.

I also contribute to the literature on evaluating instruments that mitigate moral hazard and adverse selection in marketplaces. In this regard, the closest paper to mine is Liu, Brynjolfsson, and Dowlatabadi (2021). In their settings, users are enabled to access the same level of information as a service provider does through a real-time monitoring system, accompanied by a rating system and an easy complaint channel. They find the buyer protection "tool portfolio" leads to a reduction in service providers' moral hazard. In contrast to their work, the policy I study provides an exogenous shock and enables us to identify the effect of buyer information acquisition on information asymmetry.

In addition to facilitating information disclosure, as I have discussed, previous studies illustrate that seller reputation building (Saeedi 2019; Tadelis 2016), buyer protection and seller certification (Hui *et al.* 2016; Elfenbein, Fisman, and McManus 2015b), and warranties and guarantees provision (Lwin and Williams 2006; Roberts 2011; Che *et al.* 2019) are also effective to improve market transparency. My findings on the substitutability between disclosure and acquisition of information further contribute to this literature, which has examined substitutability between, for example, warranty and brand name (Lwin and Williams 2006), warranty and seller reputation (Lwin and Williams 2006; Roberts 2011; Che *et al.* 2019), charity donation and seller reputation (Elfenbein, Fisman, and McManus 2012), certification and seller reputation (Elfenbein, Fisman, and McManus 2015b), and buyer protection and reputation badges (Hui *et al.* 2016).

The article proceeds as follows. Section 4.2 describes data and the background of the policy in more detail. Section 4.3 discusses a conceptual analysis of information disclosure and information acquisition. Section 4.4 expounds the empirical framework and the main results. Section 4.5 provides a number of robustness checks. Section 4.6 presents concluding remarks. Finally, Section 4.7 lists the limitations and points out directions for future research.

4.2 Background and Data

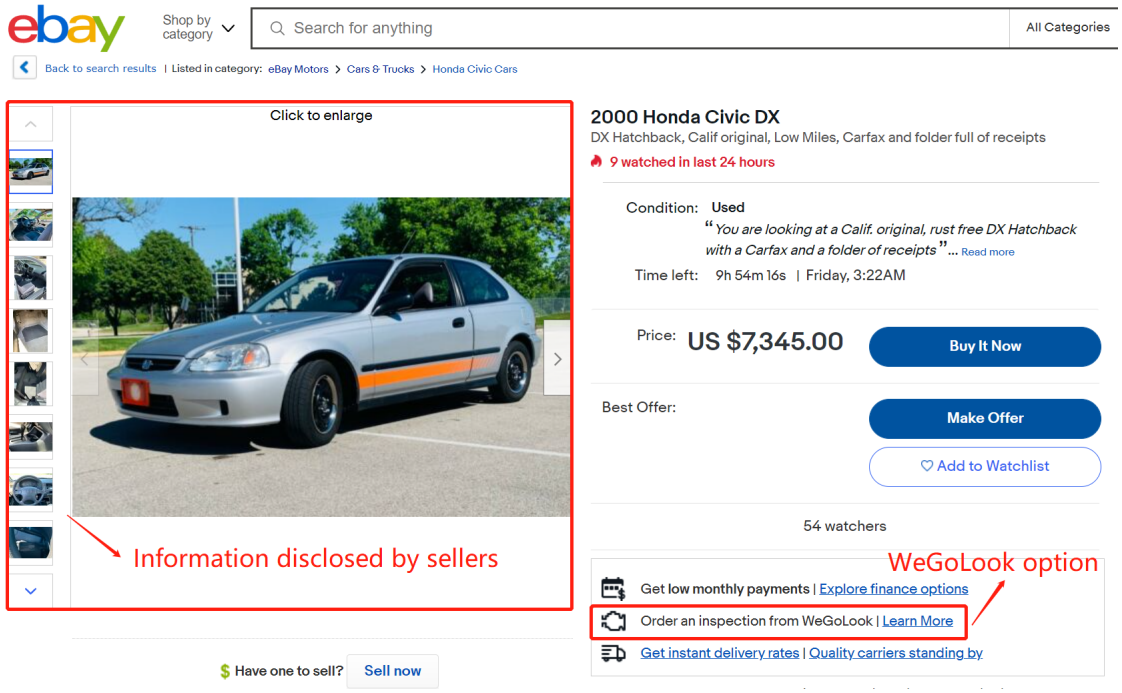

Figure 4.2.1. WeGoLook Inspection Service in an eBay Auction Listing

Source: Screenshot of an eBay Motors vehicle listing for a 2000 Honda Civic DX (item no. 195067818848), accessed May 27, 2022, at https://www.ebay.com/itm/195067818848?hash=item2d6af2b360:g:kWAAAOSwnDxihur3. The listing has since expired and is no longer publicly accessible; the original screenshot is on file with the author and available upon request.

Notes: Red rectangles and labeled arrows added by the author to highlight (i) seller-disclosed information and (ii) the WeGoLook third-party inspection option. License plate redacted to protect seller privacy. eBay and WeGoLook are trademarks of their respective owners.

eBay car auction market. eBay Motors, launched in April, 2000, has become one of the most popular online platforms for car sales, especially used cars in the United States. On eBay Motors, when a seller creates a listing for sale, some basic and standardized information about a car must be provided, such as make, body type[6], mileage traveled, and production year. Additionally, the sellers can list details of a car on the item description page using other formats, such as text, photos, and a vehicle history report.

eBay Motors offers different selling mechanisms to sellers, i.e., auctions, posted prices, and best offers (negotiation). To measure how bidders vary their willingness to pay, I in this

6. Body type can be classified into the following subcategories: Sedan, Hatchback, SUV, Convertible, and Van.

study focus on auctions only. A standard eBay auction is a variant of a second-price auction with an optional listing duration, i.e., 1, 3, 5, 7, or 10 days. Moreover, sellers can customize the auction listing by choosing the start price, secret reserve price, and shipping methods. After the auction is publicly listed, bidders arrive and submit their bids during the course of the auction. When the auction ends, the bidder with the highest bid wins the object but only pays the maximum between the second highest bid and the start price (public reserve price). If the auction has a secret reserve price, the second-highest bid should be greater than the secret reserve price; otherwise, the seller does not need to commit to the sale.

WeGoLook inspection option. WeGoLook company, launched in 2010, aims to perform inspections of items, including autos, marines, boats, real estate, and heavy equipment, as its services for customers. The inspection service covers almost the entire United States. On March 22, 2016, eBay Motors, along with WeGoLook company, announced a policy to offer inspection services to eBay customers. The purpose of the inspection service is to improve buyer confidence in vehicle transactions. Specifically, in each used car auction listing, a bidder before submitting his/her bid can request an inspection directly through the listing web page with costs of 69 U.S. dollars.[7] Then, WeGoLook assigns an agent (also referred to as a "looker") to conduct a field inspection and provide a standardized report.

The report includes 40 photos, the verification of vehicle identification number (VIN) and vehicle make/mode, odometer reading, noting major visible damage and recording all vehicle equipment options.[8] These photos record the interior and exterior of a car, including tire tread depth. Notably, the "looker" does not perform test drives on the vehicle. Moreover, the report does not include mechanical inspection, diagnostic checks, frame and body inspection, and undercarriage inspection. See Figure B.1.1 regarding the coverage of the inspection service and its price. Hence, the inspection service is mainly used to exhibit and verify the non-mechanical condition of a car, aiming at revealing whether the car has "scratches" and "dents," instead of judging the mechanical conditions of a car. See Figures 4.2.1 and 4.2.2 for an example of an eBay car auction listing with the WeGoLook inspection option and the report.

Data and descriptive statistics. The data comes from the eBay Motors website and covers successfully sold used car auction listings between December 1, 2015 and June 30, 2016. To remove distracting factors and better focus on my research questions, I impose several sample restrictions before performing the analysis. I first delete transactions through other selling mechanisms and focus on auctions with start prices only. Then I exclude observations

7. The original starting price was 69 U.S. dollars, which was raised to 99 U.S. dollars in September, 2016 (later than my sample period).

8. Available add-ons include working demonstration and exterior walkaround videos for 35 U.S. dollars.

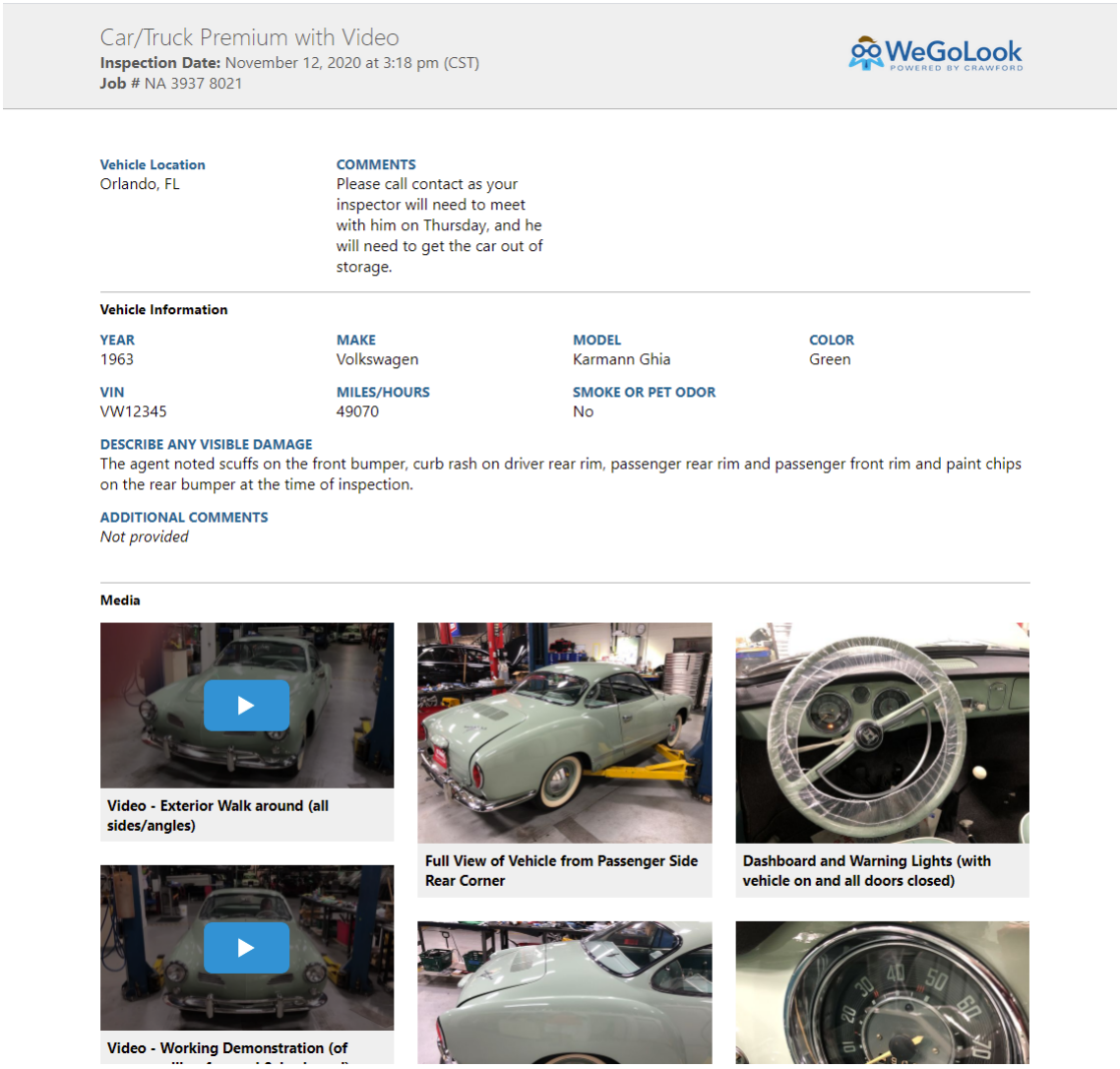

Figure 4.2.2. An Example of WeGoLook Inspection Report

Source: Sample vehicle inspection report (Car/Truck Premium with Video) for a 1963 Volkswagen Karmann Ghia, published by WeGoLook (Crawford & Company) as a public demonstration of its inspection service. Available at https://demo.wegolook.com/looks/5fab09a11e9df00021af5485/reports/public.html, accessed May 6, 2026; permanent archived version at https://web.archive.org/web/20260505171308/https://demo.wegolook.com/looks/5fab09a11e9df00021af5485/reports/public.html. The report uses demonstration data (VIN "VW12345") and does not represent an actual customer transaction.

Notes: Reproduced as published, with no annotations added by the author. WeGoLook is a trademark of Crawford & Company.

with unclear settings or missing data on the listing characteristics, i.e., no information on make, mileage, and/or production year. Furthermore, I drop the data between March 1, 2016 and March 30, 2016 to avoid the possibility that buyers have been aware of and discussed the policy change before the announcement date of March 22. As a result, my empirical analysis has 8,732 auction listings covering three months before and after the policy implementation.

In each auction listing, I observe detailed features, including the characteristics of the car, like body type, car age, traveled mileage, and vehicle title. In terms of the auction listing, I observe start price, final price, listing duration, the number of photos, the number of bidders, and who (either the buyer or the seller) pays the shipping fee in the transaction. I also observe informative details of the seller, including feedback scores, geographical location (at the state level), and professional dealership status.

