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Organizational Structure and the Limits of Knowledge Sharing: Incentive Conflict and Agency in Car Leasing

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This paper argues that conflicting incentives among managers may impede potential knowledge-sharing benefits from vertical integration. I study knowledge-based agency costs from vertical integration in car leasing, where manufacturer-owned captive lessors compete with independent lessors. Both organizational forms must acquire and integrate diffuse knowledge to accurately predict vehicle depreciation—a condition critical for profitability. Using a data set of 180,000 leases, I compare contracts of independent and captive lessors across car models, market conditions, and product life cycles. I find that managers in vertically integrated firms have conflicting incentives on whether to accurately and completely share proprietary knowledge, and show that these incentives appear to generate agency costs inconsistent with corporate profitability as managers selectively use and share knowledge for personal gain. The findings suggest that most knowledge benefits of vertical integration will be nullified when managerial interests are incompatible with the profit concerns of the firm.

Key words: knowledge-based view; vertical integration; leasing; agency theory; automotive industry
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1. Introduction

Optimizing knowledge flow is critical to the efficient design of organizations (Nonaka 1994), including the selection of firm boundaries. The knowledge-based view (KBV) argues that vertical integration facilitates knowledge flows that are essential to solving organizational problems (Langlois 2002, Nickerson and Zenger 2004) by coordinating knowledge transfer through monitoring and efficient dispute resolution (Teece 1992). Others argue that integration also creates a shared language and identity that improves knowledge exchange (Kogut and Zander 1996, Monteverde 1995, Grant 1996). The alternative of contracting for knowledge transfer in markets is hazardous because of the incomplete nature of contracts and difficulties of ex ante valuation (Arrow 1973). Markets for knowledge are frequently subject to appropriation risks caused by the inability of individuals to fully anticipate and evaluate hazards and uncertainties (Nahapiet and Ghoshal 1998, Williamson 1999).

Although recent empirical work highlights the virtues of vertical integration in facilitating knowledge transfer (Macher 2006, Macher and Boerner 2012), hierarchies are rife with incentive distortions that may discourage either the efficient transfer of knowledge or its efficient use. The scope and impact of these distortions will depend on the structure of the interrelatedness among and activities of distinct units within the firm (Holmstrom 1999, Nickerson 1997, Novak and Stern 2009). In some settings, these distinct units face divergent incentives in regard to the choice of decisions or solutions. When vertical integration creates conflicting goals and incentives among divisions and managers, two knowledge-related agency problems may arise. First, one or both parties may seek to strategically limit or distort the flow of knowledge (Eccles and White 1988, Osterloh and Frey 2000, Nickerson and Zenger 2004). Second, one or both parties may simply strategically ignore or misuse the knowledge available to them. Consequently, vertical integration may encourage information distortions or influence activities that ultimately hurt performance and negate any knowledge-based benefits from hierarchy (Williamson 1985, Nickerson and Zenger 2008). Although hierarchy typically employs low-powered incentives to minimize such distortions, low-powered incentives do not eliminate agency problems because career outcomes and financial rewards may be tied to local performance or to the social capital built by helping others within the organization (Burt 1992).

Although resolving these incentive conflicts may seem conceptually straightforward from a profit-maximization standpoint, crafting incentives that

ensure the optimal sharing and use of knowledge is practically problematic (Foss 2003). In particular, top managers are constrained in their capacity to precisely craft incentives within organizations because of political activities, concerns about social comparison, and their own cognitive limitations (Williamson 1996, Milgrom and Roberts 1990, Nickerson and Zenger 2004). Furthermore, a top manager's overconfidence may lead to excessive meddling (Bazerman 1994, Williamson 1985), despite an inability to effectively aggregate and analyze rapidly changing knowledge (Hayek 1945). This inability to selectively intervene is exacerbated by information distance across tiers of the hierarchy (Thompson 1967, Aghion and Tirole 1997), influence activities from subordinates (Argyres and Mui 2007), and psychological contracts and emotional ties (Robinson and Morrison 1995). Incentive distortions within the firm may therefore prevent the types of optimal decisions that the more extensive knowledge sharing within organizational boundaries might permit. We know little about how conflicting interests in knowledge sharing and use are resolved, and to what degree this resolution reflects profitability concerns or potentially the costs of other less efficient interests (Foss 2007, Foss and Mahnke 2003).

I examine agency problems in knowledge sharing and use in the market for automobile leasing, a common financial service provided to consumers through two distinct organizational structures: one integrated and the other not. Captive lessors, owned by automobile manufacturers, compete directly with banks and other independent lessors, with the key to profitability being the accurate forecasting of residual values (RV)—the lease-end values of cars. Overestimating residual value yields losses when vehicles are sold by the lessor at lease end, whereas underestimating residual values raises lease prices to be uncompetitive with competing offers. The costs of poor RV estimation are considerable. For instance, industry-wide failures between 2000 and 2001 led to losses of $10–$11 billion (Rauschenberg 2001) and average losses of $3,269 on returned vehicles.[1] Much like automotive manufacturing (Novak and Stern 2009), accurately predicting residual value (RV) requires extensive knowledge transfer, much of which is proprietary to the manufacturer. Leasing managers must acquire and integrate both codified and tacit knowledge that is widely distributed across divisions: design and durability knowledge from engineering, future product knowledge from strategic planning, and pricing and promotion data from marketing.

I am able to test knowledge-based agency costs of vertical integration using a unique data set of nearly 180,000 lease contracts from both captive and independent lessors. I first show that vertical integration adds additional mechanisms through which residual values impact firm performance, and that these mechanisms create conflicting incentives for the use of knowledge within the firm. Manufacturers use captive leasing subsidiaries to discount vehicles through high residual values to gain market share or to reduce existing inventory.[2] Subsidization appears to limit