Table 4.2.1. Descriptive Statistics

	Mean	SD	Min	Median	Max
Auction characteristics					
Final price ($)	8288.71	9369.64	2.00	5301.00	190001.00
Start price ($)	2194.34	5782.18	1.00	201.00	170001.00
Dealer	0.66	0.47	0.00	1.00	1.00
Seller feedback score	1223.12	2867.00	1.00	348.00	57840.00
Listing duration (days)	6.35	1.65	3.00	7.00	10.00
Buyers shipping	0.97	0.16	0.00	1.00	1.00
Number of photos	12.54	8.16	0.00	12.00	24.00
Number of bidders	10.61	5.83	1.00	11.00	33.00
Car characteristics					
Age (years)	10.54	4.39	0.00	11.00	17.00
Mileage	114254.45	78039.95	1.00	113849.00	2220000.00
Rebuilt	0.15	0.36	0.00	0.00	1.00
Clean	0.85	0.36	0.00	1.00	1.00
Body types					
SH	0.42	0.49	0	0	1
CC	0.14	0.34	0	0	1
SUV	0.23	0.42	0	0	1
VAN	0.22	0.41	0	0	1
Observations	8732				

Notes: SH = sedan and hatchback, CC = coupe and convertible, SUV = Sports utility vehicle, and VAN = Van and mini trucks.

Table 4.2.1 presents descriptive statistics for the full sample of 8,732 observations. Regarding vehicle characteristics, the average car age is 10.54 years with approximately 114,254 miles traveled.[9] The majority of vehicles (85 percent) hold a clean title, while 15 percent have a rebuilt title. In terms of seller characteristics, the average feedback score is 1,223. Given that this score accumulates based on the volume of past positive transactions, the high average indicates that the sample consists of experienced sellers familiar with auction rules. Professional dealers comprise 66 percent of the sample.[10] The auctions are competitive, averaging 10.61 bidders per listing with a mean duration of 6.35 days. Shipping costs are the buyer's responsibility in 97 percent of listings. Finally, the mean starting and final prices for the pooled sample are \$2,194 and \$8,289, respectively.

Table B.2.2 (Appendix) partitions the summary statistics by the WeGoLook policy intervention (3,640 pre-policy and 5,092 post-policy observations). Comparing the two periods, the fundamental physical characteristics of the inventory remained stable. Specifically, I do not observe significant differences in average mileage (115,073 vs. 113,669), vehicle age (10.34 vs. 10.69), or the proportion of vehicle titles (clean vs. rebuilt) after introducing the inspection option. This stability suggests that the type of cars sold did not significantly change due to the policy. However, variations appear in seller and pricing metrics. The average seller feedback score increased from 1,039 pre-policy to 1,354 post-policy. It is important to note that this increase likely reflects the mechanical accumulation of feedback ratings by incumbent sellers over time, rather than a fundamental shift in the composition of sellers entering the market. Furthermore, given that both means represent highly established sellers, the marginal impact of this score difference on buyer trust is likely limited. Regarding pricing, the raw average starting and final prices experienced a slight decline (from \$2,305 to \$2,115 and \$8,472 to \$8,158, respectively).

4.3 Theoretical Analysis

It is well known that information asymmetry leads to valuation uncertainty of a product in the market (Akerlof 1970). A commonly used way to mitigate or eliminate information asymmetry is information disclosure; that is, sellers can reduce product-valuation uncertainty and increase revenues by voluntarily disclosing verifiable information about the product to buyers. Following the seminal paper by Milgrom and Weber (1982), public information disclosure by the seller in the auction induces buyers' valuations to be more aligned, which will intensify the competition among buyers. As a result, they bid more aggressively to secure the item and that increases the expected auction final price and the seller's revenue. On eBay sellers are encouraged to disclose their private information using text and photos in the auction listings. Using eBay used car auction data, Lewis (2011) and Che *et al.* (2019)

9. In Table B.2.1 of the Appendix, I report all car makes and their volume in the sample.
10. Table B.2.4 details statistics by dealer type.

empirically find evidence that buyers rely on photos to form perceptions of the quality of cars, and information disclosure, i.e., providing more photos, increases auction final prices on eBay.

Another commonly used way to mitigate or eliminate information asymmetry is information acquisition. Collecting information about the product, before making a purchase decision, helps reduce valuation uncertainty and increase potential buyers' willingness to pay. This argument explains the purpose of introducing the WeGoLook inspection service in eBay car auctions, which attempts to provide a credible channel for the buyers to acquire relevant information with almost no cost (in contrast to a used car's value). Specifically, in an auction, buyers' information acquisition lowers the quality uncertainty of the used car and that results in more aggressive bidding, which increases the final price and auction revenue (Persico 2000).

From the discussion above, both seller information disclosure and buyer information acquisition share the same effect of eliminating information asymmetry about the quality of a car and intensifying bidding competition in an auction. This further implies that the presence of the latter may diminish the effect of the former. That is, given that buyers have access to verifiable information on the used car to be sold at their discretion, disclosing information resolves less uncertainty for buyers and thus plays a less essential role in revealing quality information. Specifically, the introduction of the WeGoLook inspection service will reduce the impacts of photos provided by the seller, and therefore, lower buyers' incentives to pay a price premium in the auction.

4.4 Empirical Model and Results

In this section, I formulate an empirical model to examine the impacts of introducing the WeGoLook inspection option on the demand side in the online marketplace. I adopt buyers' willingness to pay as a key indicator to gauge changes in demand side. In the context of eBay, I further investigate the impacts of the WeGoLook option on the existing trust system, specifically, sellers' information disclosure.

4.4.1 Empirical Strategy and Impacts on Demand Side

In order to evaluate the impacts of information disclosure and information acquisition on buyers' willingness to pay, as well as the potential interaction between those two institutions, I perform the following specification, in which I regress the natural log of the final price ($Final\ price$) of an auction listing on the WeGoLook policy dummy variable ($Post\_policy$),

the natural log of the number of photos ($ln(Photos)$), and the interaction term of the two variables as well as other controls ($Controls$).

$$ln(Final\ price)_i = \alpha + \beta Post\_policy_i + \gamma ln(Photos)_i + \delta ln(Photos)_i \times Post\_policy_i + Controls_i + \epsilon_i; \tag{4.1}$$

where i indexes a specific auction listing and ϵ is the error term. *ln(Final price)* is the natural log of the final auction price of a used car, which is the second highest bid in the auction, revealing buyer willingness to pay. The variable *Post_policy* is a dummy variable that indicates the WeGoLook inspection service, which equals one if the auction listing started after March 2016 and zero otherwise. The coefficients β and γ capture the response of buyers to the introduction of the inspection service and the number of photos disclosed by the seller in an auction listing, respectively. Furthermore, the interaction term between *Post_policy* and $ln(Photos)$ examines the substitutability of buyer information acquisition for seller information disclosure. The coefficient of interest, δ, shows how much buyers adjust their willingness to pay for the inspection service based on different levels of seller information disclosure.

In equation (4.1), the control variables denoted by *Controls* include the natural logarithm of the used car's age, mileage, and start price, a dummy variable indicating whether the seller is a professional dealer or private seller, the natural logarithm of the seller's feedback scores, the listing duration, a dummy variable indicating who pays the shipping fee (equals one if the winning buyer pays and zero otherwise), the number of bidders, and dummies for vehicle title sub-categories. Additionally, I include fixed effects for sellers, body types, and car makes. The standard error is clustered at the car make level.

Table 4.4.1 reports the estimation results. Column (1) shows that the introduction of the inspection option raises final auction prices by about 12 percent, with the $Post_policy$ coefficient positive and significant at the one percent level. The negative and significant interaction between the $Post_policy$ dummy and the number of photos indicates that the price premium from additional photos falls by roughly 5 percentage points (about 54%) after the WeGoLook service becomes available. The underlying mechanism is that buyers now have an active channel for acquiring information through third-party inspection reports, so they no longer rely solely on seller-provided photographs. As a result, the marginal trust generated by each additional photo declines. This suggests that buyer information acquisition functions as a substitute for seller information disclosure. The results remain robust after adding body-type fixed effects in column (2) and car-make fixed effects in column (3). Controlling for these attributes ensures that the estimated effects are not driven by systematic differ-

Table 4.4.1. Main Results

	(1)	(2)	(3)	(4)
Post_policy	0.119***	0.122***	0.122***	0.106***
	(0.04)	(0.03)	(0.03)	(0.02)
ln(Photos)	0.093***	0.091***	0.091***	
	(0.02)	(0.02)	(0.02)	
Post_policy×ln(Photos)	-0.049***	-0.049***	-0.049***	
	(0.02)	(0.01)	(0.01)	
Photos_Q2				0.075**
				(0.03)
Photos_Q3				0.165***
				(0.05)
Photos_Q4				0.275***
				(0.04)
Post_policy×Photos_Q2				-0.144***
				(0.03)
Post_policy×Photos_Q3				-0.117**
				(0.06)
Post_policy×Photos_Q4				-0.084**
				(0.03)
Seller FE	Y	Y	Y	Y
Body Type FE	N	Y	Y	Y
Make FE	N	N	Y	Y
R^2	0.626	0.653	0.653	0.657
Observations	8,732	8,732	8,732	8,732

Notes: Control variables are presented in Table B.2.5 of Appendix. Standard errors are clustered at car make (car brand) level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

ences in vehicle composition across periods, thereby strengthening the causal interpretation of the policy's impact.

$$\begin{aligned} ln(Final\ price)_i \ = \ \alpha \ + \ \beta Post\_policy_i \ + \ \sum_{j=2}^{4} \gamma_j Photos\_Q(j)_i \\ + \ \sum_{j=2}^{4} \delta_j Photos\_Q(j)_i \times Post\_policy_i \ + \ Controls_i \ + \ \epsilon_i; \end{aligned} \tag{4.2}$$

I then consider a specification described by equation (4.2), where $Photos\_Q(j)_i$ $(j = 2, 3, 4)$ are dummy variables indicating the quartile of photo quantity provided in the listing, with the first quartile ($Photos\_Q1$) serving as the benchmark group. Based on the data distribution, the benchmark group covers listings with minimal disclosure (0 to 5 photos), while the subsequent quartiles represent listings with 6-12, 13-21, and 22-24 photos, respectively. The estimated results are presented in column (4) of Table 4.4.1. The positive and significant coefficient on the *Post_policy* dummy (0.106^{***}) indicates that for the benchmark group with the lowest information disclosure, the introduction of the inspection service significantly increased the final auction price. This suggests that the mere option of third-party verification provides a "safety net" that boosts buyers' willingness to pay, particularly for listings that previously lacked visual evidence. Crucially, the interaction terms for all three higher quartiles exhibit significant negative coefficients (-0.144^{***}, -0.117^{**}, and -0.084^{**}), confirming a strong substitution effect. This finding implies that the availability of the inspection service dampens the price premium previously commanded by extensive seller disclosure, effectively narrowing the gap between high-disclosure and low-disclosure sellers.

Overall, table 4.4.1 presents the results of the primary regression analysis. Across all specifications, vehicle age, a key determinant of value, is negatively associated with the final auction price. The results also indicate that auction characteristics, such as start price and listing duration, significantly influence the final price. Furthermore, the number of bidders exhibits a positive and significant correlation with the final price, a finding consistent with standard economic intuition. For brevity, the full estimated coefficients for the control variables are reported in Table B.2.5 of the Appendix.

4.4.1.1Heterogeneous Impact on Vehicle Quality

Car titles are a required disclosure in the listings and can be broadly categorized into two main sub-categories: clean and rebuilt.[11] See Figure B.1.2 in the Appendix for an exam-

11. eBay also includes vehicle titles of "salvage", "Lemon & Manufacturer Buyback" and "Not Specified." A salvage-title car means that it has been severely damaged and/or deemed a total loss by an insurance company that paid a claim on it. Due to the high likelihood of significant damage, consumers are more likely

ple. A car with a clean title has no accidents officially reported by an insurance company, while a rebuilt title is given to a car that has been repaired and has passed the (U.S) state government inspection. With a rebuilt title, there is little uncertainty in the mechanical and non-mechanical conditions of a used car. Conversely, with a clean title, there are often hidden problems, such as flaws and damages, which lead to substantial quality uncertainty.

This feature allows us to explore how the effect of buyer information acquisition on the auction final price varies with the level of quality uncertainty buyers face. The incentives for buyers to obtain information may differ across vehicle-title sub-categories. Since the cost of the report is relatively low compared to the potential price paid, the decision to obtain information depends on its value in reducing quality uncertainty for a used car. Based on the characteristics of different vehicle-title sub-categories, I can analyze how buyers' information acquisition behavior affects the auction final price. In the case of rebuilt-title cars, which have been repaired and passed state inspection, there is little uncertainty in both mechanical and non-mechanical conditions. Therefore, one can expect that buyers are less interested in acquiring information about the mechanical and non-mechanical conditions of these cars. In contrast, the inspection service is more valuable for clean-title cars, where buyers face uncertainty that can be largely resolved by obtaining information about minor and non-mechanical conditions such as dents or scratches. This prediction suggests that the number of photos may be more substitutable for the clean-title sub-category than for the rebuilt sub-category.

In table 4.4.2, I examine how the impacts of the WeGoLook inspection service and its substitutability for the number of photos would vary with different vehicle title sub-categories. To do so, I separately re-estimate equation (4.1) for the rebuilt-title and clean-title sub-categories, and report the results in Table 4.4.2. For the clean-title sub-category in column (2), I still observe that the coefficients of the *Post_policy* dummy and its interaction term with the number of photos are significant; the average effect of the inspection service on the sub-category increases the final price by 13.2 percent and lowers the price premium from photos by 5 percent. However, I do not find the same pattern for the rebuilt-title sub-categories; that is, in columns (1), the coefficients of interest are insignificant, although their signs are the same as in Table 4.4.1.

The estimation results show the conditions under which the WeGoLook inspection service would lower information asymmetry and increase the final price. The rebuilt-title cars are

to buy such used cars for car parts or other purposes rather than for driving. Therefore, I exclude the salvage sub-category. I also exclude "Lemon & Manufacturer Buyback" due to the limited number of auction listings available, only 19 in this case. The inclusion of such a small sample size could potentially introduce noise or bias into the analysis and potentially affect the reliability of my results. Finally, I removed "Not Specified" due to missing information about the car title.

refurbished and painted, and more importantly, has passed the inspections by the state government. As a result, the obvious mechanical problems of rebuilt title used cars are largely eliminated and the non-mechanical uncertainties are relatively lower compared to clean titles. Therefore, the inspection service for rebuilt sub-category is not as valuable as for the clean-title sub-category, in which the quality uncertainty is mainly from the non-mechanical conditions. My finding contrasts with the result by Tadelis and Zettelmeyer (2015) that information-asymmetry mitigation would be more beneficial for the high- and low-quality car groups.

4.4.1.2Heterogeneous Impact on Seller Types

In the data, I can observe whether the car auction is listed by a professional dealer or a private seller. It is then of interest to examine whether and how the introduction of the WeGoLook inspection service would affect bidders' bidding behavior and final prices differently across these two types of sellers. In contrast to private sellers, professional dealers have higher incentives to maintain their reputations in the markets. Indeed, the professional dealers have substantially higher reputations (measured by feedback scores) on average in my sample. Moreover, the different reputation concerns imply different daily efforts in maintaining the used cars in good (both mechanical and non-mechanical) conditions. In addition, the professional dealers would have more expertise in repairing and removing mechanical problems; on eBay, a reasonably large proportion of the dealers provide after-sales warranties, i.e., 90 days and/or $3,000$ miles. Thus, the status of a dealership can also signal the quality of a car, implying that the degree of quality uncertainty with the used cars listed by the private sellers is relatively high such that the inspection service (which focuses on non-mechanical conditions) would hardly resolve.

In Table 4.4.2, I examine whether and how the impacts of the WeGoLook inspection service and its substitutability for seller information disclosure differ across two types of sellers. I estimate equation (4.1) separately for professional dealers and private sellers, and report the results in columns (3) and (4) of the table 4.4.2. The results indicate that the presence of the inspection service and its substitution for the number of photos have a significant effect on the professional dealer group only. This finding is consistent with my predictions, suggesting that cars listed by professional dealers would have relatively lower quality uncertainty compared to those listed by private sellers. As a result, the presence of the WeGoLook inspection service, which mainly inspects the non-mechanical conditions of a car, would impact professional dealers more than private sellers. My empirical finding is consistent with my prior predictions.

Based on the previous discussion of the uncertainties associated with car title and seller type,

Table 4.4.2. The Heterogeneous Impacts of WeGoLook Policy

Panel A: The Heterogeneous Impacts Across Dealership and Vehicle Titles				
	Rebuilt	Clean	Dealer	Private seller
	(1)	(2)	(3)	(4)
Post_policy	0.018	0.132***	0.081**	0.057
	(0.17)	(0.03)	(0.04)	(0.07)
ln(Photos)	0.158***	0.082***	0.038**	0.315***
	(0.05)	(0.02)	(0.02)	(0.04)
Post_policy×ln(Photos)	-0.020	-0.050***	-0.026*	-0.026
	(0.06)	(0.01)	(0.01)	(0.03)
Seller FE	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y
Make FE	Y	Y	Y	Y
R^2	0.604	0.624	0.740	0.595
Observations	1,347	7,385	5,776	2,956

Panel B: The Heterogeneous Impacts Across Uncertainty Levels				
	Dealer		Private Seller	
	Rebuilt	Clean	Rebuilt	Clean
	(1)	(2)	(3)	(4)
Post_policy	0.090	0.070*	-0.709	0.081
	(0.11)	(0.04)	(0.49)	(0.07)
ln(Photos)	0.126*	0.021	0.097	0.319***
	(0.06)	(0.02)	(0.15)	(0.04)
Post_policy×ln(Photos)	-0.042	-0.011	0.236	-0.034
	(0.04)	(0.01)	(0.16)	(0.03)
Seller FE	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y
Make FE	Y	Y	Y	Y
R^2	0.611	0.711	0.613	0.603
Observations	1,097	4,679	250	2,706

Notes: The table includes dummy variables: "Rebuilt" equals one for rebuilt-title used cars and zero otherwise, "Clean" equals one for clean-title used cars and zero otherwise, "Dealer" equals one for professional dealer sellers and zero otherwise, and "Private Seller" equals one for private seller sellers and zero otherwise. Standard errors are clustered at car make (car brand) level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

the combination of these factors can generate more uncertainties about product quality. For instance, a clean-title used car sold by a private seller may have different quality uncertainties compared to the same title sold by a dealer due to the former having fewer reputation concerns and limited technical resources. However, the effectiveness of the WeGoLook service in reducing these uncertainties is not clear. To address this, I further divided the products sold by dealers and private sellers into rebuilt and clean subgroups and re-estimated Equation 4.1. The results are presented in Panel B of Table 4.4.2. Column (2) shows that the WeGoLook option significantly increases buyers' willingness to pay for used cars with clean titles sold by dealers, suggesting a refined boundary of the WeGoLook policy. I also observe that the seller's disclosure is not significant in this case, indicating that the WeGoLook service does not replace the premium that buyers place on seller disclosure.

4.4.2 Impacts on Supply Side

I also observe a change in sellers' behavior after the introduction of the inspection policy. In this section, using the number of photos posted by the sellers and other performance measures, I am able to further test the "inspection effect" from the supply side. I first present evidence that shows a reduction in moral hazard due to an overall improvement in seller disclosure. Based on this, I further conduct the analysis at the sub-category level and reveal the change across vehicle quality and seller expertise. Next, I show evidence of an improvement in sellers' efforts with other metrics. Finally, I show evidence suggesting the reduction in adverse selection is likely due to the improved product quality, rather than a higher market share of high-quality sellers. Overall, I present evidence that the policy has had an impact on improving the average transparency and efficiency in the market.

4.4.2.1Impacts on Moral Hazard

The introduction of the inspection policy allows buyers to access product information, and consequently, enables buyers to verify the authenticity of the information already disclosed by sellers. On this basis, after implementing the inspection policy, sellers may adopt different disclosure strategies based on different considerations.

On the one hand, reputation concerns compel sellers to disclose more to mitigate uncertainty in products and signal their quality. When a seller discloses more information, the chance that buyers obtain some information are not covered by what the seller disclosed is lower. Hence, the seller is less susceptible to fraudulent behavior and is more likely to obtain a better price. He can also build up a reputation of honesty by doing so, which contributes to his future transactions. On the other hand, Matthews and Postlewaite (1985) and Shavell

(1994) suggest that if sellers have to disclose unfavorable information that may affect their profits, they will minimize the gathering of such information. Prior to the introduction of the WeGoLook service, sellers are able to manipulate the disclosed information to attract buyers without any risk of being caught. However, the implementation of WeGoLook service has brought the potential risk of false disclosures being detected by buyers, which could result in a loss of trust and revenue for sellers. As a result, sellers may choose to either reduce their level of disclosures to avoid such repercussions or invest more in improving the quality of secondhand cars to guarantee trustworthy and beneficial disclosure. Based on research by Grossman and Hart (1980) and Jovanovic (1982), the decision of whether or not to disclose information can be influenced by the costs involved. Therefore, sellers may prefer to reduce their level of disclosure to avoid incurring higher costs. Therefore, further research is needed to investigate the impacts of the WeGoLook service on seller behavior, given the conflicting incentives of reputation concerns and potential risks of false disclosures.

In Table 4.4.3, I present the impacts of the inspection policy on seller disclosure behavior. To evaluate these impacts, I perform a regression analysis of the natural logarithm of the number of photos disclosed by sellers on the policy dummy *Post_policy*, along with other covariates and fixed effects specified in the main model. Column (1) of Panel A reports a statistically significant increase of 17.2% in the number of photos disclosed by sellers after the implementation of the policy (see Fig B.2.1 of the Appendix), suggesting that the inspection policy has had a positive effect on the seller behavior by encouraging them to disclose more information about their used cars. This improvement in seller behavior is indicative of a reduction in moral hazard and an enhancement in market transparency. However, this raises questions about the underlying causes of this change, which I aim to explore in the following discussion.

Heterogeneous vehicle qualities. In section 4.4.1.1, I have established that the title of a car has a significant impact on the perceived uncertainty about its quality, which in turn affects the consumers' willingness to pay for additional information. With the introduction of the WeGoLook policy, I anticipate that the levels of uncertainty associated with the quality of used cars will continue to influence the disclosure strategies of sellers.

Table 4.4.3 showcases the sellers' heterogeneous response to the inspection policy for different qualities of used cars. To investigate this, I divided my sample into two groups based on the car's title and then conducted the same regression as column (1) of Table 4.4.3. The results, presented in columns (2) and (3) in Panel A, indicate that sellers significantly increase the number of disclosed pictures by approximately 20% for clean-title cars, while there is no such increase for rebuilt-title cars. This may be due to the fact that rebuilt-title cars are typically more customized and high-end, leading to less uncertainty for buyers and thus less

motivation for sellers to provide additional information. Conversely, for clean-title used cars that are perceived as having a higher level of uncertainty, sellers rely on photo displays to alleviate buyers' quality concerns and increase their purchasing confidence.

Heterogeneous seller types. I further investigate the response of different types of sellers to the WeGoLook policy. Although dealers and private sellers face uncertainty of product quality due to information asymmetry, the degree of uncertainty in their products and the marginal cost to provide additional photos differ.

In Panel A, columns (4) and (5) of Table 4.4.3, I sort sellers into two groups, professional dealers and private sellers, and estimate the regression in column (1) of this table separately for each group. My findings suggest that the policy had a significant impact on the disclosure behavior of professional dealers, who increased their disclosure by 23.8% at a significance level of 1%, whereas private sellers did not change their disclosure behavior significantly. I attribute this difference to the professionalism of dealers and the lower marginal cost they have for photo disclosure. From a cost-benefit perspective, dealers are more likely to benefit from investing in disclosure than private sellers. In addition, as previously discussed in Table 4.4.1, the introduction of the inspection service results in a lower price premium for information disclosure at every level, which may encourage sellers to disclose more information to maintain their previous price premium level. However, low-quality sellers are unlikely to imitate the disclosure behavior of high-quality sellers as they cannot generate net revenue through increased disclosure after the policy announcement.

Given that the uncertainty brought about by car title and seller type is not independent of each other, their combination will produce more uncertainty about product quality. Specifically, with the same clean title, the quality uncertainty of products sold by private sellers may differ from those sold by dealers, as private sellers have fewer reputation concerns and limited technical resources. To further investigate this issue, on the basis of columns (4) and (5) in Panel A, I divided the products sold by dealers and private sellers into rebuilt and clean groups according to car title, respectively. I then re-ran the regression in column (1) in Panel A, and the results are reported in Panel B of Table 4.4.3. According to the result in column (2), the WeGoLook policy significantly increases the information disclosure for clean-title used cars sold by dealers. These findings increase the robustness of my discussion about quality uncertainty and its corresponding affects.

In summary, the above discussion reveals that the implementation of WeGoLook leads to an overall increase in buyer effort to improve the quality of services, suggesting a reduction in moral hazard in the market. The change in seller behavior is primarily observed among dealers rather than private sellers. Moreover, the response of sellers to WeGoLook policies

is determined by the level of uncertainty associated with product quality, and this, in turn, influences their disclosure strategy.

4.4.2.2Impacts on Adverse Selection

In this section, I provide indirect evidence to show that the change in seller behavior I discussed in last section is not driven by the composition of sellers in the market. To address this concern, I regress the dummy variable *Dealer* on the policy dummy *Post_policy*, while controlling for all the covariates and fixed effects in my main specification. The result in column (1) in Panel A of Table 4.4.4 indicates that there is no significant change in the proportion of dealers after the release of the WeGoLook policy (see Fig B.2.3 of the Appendix). Considering that my model only selects the data of three months before and after the policy change, a shorter time period can guarantee the consistency of consumer preferences. Therefore, the transaction data I use can also indirectly indicate that the composition of incumbent dealers and private sellers on eBay has not changed significantly.

Next, I present additional evidence that sellers exert more effort, using alternative indicators to demonstrate the robustness of my results to different specifications. Specifically, I examine the seller feedback score and eBay Top Rated Seller reputation badge (hereafter, eTRS), both of which reflect the overall performance of sellers.

To demonstrate that the reduction in moral hazard in markets is robust to other measures, I perform additional regression analyzes using alternative indicators. Firstly, I conduct a similar regression analysis on the proportion of sellers who have earned the eTRS badge. The eTRS badge indicates that a seller has consistently provided a high level of customer service and has met specific performance standards. Column (2) in Panel B of Table 4.4.4 shows that the policy has a positive and significant impact on the proportion of badged sellers, with an increase of 14.2% after the policy change, suggesting that sellers have improved their overall customer service and managed to earn a badge. Furthermore, I perform separate regression analyzes for dealers and private sellers. The results show that both types of sellers significantly improve their service quality, indicating that the reduction in moral hazard in the market is equally robust for both dealer and private sellers.

Secondly, I conduct a regression of seller feedback score, which reflects the overall performance of sellers, on the policy dummy, while controlling for all the covariates and fixed effects in main specification. The results in column (5)-(7) in Panel A of Table 4.4.4 show that the introduction of the inspection policy leads to a significant increase of 12.5% percent in sellers' feedback scores. The improvement is mainly driven by dealers, whose feedback score has increased significantly by 20%, indicating that sellers put more effort into providing

Table 4.4.3. The Impacts of WeGoLook Policy on Photos across Vehicle and Seller Types

Panel A: Policy effects on mitigating asymmetric information					
Dep. var: ln(Photo)	Full sample	Rebuilt	Clean	Dealer	Private seller
	(1)	(2)	(3)	(4)	(5)
Post_policy	0.172***	0.006	0.196***	0.238***	0.032
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Seller FE	Y	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y	Y
Make FE	Y	Y	Y	Y	Y
R^2	0.236	0.436	0.175	0.300	0.339
Observations	8,732	1,347	7,385	5,776	2,956

Panel B: Classify sellers according to Dealership and Car title				
Dep. var: ln(Photo)	Dealer		Private Seller	
	Rebuilt	Clean	Rebuilt	Clean
	(1)	(2)	(3)	(4)
Post_policy	0.009	0.285***	-0.025	0.036
	(0.03)	(0.03)	(0.08)	(0.02)
Seller FE	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y
Make FE	Y	Y	Y	Y
R^2	0.569	0.210	0.376	0.348
Observations	1,097	4,679	250	2,706

Notes: The table includes dummy variables: "Rebuilt" equals one for rebuilt-title used cars and zero otherwise, "Clean" equals one for clean-title used cars and zero otherwise, "Dealer" equals one for professional dealer sellers and zero otherwise, and "Private Seller" equals one for private seller sellers and zero otherwise. Standard errors are clustered at car make (car brand) level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

a better experience for buyers, which aligns with myprior findings. This suggests that the reduction in moral hazard in the market is not only reflected in the proportion of badged sellers but also in the overall performance of sellers.

In Panel B of Table 4.4.4, I present evidence that WeGoLook has mitigated adverse selection in the market by examining changes in the quality of used cars sold by market incumbents before and after the policy's introduction. Among the quality indicators, mileage is one of the most critical indicators for consumers. Therefore, I conduct a regression of $Mileage$ (a vehicle's traveled mileage) on the policy dummy, while controlling for all the covariates and fixed effects in the main specification. Column (1) shows that sellers provide cars with 4% less traveled mileage after the policy's implementation (see Fig B.2.2 of the Appendix), with a statistical significance level of 5%. After grouping dealers and private sellers and performing regression respectively, columns (2) and (3) reveal that the quality of used cars sold by incumbents in the market has improved, mainly because private sellers have enhanced the quality of used cars they sell.

In the context of eBay, the title of a used car is also an indicator of car quality that consumers clearly perceive. Therefore, I perform a regression of the dummy variable *Rebuilt* on the policy dummy, while controlling for all the covariates and fixed effects in the main specification. Column (4) shows that buyers are significantly more likely to buy a rebuilt-title car by 1.6% after the introduction of the WeGoLook policy. Further analyzes in columns (5) and (6) reveal the same pattern as I find in the change in car mileage, proving that private sellers who remain active on the market after the policy significantly improve their product quality.

This study produced comparable outcomes to those of Hui *et al.* (2016), but my research revealed a distinct mechanism. Specifically, my study found that the newly implemented trust system led to enhancements in product quality for active low-quality sellers in the market, rather than improving their service quality, thereby mitigating adverse selection.

4.5 Robustness

In this section, I consider a variety of alternative explanations to examine the robustness of the results.

Different specifications of the regression. I first address the concern that whether the main findings are driven by the particular specification of the natural logarithm of photos in the estimation. In column (1) of Table 4.5.1, I re-estimate equation (4.1) by using the number of photos instead of its natural logarithm and find that my empirical findings still hold.

Table 4.4.4. The Impacts of WeGoLook Policy on Mitigating Information Asymmetry

Panel A: Policy impacts on mitigating moral hazard

	Dealership	Seller Feedback Score		
		Full sample	Dealer	Private seller
	(1)	(2)	(3)	(4)
Post_policy	0.007	0.125***	0.200***	-0.082
	(0.01)	(0.04)	(0.04)	(0.07)
Seller FE	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y
Make FE	Y	Y	Y	Y
R^2	0.354	0.349	0.479	0.150
Observations	8,732	8,732	5,776	2,956

Panel B: Policy impacts on mitigating adverse selection

	Mileage			Rebuilt		
	Full sample	Dealer	Private seller	Full sample	Dealer	Private seller
	(1)	(2)	(3)	(4)	(5)	(6)
Post_policy	-0.040**	-0.001	-0.109***	0.016**	0.017	0.018**
	(0.02)	(0.02)	(0.03)	(0.01)	(0.01)	(0.01)
Seller FE	Y	Y	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y	Y	Y
Make FE	Y	Y	Y	Y	Y	Y
R^2	0.360	0.422	0.240	0.329	0.399	0.100
Observations	8,732	5,776	2,956	8,732	5,776	2,956

Notes: Panel A includes several regression columns with the dependent variable "Dealer" in column (1), "eTRS" dummy variable for eBay Top Rated Sellers in columns (2)-(4), and sellers' feedback score in columns (5)-(7). Panel B includes regression columns with the dependent variable "Mileage" for cars' traveled mileage in the first three columns and the "Rebuilt" dummy variable in the last three columns. Standard errors are clustered at car make (car brand) level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table 4.5.1. Robustness Check – I

	Photos	No Bidders	Brands	
	(1)	(2)	(3)	(4)
Post_policy	0.051**	0.078**	0.162***	0.132***
	(0.02)	(0.03)	(0.03)	(0.03)
ln(Photos)		0.070***	0.110***	
		(0.02)	(0.02)	
Post_policy×ln(Photos)		-0.029**	-0.066***	
		(0.01)	(0.01)	
Photos	0.012***			
	(0.00)			
Post_policy×Photos	-0.003**			
	(0.00)			
Photos_Q2				0.124***
				(0.03)
Photos_Q3				0.206**
				(0.07)
Photos_Q4				0.310***
				(0.05)
Post_policy×Photos_Q2				-0.174***
				(0.04)
Post_policy×Photos_Q3				-0.160**
				(0.06)
Post_policy×Photos_Q4				-0.126***
				(0.03)
Seller FE	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y
Make FE	Y	Y	Y	Y
R^2	0.655	0.616	0.659	0.662
Observations	8,732	8,732	6,621	6,621

Notes: Standard errors are clustered at car make (car brand) level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Second, one may argue that bidders endogenously make their entry decisions in participating in the listed auction. Therefore, my regression results may be biased by including such an endogenous variable (*the number of bidders*). To cope with this concern, I re-estimate equation (4.1) by excluding the number of bidders. Column (2) shows that although there is a drop in the magnitude of the variables of interest, I still observe that the WeGoLook inspection service increases the final price and lowers the price premium from photos.

Next, I examine whether the results would be driven by including those car brands which take relatively small market shares. To address this concern, I only keep the top 10 best-selling car brands in the sample and then re-do equations (4.1) and (4.2).[12] The estimation results are presented in columns (3) and (4) of Table 4.5.1, suggesting that the empirical findings are not affected.

Table 4.5.2. Robustness Check – II

	-2/+2 Months	-3/+1 Months	-3/+2 Months	Weekend	Weekday
	(1)	(2)	(3)	(4)	(5)
Post_policy	0.107**	0.188***	0.150***	0.061	0.139***
	(0.04)	(0.04)	(0.04)	(0.14)	(0.03)
ln(Photos)	0.091***	0.092***	0.093***	0.080*	0.096***
	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)
Post_policy×ln(Photos)	-0.057***	-0.064***	-0.055***	-0.041	-0.050***
	(0.02)	(0.01)	(0.01)	(0.05)	(0.01)
Seller FE	Y	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y	Y
Make FE	Y	Y	Y	Y	Y
R^2	0.663	0.656	0.651	0.658	0.658
Observations	5,545	5,612	7,182	1,320	7,412

Notes: Standard errors are clustered at car make (car brand) level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Different time periods. I then conduct regression analyzes to investigate the robustness of the results to different time windows, and the findings are presented in Table 4.5.2. Column (1) shows the estimation when including two-month transactions before and after the introduction of the inspection service, and the results indicate that the findings remain robust. Additionally, I obtained similar results when excluding two-month and one-month transac-

12. The top brands are Toyota, Honda, Chrysler, Ford, Mercedes, Volkswagen, BMW, Audi, Cadillac and Nissan.

tions after the inspection service (as shown in columns (2) and (3)).

As the service provider of WeGoLook adopts crowdsourcing, there are typically more quality inspectors available on weekdays than on weekends. Due to privacy concerns, I could not directly observe whether consumers use this service. However, the results in columns (4) and (5) demonstrate that consumers' willingness to pay increases significantly by approximately 14% during weekdays when WeGoLook is more available. Since the composition of sellers and the quality of products offered can not be changed significantly on weekends, I interpret the increase in consumers' willingness to pay after the introduction of WeGoLook as the impact of the policy itself.

Willingness to pay from other bidders. There exists a possibility that since buyers who are willing to bid high prices may be more sensitive to market changes, the introduction of the WeGoLook inspection service and its substitutability for seller information disclosure would only affect the willingness to pay of the auction winners but not commonly for other participating bidders. To address this question, I here replicate the estimations in equation (4.1) by using the natural log of the i-highest bid as the dependent variable, where $i = 3; 4; 5$. The estimation results are presented in columns (1)-(3) of Table 4.5.3, none of which significantly changes, providing further evidence to support the results.

Heterogeneity across vehicle segments. Market segments differ significantly in their inherent quality uncertainty and usage patterns. One might argue that the impact of the WeGoLook inspection service is not uniform across the whole market but rather concentrated in segments with higher information asymmetry. To test this, I re-estimate equation (4.1) by classifying vehicles into four sub-categories: sedan and hatchback (SH), coupe and convertible (CC), van and mini trucks (VAN), and SUV.

Columns (4)-(7) of Table 4.5.3 report the results. The coefficient for $Post\_policy$ is positive and statistically significant for the CC and VAN sub-categories. This finding aligns with the intuition that coupes and convertibles often possess specialized mechanical features or enthusiast-driven histories, while vans are frequently subject to intense commercial wear; both scenarios generate high ex-ante uncertainty, thereby increasing the marginal value of the verification option. Conversely, for SH and SUV models, which represent more standardized commuter vehicles with lower baseline risk, the average price effect is statistically insignificant. However, it is worth noting that the interaction term remains negative and significant for the SH group. This suggests that even in commoditized segments where the policy does not drive a uniform price increase, it still fundamentally alters the information structure by reducing the market's reliance on seller-provided photos.

Table 4.5.3. Robustness Check – III

	3^{rd} Bid	4^{th} Bid	5^{th} Bid	SH	CC	SUV	VAN
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post_policy	0.104***	0.097**	0.082*	0.062	0.268**	0.081	0.224***
	(0.03)	(0.04)	(0.04)	(0.04)	(0.10)	(0.06)	(0.05)
ln(Photos)	0.070***	0.060**	0.057**	0.049**	0.166***	0.079***	0.073**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Post_policy×ln(Photos)	-0.048***	-0.041**	-0.035**	-0.031*	-0.092**	-0.041	-0.074***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.04)	(0.02)	(0.02)
Seller FE	Y	Y	Y	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y	Y	Y	Y
Make FE	Y	Y	Y	Y	Y	Y	Y
R^2	0.685	0.680	0.664	0.719	0.546	0.713	0.614
Observations	7,248	6,885	6,567	3,660	1,184	2,005	1,883

Notes: Columns (1)-(3) have the natural log of the i-highest bid as the dependent variable, where i equals 3, 4, or 5. The car types are indicated by SH for Sedan and Hatchback, CC for Coupe and Convertible, SUV for SUV, and VAN for Van and Mini Truck. Standard errors are clustered at car make (car brand) level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table 4.5.4. Car characteristics

	Buyer shipping (1)	Start price (2)	Age (3)	Mileage (4)	Warranty (5)
Post_policy	0.129*	0.110**	0.490***	0.423***	0.146***
	(0.07)	(0.04)	(0.06)	(0.09)	(0.04)
ln(Photos)	0.091***	0.092***	0.113***	0.109***	0.091***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Post_policy×					
ln(Photo)	-0.049***	-0.050***	-0.082***	-0.075***	-0.062***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Buyer shipping	-0.006				
	(0.06)				
Start price		0.002			
		(0.01)			
Age			-0.028***		
			(0.00)		
Mileage				-0.000***	
				(0.00)	
Warranty					0.115***
					(0.03)
Seller FE	Y	Y	Y	Y	Y
Body Type FE	Y	Y	Y	Y	Y
Make FE	Y	Y	Y	Y	Y
R^2	0.653	0.653	0.657	0.664	0.670
Observations	8,732	8,732	8,732	8,732	7,381

Notes: Standard errors are clustered at car make (car brand) level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Auction characteristics. I acknowledge the possibility that the impact of the WeGoLook inspection service may be systematically correlated with the underlying characteristics of the auction listing and the car, which could affect the auction's final price. For instance, prior research by Che *et al.* (2019) suggests that a warranty as a quality signal can reduce information asymmetry and generate a price premium for sellers in car auctions. To address this concern, I re-estimate equation (4.1) by adding interaction terms between the *Post_policy* dummy and auction listing features, such as buyer shipping and start price, as well as car attributes, including age, mileage, and warranty, as additional control variables.

The results, reported in Table 4.5.4, indicate that the significance of the inspection service dummy and its interaction terms with the natural log of the number of photos remain unaffected after controlling for the features of the listings and the characteristics of the cars. Therefore, my findings are robust to potential confounding factors related to the auction listings and the cars being sold, and support the conclusion that the WeGoLook inspection service has a positive effect on the final price of used cars in online auctions.

4.6 Conclusion and Policy Implications

Using the used car auction data from eBay Motors, I find that introducing the WeGoLook inspection service, which allows potential buyers to acquire information on the underlying items, helps mitigate quality uncertainty and increases the final prices of the auctions. I also find that the price premium from seller information disclosure (revealing more photos) becomes lower after the introduction of the service, suggesting that there exists a significant substitution between buyer information acquisition and seller information disclosure in eliminating information asymmetry. I further analyze the heterogeneous effects of the inspection service across different vehicle titles and seller types, finding that the service generates a greater impact on the clean-title group than the rebuilt- and salvage-title groups, and affects the professional dealers more than the private sellers. This reflects that buyers would be more interested in using the inspection service to avoid potential non-mechanical problems. Finally, I find that this service can alleviate moral hazard and adverse selection problems in the market and improve market efficiency.

My empirical findings provide some policy implications. First, information asymmetry is one of the essential issues that online platforms have to cope with in their daily operations. The WeGoLook inspection service can improve market efficiency by reducing moral hazard and adverse selection, which helps buyers make more informed decisions and encourages sellers to provide higher quality products. This, in turn, can lead to a more efficient allocation of resources and enhance market efficiency. Differing from previous studies focusing on seller information disclosure, this study finds that facilitating information acquisition by

the uninformed party, i.e., buyers, with a low cost improves transparency in the market and increases buyers' willingness to pay. This empirical finding provides another channel that online platforms would use to overcome information asymmetry.

Second, my results show that information acquisition by buyers has a similar effect as information disclosure by sellers, which sheds light on understanding the substitution relationship between the two mechanisms in mitigating adverse selection problems in the online markets. Despite that service from WeGoLook was introduced only recently to eBay Motors, buyer information acquisition must exist in other forms, such as looking for information about online sellers and the products being sold in online forums or social media. The market outcomes are determined jointly by such information acquisition and other instruments available to the online platform users, such as information disclosure. Given the increasing importance of e-commerce and the development of the digital economy, designing the information-asymmetry-elimination mechanisms independently may not be optimal. Hence, it is beneficial for online platforms to take interactions among mechanisms into account in designing policies in online marketplaces.

Third, by exploring the impacts of the WeGoLook inspection service, I also contribute to providing insights into the conditions and boundaries under which buyer information acquisition would work. My empirical findings suggest that a uniform information acquisition policy across all the products and sellers would not be optimal and further provide guidance for the online platforms and relevant policymakers to implement targeted policies by considering the characteristics of products and seller types.

4.7 Limitations and Future Research

This study provides new empirical evidence on how buyer information acquisition affects online market outcomes. However, as with any empirical research, several limitations must be acknowledged. These limitations primarily concern data availability, potential endogeneity, and the need for stronger theoretical and behavioral foundations.

One of the main concerns in this study arises from the inability to observe the actual usage of the WeGoLook inspection service by buyers. The analysis treats the WeGoLook policy as a binary change, assuming full exposure for all listings after March 2016. In practice, buyer adoption of the inspection option was voluntary, and utilization rates may vary across regions, price segments, or seller reputations. Without detailed data on inspection usage, the estimated effect should be interpreted as an intention-to-treat (ITT) rather than an average treatment effect on the treated (ATT). Consequently, the results may either overestimate or underestimate the true behavioral response of consumers to the inspection option. Future

work could combine eBay transaction data with WeGoLook's internal records to construct a more precise measure of policy exposure and identify heterogeneous treatment effects.

A second limitation concerns the potential endogeneity in seller disclosure behavior. In this study, the number of photos is treated as an exogenous indicator of information disclosure. Yet sellers may strategically choose how much to disclose based on their private information about product quality or anticipated buyer demand. This simultaneity could bias the estimated effects, as high-quality sellers are both more likely to post additional photos and to receive higher prices. Future studies could address this challenge by using instrumental variables that capture exogenous variation in disclosure costs (e.g., bandwidth constraints, listing fees, or platform-level photo limits) or by leveraging natural experiments involving platform design changes.

Beyond these empirical concerns, there are several promising directions for future research. First, the behaviors described in this paper remain underexplored in the theoretical literature. Future studies could formalize the mechanisms of buyer information acquisition and seller disclosure within a unified framework of asymmetric information. A model deriving comparative statics on equilibrium disclosure and acquisition decisions would complement the empirical findings and clarify the welfare implications. Moreover, explicitly modeling the interaction between buyers' inspection choices and sellers' disclosure strategies could reveal how the two mechanisms jointly determine equilibrium outcomes and platform efficiency.

Second, future research could integrate external data sources to provide a more granular understanding of consumer perception and behavioral responses. The current interpretation relies on the assumption that higher final prices reflect improved buyer information and reduced information asymmetry. However, alternative mechanisms, such as enhanced buyer confidence, changes in bidder composition, or platform algorithm adjustments, remain unexplored. Incorporating complementary datasets, such as actual inspection usage rates, buyer review histories, or cross-listing behavior across platforms, would enable researchers to disentangle these channels and validate the underlying behavioral assumptions.

In summary, while this study provides credible empirical evidence that enabling buyer information acquisition can mitigate information asymmetry and improve market efficiency, future research should extend these findings by combining theoretical modeling, richer behavioral data, and cross-market evidence. Doing so would yield a more comprehensive understanding of how digital inspection and disclosure systems reshape trust, transparency, and welfare in online markets.

Chapter 5

Thesis Conclusions

This dissertation has examined how information asymmetry shapes market efficiency, trust, and welfare in the used car market and how digital transformation alters the mechanisms through which these asymmetries are mitigated. Across three independent but conceptually connected essays, it has explored how information flows, through digital platforms, corporate social responsibility initiatives, and buyer, driven inspection services-affect market behavior, pricing, and consumer confidence. Collectively, these chapters provide a unified understanding of how credible information mechanisms and institutional design can enhance transparency and restore efficiency in markets characterized by imperfect information.

Chapter 2 provides a comprehensive synthesis of theoretical and empirical studies addressing information asymmetry in the used car market, emphasizing the transformative role of digital platforms. The analysis integrates findings from both offline and online contexts, showing that while digitalization reduces traditional frictions, it also introduces new forms of informational complexity, including information overload and heterogeneous trust formation. The chapter highlights that effective platform design, achieved through reputation systems, quality disclosures, and buyer protection policies, serves as an institutional complement to classical market mechanisms. It concludes that information asymmetry is not merely an informational issue but a design problem that requires credible intermediaries and transparent governance to sustain efficiency and trust in digital marketplaces.

Chapter 3 investigates whether consumers respond to non-voluntary CSR initiatives, using Volkswagen's 2017 Zero Emission Vehicle (ZEV) investment plan as a natural experiment. Exploiting eBay Motors auction data in a difference-in-differences framework, it identifies a significant 13.5% increase in the final auction price of Volkswagen used cars following the

announcement of the ZEV plan. This result reflects an increase in consumers' willingness to pay, driven by restored trust and enhanced perceived integrity of the brand. The effect is strongest in environmentally conscious regions, highlighting the role of local preferences in shaping CSR effectiveness. Robustness tests confirm that the estimated effects are not driven by compositional shifts or random factors. Conceptually, the chapter reframes CSR as a credibility mechanism: even when mandated by regulation rather than voluntary goodwill, transparent and verifiable CSR can act as a market signal that strengthens brand equity and generates welfare gains.

Chapter 4 examines the role of buyer-side information acquisition in mitigating asymmetric information, using the introduction of eBay's WeGoLook inspection service as a quasi-natural experiment. By allowing buyers to obtain third-party vehicle assessments prior to purchase, this policy provides a clean setting to analyze how inspection availability affects transaction outcomes. The results indicate that the introduction of the inspection service increased final prices and reduced price dispersion, suggesting improved information precision and matching efficiency. The findings also reveal strategic interactions between buyers and sellers: buyers use third-party inspections as substitutes for unverified seller disclosures, while sellers respond by adjusting their information provision (e.g., number of photos, listing detail). This chapter contributes to the literature on market design by showing that information acquisition and disclosure are interdependent mechanisms that jointly determine equilibrium transparency and welfare outcomes in digital markets.

To conclude, these three chapters contribute to the broader literature on information economics, digital platforms, and market design in several ways. First, they collectively demonstrate that mechanisms enhancing information credibility, whether through market signals, institutional mandates, or technological intermediaries, play a central role in restoring efficiency in markets prone to asymmetric information. Second, the dissertation bridges theoretical insights with empirical evidence, connecting classical models of signaling, disclosure, and certification to modern digital contexts where algorithms, platforms, and data infrastructures reshape trust formation. Third, by combining cross-sectional, quasi-experimental, and policy evaluation approaches, the studies provide a multidimensional view of how information asymmetry interacts with regulation, corporate behavior, and technological innovation. Finally, the dissertation underscores that effective governance of digital markets depends not merely on information availability, but on its credibility, verifiability, and interpretability-principles that are increasingly vital for designing transparent, efficient, and socially responsible marketplaces in the digital age.

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Appendix A

Supplementary Material for Chapter 3

This appendix provides supplementary materials supporting the empirical and interpretative analyzes presented in Chapter 3. It includes additional quantitative estimations, robustness checks, and contextual evidence to strengthen the validity of the main findings. The first section extends the welfare analysis by quantifying the social benefits of Volkswagen's Zero-Emission Vehicle (ZEV) investment plan in the context of its 2017 U.S. sales, comparing estimated welfare gains with the company's legally mandated investment commitments. The second section presents alternative model specifications, including robustness tests that exclude Audi from the treatment group and shorten the observation window to three months before and after the event. Subsequent sections provide detailed summary statistics and additional data descriptions, including variable definitions and car make distributions. The appendix concludes with contextual materials, regional classification by the U.S. Census Bureau, documentation of Volkswagen's pre-Dieselgate environmental branding, and a compilation of executive statements before and after the scandal, that collectively substantiate the interpretation of the ZEV investment plan as a non-voluntary corporate social responsibility initiative.

A.1 Welfare Gain Estimation in Volkswagen's 2017 U.S. Sales Context

Using the committed investment amounts specified in the Zero-Emission Vehicle Investment Plan and estimated changes in consumers' willingness to pay from revealed preference data, I assess the net social welfare effects of this electric vehicle adoption initiative.

My analysis begins by estimating secondary market transactions. In 2017, Volkswagen re-

ported 339,676 new vehicle sales in the U.S. [1], while Audi reported 226,511 new car sales [2]. Applying a new-to-used vehicle transaction ratio of 1:2.5, consistent with 2013–2022 U.S. market averages[3], I estimate that approximately 1.42 million Volkswagen Group vehicles entered the used car market in 2017.

In terms of market share, Volkswagen Group (including Audi) delivered 625,100 new vehicles in the U.S. in 2017, representing approximately 3.3% of the total new vehicle market. Given that total U.S. used car sales reached 39.2 million that year, I approximate Volkswagen Group's used car sales at around 1.29 million, using its new vehicle market share as a proxy.

Combining alternative calculation methods, I estimate the Volkswagen Group's used car sales in North America to range between 1.29 million and 1.42 million. Assuming an average increase in consumers' willingness to pay of $767 per vehicle, this would generate total social welfare gains of $989 million to $1.086 billion.

Given that Volkswagen was required to invest $200 million annually in Zero Emission Vehicle (ZEV) infrastructure, access, and education programs in the United States, the estimated social value generated represents roughly four times the investment cost.

It is important to note that my estimates are based on a simplified calculation derived from my data and model assumptions, and thus have limited external validity. Nevertheless, these results provide a useful reference for evaluating the social benefits of corporate social responsibility (CSR)-driven investments.

A.2 Alternative Specifications

In my initial analysis, I included Audi in the treatment group since it is a sub-brand of the Volkswagen Group and was also implicated in the dieselgate scandal. However, it is possible that some consumers may not associate Audi with Volkswagen and thus may have different perceptions of the Audi brand. To account for this, I re-estimate my main specification, excluding Audi from the sample. The results, presented in Panel A of Table A.2.1, show that the coefficient of the interaction term is higher when Audi is excluded, but it remains positively significant at the one percent level.

I initially included a 3-month period before and a 6-month period after the event date in

1. Volkswagen Group of America. (2018). *2017 Year-End Sales Report.* Retrieved from https://media.vw.com/en-us/releases/966

2. https://media.audiusa.com/releases/215

3. Experian. (2024). *New and used light vehicle sales in the United States from 2010 to Q3 2024* [Data set]. Statista. Accessed March 3, 2025. https://www.statista.com/statistics/183713/

my original sample to reduce unexpected variance caused by a shorter post-event period. However, some may be concerned that the 6-month window could introduce more unobservable factors compared to a 3-month period. To address this concern, I re-estimated the main regression using only a 3-month period following the event and exclude Audi from the treatment group and limiting the sample period to 3 months before and after the release of the investment plan. The estimated results, presented in Panel B of Table A.2.1, confirm the robustness of my findings.

Table A.2.1. Robustness – Alternative Specifications

Panel A: Without Audi In Treatment Group				
Dep. var: ln(Price)	(1)	(2)	(3)	(4)
Release×Volkswagen	0.133***	0.180***	0.178***	0.185***
	(0.03)	(0.02)	(0.02)	(0.02)
Volkswagen	-0.141***	-0.578***	-0.581***	-0.592***
	(0.02)	(0.04)	(0.05)	(0.04)
Release	-0.028	0.024	0.137	0.094
	(0.03)	(0.01)	(0.23)	(0.23)
R^2 (within)	0.11	0.71	0.71	0.73
N	14229	14229	14229	14229
Panel B: Without Audi In Treatment Group and 3 Month Before And After Event Date				
Dep. var: ln(Price)	(1)	(2)	(3)	(4)
Release×Volkswagen	0.120***	0.152***	0.149***	0.145***
	(0.02)	(0.03)	(0.03)	(0.02)
Volkswagen	-0.537***	-0.575***	-0.580***	-0.591***
	(0.05)	(0.06)	(0.06)	(0.05)
Release	0.039	0.040*	0.234	0.160
	(0.02)	(0.02)	(0.22)	(0.22)
R^2 (within)	0.69	0.71	0.71	0.73
N	7013	7013	7013	7013

Notes: All fixed effects controlled as main results. Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

A.3 Summary Statistics

Table A.3.1. Covariates in Main Specification

ln(Start price)	0.047***	0.087***	0.087***	0.092***
	(0.01)	(0.01)	(0.01)	(0.01)
Buyer shipping		0.043	0.041	0.063**
		(0.03)	(0.03)	(0.02)
ln(Number of pictures)		0.143***	0.144***	0.119***
		(0.01)	(0.01)	(0.01)
Number of bidders		0.057***	0.057***	0.060***
		(0.00)	(0.00)	(0.00)
Listing duration (5 days)		0.544***	0.550***	0.403***
		(0.03)	(0.03)	(0.03)
Listing duration (7 days)		0.675***	0.683***	0.533***
		(0.02)	(0.02)	(0.03)
Listing duration (10 days)		0.921***	0.928***	0.755***
		(0.04)	(0.04)	(0.05)
Dealer		0.132***	0.133***	0.069***
		(0.02)	(0.02)	(0.02)
ln(Seller feedback scores)		-0.096***	-0.095***	-0.060***
		(0.01)	(0.01)	(0.00)
Bidder feedback score		-0.000	-0.000	-0.000
		(0.00)	(0.00)	(0.00)
Diesel		0.687***	0.685***	0.634***
		(0.19)	(0.19)	(0.17)
ln(Car age)		-0.698***	-0.699***	-0.703***
		(0.04)	(0.04)	(0.04)
ln(Mileage)		-0.048***	-0.048***	-0.044***
		(0.01)	(0.01)	(0.01)
Clean		0.106*	0.108*	0.085**
		(0.06)	(0.06)	(0.04)
constant	7.561***	8.739***	8.773***	8.877***
	(0.04)	(0.15)	(0.16)	(0.23)

Notes: Standard errors are clustered at car-make level. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table A.3.2. Car Makes

Make	Freq.	Percent	Cum.
Ford	2,350	16.09	40.35
Toyota	1,277	8.74	93.66
Mercedes-Benz	1,179	8.07	71.96
BMW	987	6.76	10.46
Honda	911	6.24	49.03
Cadillac	845	5.79	18.36
Nissan	747	5.11	80.28
Volkswagen	584	4.00	97.66
Lexus	398	2.72	59.93
Chrysler	387	2.65	22.18
Audi	377	2.58	3.70
GMC	357	2.44	42.80
Volvo	342	2.34	100.00
Lincoln	337	2.31	62.24
Jeep	310	2.12	54.98
Buick	308	2.11	12.57
Subaru	307	2.10	84.92
Dodge	304	2.08	24.26
Mazda	241	1.65	63.89
Land Rover	207	1.42	57.21
Jaguar	206	1.41	52.85
Hyundai	191	1.31	50.34
Mini	178	1.22	74.13
Chevrolet	172	1.18	19.53
Acura	164	1.12	1.12
Infiniti	161	1.10	51.44
Pontiac	153	1.05	81.33
Mitsubishi	152	1.04	75.17
Mercury	138	0.94	72.91
Kia	119	0.81	55.79
Saab	109	0.75	82.08
Saturn	108	0.74	82.82
Total	14,606	100.00	

Table A.3.3. Summary Statistics Before and After Release

	Before Release				After Release			
Variable	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Auction listing characteristics								
Start price	1846.79	5052.32	0	128000	2044.54	5299.97	0	99999
Final price	7283.12	8835.57	1	128000	7410.33	9207.52	2	110100
Buyer shipping	0.96	0.20	0	1	0.89	0.31	0	1
Number of pictures	13.55	7.69	0	24	14.67	7.28	0	24
Number of bidders	9.71	6.21	1	33	9.12	6.12	1	33
Listing duration (3 days)	0.19	0.39	0	1	0.23	0.42	0	1
Listing duration (5 days)	0.16	0.37	0	1	0.16	0.36	0	1
Listing duration (7 days)	0.60	0.49	0	1	0.55	0.50	0	1
Listing duration (10 days)	0.05	0.21	0	1	0.06	0.24	0	1
Release	0.00	0.00	0	0	1.00	0.00	1	1
Volkswagen	0.07	0.26	0	1	0.06	0.24	0	1
Seller and buyer characteristics								
Dealer	0.49	0.50	0	1	0.46	0.50	0	1
Seller feedback score	2105.55	4228.06	1	63871	2622.05	5149.52	1	167401
Bidder feedback score	235.32	495.44	1	12223	282.68	1506.87	1	119765
Used car characteristics								
Diesel	0.05	0.22	0	1	0.05	0.22	0	1
Car age (years)	11.79	6.19	1	27	12.27	6.64	1	27
Mileage	120316.15	86172.29	1	1620000	129854.45	981104.50	1	99999999
Clean	0.83	0.37	0	1	0.84	0.36	0	1
Rebuilt	0.17	0.37	0	1	0.16	0.36	0	1
Sedan and Hatchback	0.42	0.49	0	1	0.40	0.49	0	1
Coupe and Convertible	0.16	0.36	0	1	0.17	0.38	0	1
Suv	0.25	0.43	0	1	0.24	0.43	0	1
Van	0.18	0.38	0	1	0.19	0.39	0	1
Obs	4166				10440			

Table A.3.4. Summary Statistics: Volkswagen Group

	Before Release				After Release			
Variable	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Auction listing characteristics								
Start price	1488.42	3883.27	0	40000	1832.95	4517.07	0	48000
Final price	5687.29	8194.83	200	91100	6454.21	9958.16	200	109000
Buyer shipping	0.94	0.23	0	1	0.90	0.31	0	1
Number of pictures	12.55	7.68	1	24	13.70	7.03	1	24
Number of bidders	9.40	6.28	1	33	8.44	5.70	1	28
Listing duration (3 days)	0.17	0.37	0	1	0.22	0.41	0	1
Listing duration (5 days)	0.22	0.42	0	1	0.15	0.35	0	1
Listing duration (7 days)	0.56	0.50	0	1	0.57	0.50	0	1
Listing duration (10 days)	0.05	0.22	0	1	0.06	0.24	0	1
Release	0.00	0.00	0	0	1.00	0.00	1	1
Volkswagen	1.00	0.00	1	1	1.00	0.00	1	1
Seller and buyer characteristics								
Dealer	0.46	0.50	0	1	0.43	0.50	0	1
Seller feedback score	1661.43	3450.88	1	13484	2409.71	4462.55	1	14016
Bidder feedback score	282.01	641.95	1	7561	259.37	461.56	1	4827
Used car characteristics								
Diesel	0.10	0.30	0	1	0.12	0.32	0	1
Car age (years)	11.56	4.68	1	27	11.94	5.45	1	27
Mileage	118888.28	55045.06	1	369536	124061.91	69642.27	1	999999
Clean	0.89	0.31	0	1	0.89	0.31	0	1
Rebuilt	0.11	0.31	0	1	0.11	0.31	0	1
Sedan and Hatchback	0.55	0.50	0	1	0.57	0.49	0	1
Coupe and Convertible	0.30	0.46	0	1	0.22	0.42	0	1
Suv	0.06	0.24	0	1	0.05	0.21	0	1
Van	0.08	0.27	0	1	0.16	0.36	0	1
Obs	302					659		

Table A.3.5. Summary Statistics: Non-Volkswagen Group

	Before Release				After Release			
Variable	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Auction listing characteristics								
Start price	1874.80	5131.83	0	128000	2058.80	5348.50	0	99999
Final price	7407.84	8872.60	1	128000	7474.75	9151.68	2	110100
Buyer shipping	0.96	0.20	0	1	0.89	0.31	0	1
Number of pictures	13.63	7.68	0	24	14.74	7.29	0	24
Number of bidders	9.73	6.20	1	32	9.16	6.14	1	33
Listing duration (3 days)	0.19	0.39	0	1	0.23	0.42	0	1
Listing duration (5 days)	0.16	0.37	0	1	0.16	0.36	0	1
Listing duration (7 days)	0.60	0.49	0	1	0.55	0.50	0	1
Listing duration (10 days)	0.05	0.21	0	1	0.06	0.24	0	1
Release	0.00	0.00	0	0	1.00	0.00	1	1
Volkswagen	0.00	0.00	0	0	0.00	0.00	0	0
Seller and buyer characteristics								
Dealer	0.49	0.50	0	1	0.46	0.50	0	1
Seller feedback score	2140.26	4281.30	1	63871	2636.36	5192.42	1	167401
Bidder feedback score	231.67	482.03	1	12223	284.26	1552.19	1	119765
Used car characteristics								
Diesel	0.05	0.21	0	1	0.05	0.21	0	1
Car age (years)	11.81	6.30	1	27	12.29	6.71	1	27
Mileage	120427.74	88147.16	1	1620000	130244.72	1013458.11	1	99999999
Clean	0.83	0.38	0	1	0.84	0.37	0	1
Rebuilt	0.17	0.38	0	1	0.16	0.37	0	1
Sedan and Hatchback	0.41	0.49	0	1	0.39	0.49	0	1
Coupe and Convertible	0.14	0.35	0	1	0.17	0.37	0	1
Suv	0.26	0.44	0	1	0.25	0.44	0	1
Van	0.18	0.39	0	1	0.19	0.39	0	1
Obs	3864				9781			

A.4 Census Bureau Division

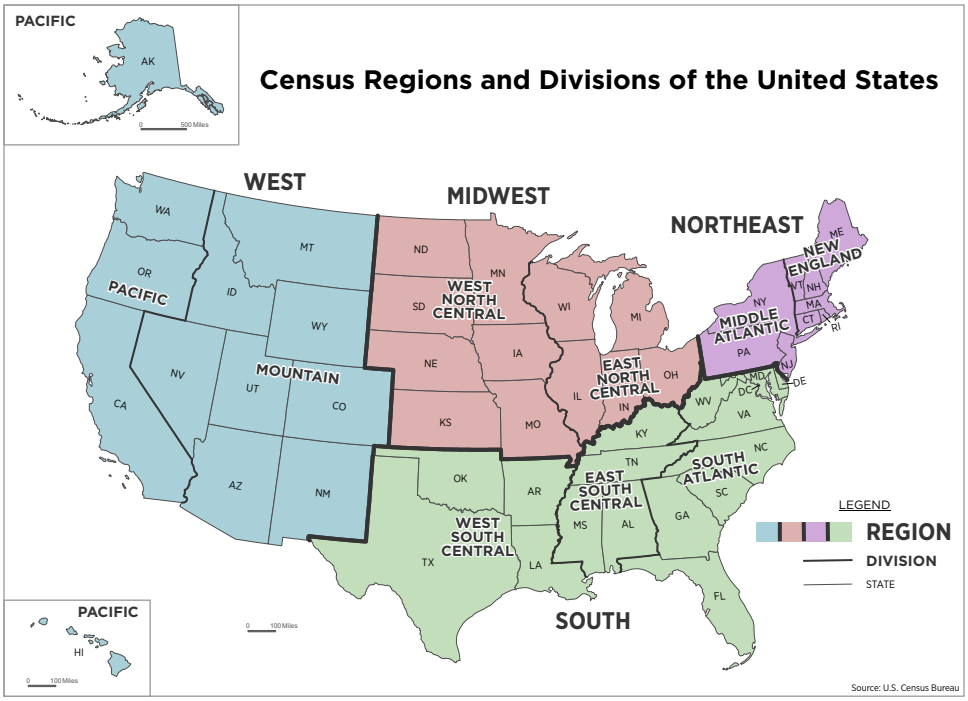

Figure A.4.1. Census Regions and Divisions of the United States

Source: U.S. Census Bureau, "Census Regions and Divisions of the United States," accessed May 6, 2026, https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf. Reproduced as published; work of the U.S. federal government in the public domain.

Notes: No annotations added by the author.

Table A.4.1. Census Bureau Division

Census Bureau Division	**States Included**
New England	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
Middle Atlantic	New Jersey, New York, Pennsylvania
East North Central	Illinois, Indiana, Michigan, Ohio, Wisconsin
West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
South Atlantic	Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia
East South Central	Alabama, Kentucky, Mississippi, Tennessee
West South Central	Arkansas, Louisiana, Oklahoma, Texas
Mountain	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
Pacific	Alaska, California, Hawaii, Oregon, Washington

A.5 Engine-Based Classification and Supporting Evidence

This section provides supporting evidence for the engine-based classification introduced in the main text.

To validate the tercile-based classification of engine capacity, we estimate the baseline specification separately for each engine group. Table A.5.1 reports the results. The coefficient on $Release \times Volkswagen$ is positive and statistically significant for the economy and mainstream segments, but insignificant for the performance segment. This pattern suggests that engine capacity serves as a meaningful proxy for environmental performance, with stronger consumer responses concentrated among vehicles with relatively smaller engines.

To further quantify this heterogeneity, we estimate a triple-difference specification:

$$\begin{aligned} ln(Price)_i \;=\; & \beta_0 \;+\; \beta_1 Release_i \times Volkswagen_i \\ & +\; \beta_2 Release_i \times Volkswagen_i \times Green\ Engine_i \\ & +\; Controls_i \;+\; \tau_m \;+\; \tau_w \;+\; \delta_s \;+\; \mu_j \;+ \epsilon_i; \end{aligned} \tag{A.1}$$

where $GreenEngine_i$ equals one for vehicles in the economy and mainstream groups, otherwise zero. The results indicate that the interaction term is positive and statistically significant. This finding implies that environmentally oriented CSR behavior, such as the ZEV announcement, enhance the brand's environmental reputation and significantly increase willingness to pay for vehicles with better environmental attributes.

Table A.5.1. Heterogeneity in Engine

Dep. var: ln(Price)	Economy (1)	Mainstream (2)	Performance (3)	Full (4)
Release×Volkswagen	0.178***	0.237***	-0.077	
	(0.04)	(0.07)	(0.10)	
Green Engine×Release×Volkswagen				0.188*
				(0.11)
Fixed Effects	Yes	Yes	Yes	Yes
R^2 (within)	0.78	0.80	0.67	0.76
N	4527	3334	3042	10903

Notes: Columns (1) to (3) report subsample results categorized by engine capacity terciles: Economy (1.0-3.0 liters), Mainstream (3.1-4.0 liters), and Performance (above 4.0 liters).

A.6 Volkswagen's Environmental Branding

Table A.6.1. Volkswagen's Environmental Branding in North America Before Dieselgate

Date	Source	Evidence Description
Mar 12, 2014	Volkswagen Group of America CSR Report	VW and Audi accounted for 75% of U.S. clean diesel vehicle sales in 2013, promoting fuel economy and environmental performance. [1]
Nov 25, 2008	MotorTrend	2009 VW Jetta TDI named Green Car of the Year for strong performance, fuel economy, and low emissions. [2]
Jun 9, 2014	Inside Climate News	VW dominates North American diesel market with clean diesel vehicles, promoting efficiency and low global warming gases. [3]
Jun 29, 2015	Green Car Reports	VW tested renewable diesel in TDI models, claiming same drivability with 50% lower carbon emissions. [4]
Dec 31, 2014	Volkswagen Sustainability Report 2014	Emphasized clean diesel in eco-efficiency models, highlighting low CO2 emissions and awards for environmental performance in North America. [5]

Notes: Source:
1. Volkswagen Group of America CSR Report
2. MotorTrend
3. Inside Climate News
4. Green Car Reports
5. Volkswagen Sustainability Report 2014

A.7 Volkswagen Executive Statements

A.7.1 Before Dieselgate scandal

To investigate Volkswagen's public statements on electric vehicles (EVs) and zero-emission technologies prior to the Dieselgate scandal (September 18, 2015), a systematic search was conducted covering January 2009 to September 17, 2015. This period was chosen as it aligns with the maturation of EV technologies, when battery costs began declining and market viability increased, making public discussions on EV investments feasible. Before 2009, zero-emission technologies were nascent, with limited commercial prospects, rendering earlier statements less relevant. Search terms included "Volkswagen electric vehicles investment," "Martin Winterkorn e-mobility," "zero-emission funding," and "charging infrastructure," combined using Boolean operators and filtered by date (e.g., "before:2015-09-18"). Sources prioritized official documents (annual reports, press releases, speeches) from Volkswagen's website (site:volkswagenag.com) and credible outlets (e.g., Automotive News, Green Car Congress), with cross-verification via archive.org for defunct links. Data were extracted for date, spokesperson, event, quote, investment relevance, region, and source URL, yielding seven entries. Notably, no statements indicated specific EV or zero-emission investment plans in the United States, suggesting Volkswagen's strategic focus remained elsewhere, likely due to market dynamics favoring diesel in the U.S. during this period.

Table A.7.1. Volkswagen Executive Statements on Electric Vehicles and Zero-Emission Technologies Before Dieselgate

Date	Direct Quote	Refers to Investment	Region
Mar 2, 2009	"Volkswagen CEO Martin Winterkorn said electric vehicles will not dominate the world's car showrooms anytime soon."	No	Global[1]
Mar 14, 2013	"In the period up to 2015, the Volkswagen Group will be investing approximately €50.2 billion in new plants, products and technologies. More than ever before."	Yes	Global[2]
Mar 14, 2013	"Added to this is the further €9.8 billion that our joint ventures in China will be spending."	Yes	China[3]
Mar 14, 2013	"We will invest more than €33 billion in Europe over the next three years."	Yes	Europe[4]
Mar 12, 2015	"We firmly believe in e-mobility. We need it to comply with worldwide CO2 targets. And we are confident that it will become established in the long term."	No	Global (focus on Germany)[5]
Mar 17, 2015	"The Volkswagen Group has established pioneering innovations, particularly in the field of plug-in hybrid technology, where the Audi, Porsche, and Volkswagen brands are leaders within the industry."	Yes	Global (U.S. tech company INRIX)[6]
May 5, 2015	"Our Group will invest over €85 billion in products, technologies and plants over the next five years. On top of this, our joint ventures in China will invest €22 billion."	Yes	Global (China joint ventures)[7]

Notes: All quotes above are statements by **Martin Winterkorn**, former Volkswagen CEO. Source:
1. Automotive News: VW CEO says electric vehicles are very far away
2. Volkswagen Press: Speech Manuscript Prof. Dr. Winterkorn
3. Volkswagen Press: Speech Manuscript Prof. Dr. Winterkorn Volkswagen Press: Speech Manuscript Prof. Dr. Winterkorn
4. Volkswagen Press: Speech Manuscript Prof. Dr. Winterkorn
5. Volkswagen Press: Annual Press Conference 2015 Winterkorn Speech
6. Porsche SE: Porsche SE Financial Press Conference 2015
7. Volkswagen Press: Annual General Meeting 2015 Winterkorn Speech

A.7.2 After Dieselgate scandal

To further verify the exogeneity of the investment plan, I examined whether Volkswagen's zero-emission investment initiatives were directly related to its automobile manufacturing operations in the United States. Specifically, I collected all public statements made by Volkswagen in the U.S. regarding investments in zero-emission technologies, including electric vehicles (EVs), charging infrastructure, and zero-emission education and promotion programs, after the exposure of the Dieselgate scandal on September 18, 2015, up to October 11, 2025. The search strategy followed the same approach as in earlier stages of the study, using English keywords such as *"Volkswagen EV investment US post-Dieselgate"* and *"Volkswagen zero-emission funding United States after:2015-09-18"*. Priority was given to official press releases, annual reports, CEO interviews, and filings with U.S. regulatory agencies. The results indicate that Volkswagen's post-Dieselgate investments in zero-emission technologies in the United States were largely driven by the Environmental Protection Agency (EPA) and California Air Resources Board (CARB) settlement agreements reached in 2016. Under these agreements, Volkswagen was required to pay a total of $14.7 billion, including a dedicated allocation of 2$ billion for electric vehicle charging infrastructure and educational programs. These commitments were implemented through Volkswagen's U.S. subsidiary, *Electrify America*.

In the early years from 2016 to 2018, Volkswagen's public communications primarily focused on fulfilling the settlement obligations imposed by regulators. In the later years from 2019 to 2025, the company increasingly emphasized its strategic transition toward electrification, including the launch of the *ID.4 SUV* produced in the United States and its ambition to become a global leader in the electric vehicle market. It is important to note that these public statements and investment activities were mainly driven by the settlement terms rather than by voluntary business expansion. The investments concentrated on infrastructure development, particularly through the *Electrify America* network, which deployed approximately 4,000 charging stations across the country, instead of large-scale electric vehicle manufacturing in the United States. This evidence supports the interpretation that Volkswagen's U.S. investment plan represented a legally mandated environmental remediation effort rather than a profit-driven initiative connected to its domestic manufacturing operations.

Table A.7.2. Volkswagen Executive Statements on Electric Vehicles and Zero-Emission Technologies After Dieselgate – United States

Date	Direct Quote	Refers to Investment	Region
Jun 28, 2016	"Volkswagen will invest up to $14.7 billion to settle allegations, including $2 billion to build out a charging network and educate the public on electric cars."	Yes ($2B specific funds)	United States[1]
Apr 13, 2018	"Our industry will undergo more fundamental change over the next 10 years... The breakthrough of electric cars is just four or five years away."	No (strategic vision)	Global (US market implications)[2]
May 10, 2019	"Electrify America must spend that $2 billion by the end of 2026... providing a minimum of 150 kW at 400 volts."	Yes ($2B funds allocation)	United States[3]
Nov 22, 2019	"Volkswagen wants to be the world leader in electric cars by 2025... with a major shift to clean-energy vehicles in the wake of Dieselgate."	No (but implies investment)	United States/Global[4]
Mar 19, 2021	"The ID.4, starting at $40,000 before incentives, offers Volkswagen its best chance to reclaim market share... with a line of vehicles developed from the ground up to run on batteries."	Yes (local manufacturing investment)	United States[5]
Nov 10, 2021	"The diesel crisis gave us a sense of purpose... We started this four or five years ago, accelerating our lower-emission strategy."	Yes (strategic funds toward EV)	Global (US market)[6]
Dec 5, 2022	"Embracing a fundamental shift to clean, e-mobility technology was the best option... Building a world-class EV infrastructure with $2B from settlement."	Yes ($2B infrastructure investment)	United States[7]

Notes:
1. Matthias Müller, Justice Department: Volkswagen to Spend $14.7 Billion to Settle Allegations
2. Herbert Diess, NPR: After Diesel Scandal, VW Turns to New Leadership and Electric Cars
3. Electrify America Executive, CNBC: VW's $2 Billion Penalty Builds EV Charging Network Across US
4. Herbert Diess, The Guardian: VW Shifts Focus to Electric Cars with US Expansion Plan
5. Scott Keogh, New York Times: Volkswagen Aims to Use Its Electric Cars to Steal Market Share
6. Andreas Walingen, The Guardian: VW's $1bn Bid to Lead the Charge in Electric Vehicle Production
7. Georg Kell, Forbes: VW's Journey from Dieselgate to Embracing E-Mobility

Appendix B

Supplementary Material for Chapter 4

This appendix provides supplementary materials that support the empirical analyzes presented in Chapter 4. It includes detailed descriptions of data sources, variable construction, and additional descriptive statistics that complement the results reported in the main text. The first section introduces the WeGoLook inspection service and explains the process of constructing the dataset used in the analysis, accompanied by visual documentation of inspection coverage and vehicle title filters. Subsequent sections present comprehensive summary statistics by policy period, vehicle title, and seller type, along with regression tables for the control variables. Finally, a set of additional figures illustrates weekly trends in key variables such as mileage, listing photos, and dealership participation, offering a fuller understanding of the data characteristics underlying the main results.

B.1 WeGoLook Inspection Service and Data Construction

B.2 Summary Statistics

Table B.2.1. All the Car Makes in the Sample

	Frequency	Percentage
Audi	332	4%
BMW	744	9%
Cadillac	498	6%
Chrysler	384	4%
Dodge	325	4%
Ford	1,549	18%
GMC	236	3%
Honda	654	7%
Hyundai	185	2%
Jeep	226	3%
Lexus	238	3%
Lincoln	195	2%
Mazda	220	3%
Mercedes-Benz	646	7%
Nissan	492	6%
Subaru	265	3%
Toyota	799	9%
Volkswagen	523	6%
Volvo	221	3%
Total	8,732	100%

Notes: I first deleted the used cars with a sales volume of less than 200, and then deleted the used cars with a salvage title. After deleting the vehicles with the salvage title, there are two brands (*Hyundai* and *Lincoln*) with less than 200 vehicles sold, but they are still kept in the sample.

Table B.2.2. Descriptive Statistics by Policy

	Before policy		After policy	
	Mean	S. D.	Mean	S. D.
Auction characteristics				
Final price ($)	8471.90	9435.92	8157.75	9320.70
Start price ($)	2305.23	5602.60	2115.07	5906.48
Dealer	0.65	0.48	0.67	0.47
Seller feedback score	1038.87	2665.45	1354.83	2996.12
Listing duration (days)	6.40	1.63	6.32	1.66
Buyers shipping	0.98	0.15	0.97	0.17
Number of photos	11.87	8.44	13.01	7.92
Number of bidders	10.48	5.80	10.71	5.85
Car characteristics				
Age (years)	10.34	4.32	10.69	4.44
Mileage	115072.94	78616.09	113669.35	77627.93
Rebuilt	0.14	0.35	0.16	0.37
Clean	0.86	0.35	0.84	0.37
Body types				
SH	0.40	0.49	0.43	0.50
CC	0.13	0.33	0.14	0.35
SUV	0.25	0.43	0.21	0.41
VAN	0.22	0.41	0.21	0.41
Observations	3640		5092	

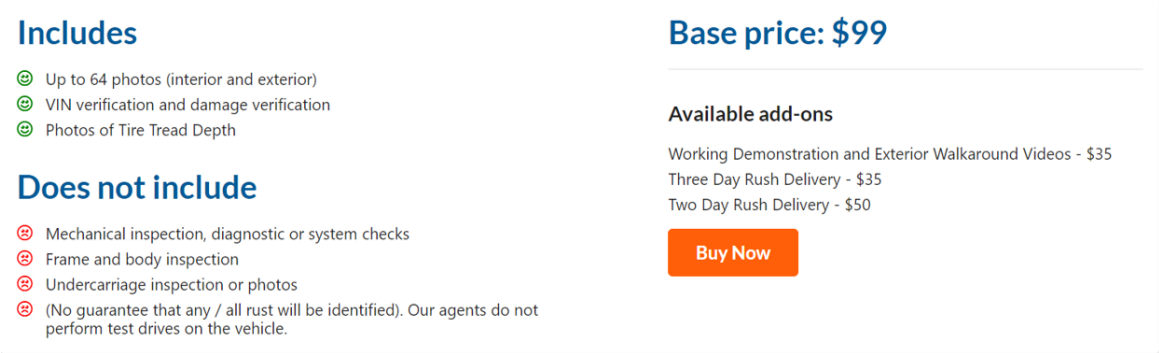

Figure B.1.1. An Introduction to WeGoLook Inspection

Source: WeGoLook Auto Inspection service page, "An Introduction to WeGoLook Inspection," accessed May 6, 2026, at https://placeorder.wegolook.com/instant-inspections/auto. Prices and service specifications reflect the offering as of the access date.

Notes: Reproduced as published, with no annotations added by the author. WeGoLook is a trademark of Crawford & Company.

Table B.2.3. Descriptive Statistics by Vehicle Titles

	Rebuilt Title		Clean Title	
	Mean	S. D.	Mean	S. D.
Auction characteristics				
Final price ($)	15354.54	8421.42	6999.92	8950.33
Start price ($)	1411.39	3978.57	2337.15	6042.76
Dealer	0.81	0.39	0.63	0.48
Seller feedback score	532.77	744.20	1349.04	3084.70
Listing duration (days)	6.88	1.12	6.26	1.71
Buyers shipping	0.96	0.20	0.98	0.15
Number of photos	19.53	7.06	11.26	7.69
Number of bidders	12.70	5.38	10.23	5.83
Car characteristics				
Age (years)	5.15	3.42	11.53	3.79
Mileage	42659.59	39361.21	127313.12	76244.31
Body types				
SH	0.50	0.50	0.40	0.49
CC	0.15	0.35	0.13	0.34
SUV	0.26	0.44	0.22	0.42
VAN	0.09	0.29	0.24	0.43
Observations	1347		7385	

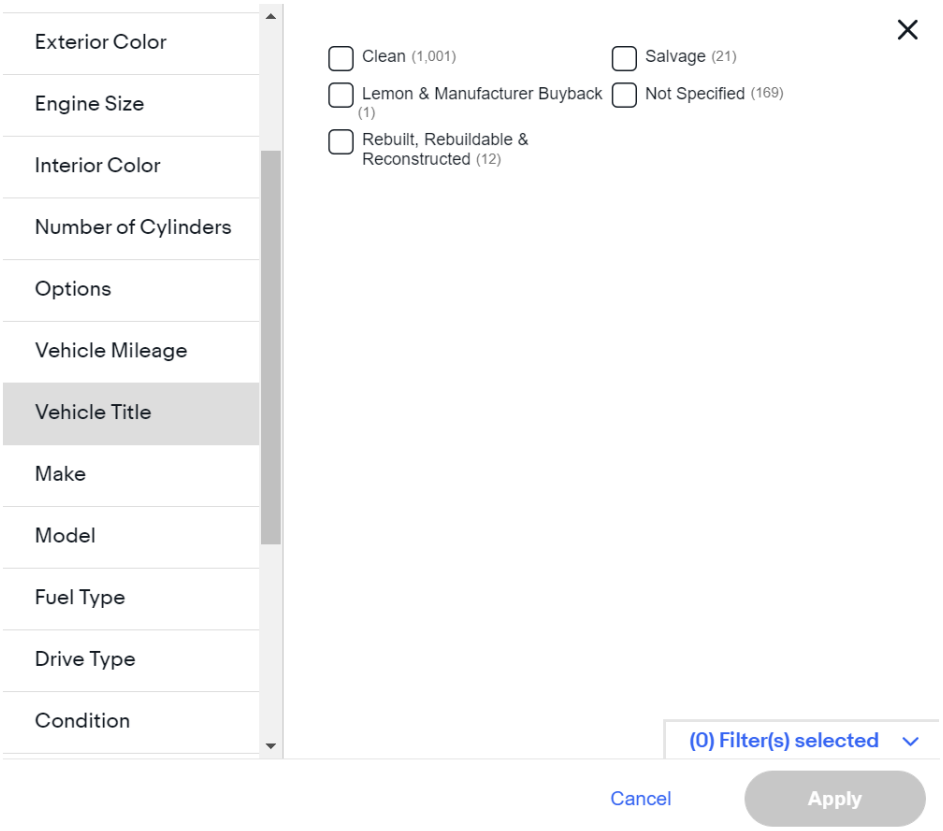

Figure B.1.2. Vehicle Title Filters

Source: Screenshot of the "Vehicle Title" filter dialog on the eBay Motors Cars & Trucks search page, accessed via the "All Filters" menu at https://www.ebay.com/b/Cars-Trucks/6001/bn_1865117, accessed May 6, 2026. The five categories shown (Clean, Lemon & Manufacturer Buyback, Rebuilt/Rebuildable & Reconstructed, Salvage, and Not Specified) constitute eBay's platform-defined title classification system, applied uniformly to all vehicle listings. Listing counts in parentheses reflect active inventory at the time of access and vary continuously.

Notes: Reproduced as published, with no annotations added by the author. eBay is a trademark of eBay Inc.

Table B.2.4. Descriptive Statistics by Seller Types

	Dealer		Private seller	
	Mean	S. D.	Mean	S. D.
Auction characteristics				
Final price ($)	8789.94	8841.65	7309.30	10254.79
Start price ($)	1203.02	3535.43	4131.37	8287.51
Seller feedback score	1558.96	3228.09	566.90	1808.33
Listing duration (days)	6.42	1.67	6.22	1.60
Buyers shipping	0.97	0.16	0.97	0.17
Number of photos	12.37	8.70	12.86	6.99
Number of bidders	12.33	5.23	7.26	5.49
Car characteristics				
Age (years)	9.89	4.54	11.82	3.77
Mileage	107595.41	68531.81	127266.16	92519.41
Rebuilt	0.19	0.39	0.08	0.28
Clean	0.81	0.39	0.92	0.28
Body types				
SH	0.43	0.49	0.40	0.49
CC	0.12	0.32	0.17	0.38
SUV	0.25	0.43	0.19	0.39
VAN	0.21	0.41	0.23	0.42
Observations	5776		2956	

Table B.2.5. Control Variables

	(1)	(2)	(3)	(4)
ln(Age)	-1.101***	-1.160***	-1.160***	-1.154***
	(0.07)	(0.05)	(0.05)	(0.05)
ln(Mileage)	-0.044***	-0.041***	-0.041***	-0.041***
	(0.01)	(0.01)	(0.01)	(0.01)
Clean title	0.090***	0.092***	0.092***	0.113***
	(0.03)	(0.03)	(0.03)	(0.03)
ln(Start price)	0.104***	0.097***	0.097***	0.095***
	(0.01)	(0.01)	(0.01)	(0.01)
Dealership	-0.009	-0.008	-0.008	-0.011
	(0.02)	(0.01)	(0.01)	(0.02)
ln(Seller feedback score)	-0.024***	-0.024***	-0.024***	-0.025***
	(0.01)	(0.01)	(0.01)	(0.01)
Listing duration	0.080***	0.077***	0.077***	0.075***
	(0.01)	(0.01)	(0.01)	(0.01)
Buyers shipping	-0.005	-0.023	-0.023	-0.012
	(0.06)	(0.04)	(0.04)	(0.04)
Number of bidders	0.049***	0.046***	0.046***	0.044***
	(0.00)	(0.00)	(0.00)	(0.00)

Notes: Standard errors are in parentheses. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Figure B.2.1. Weekly Average ln(Photos)

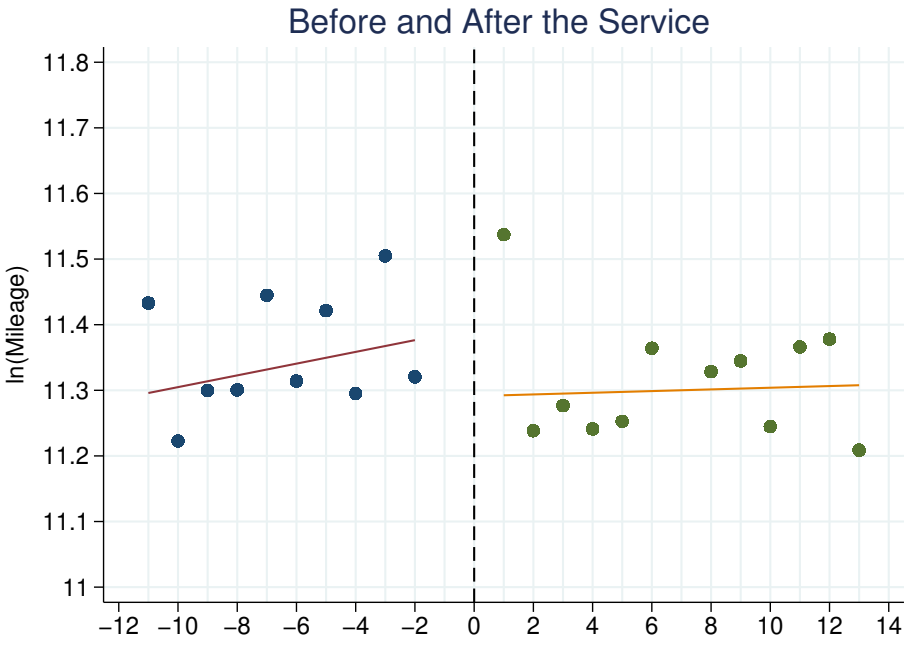

Figure B.2.2. Weekly Average ln(Mileage)

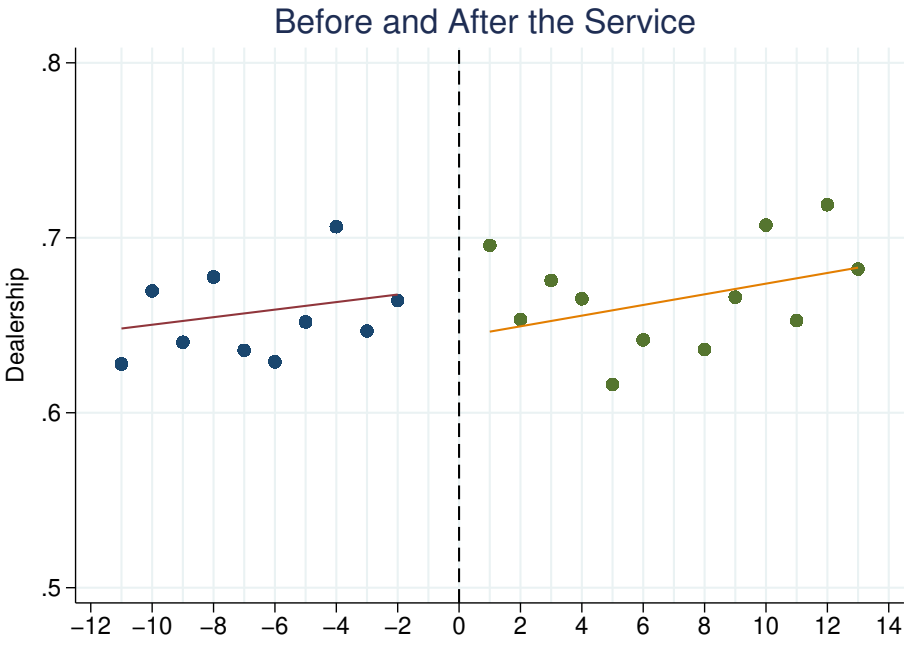

Figure B.2.3. Weekly Average Dealership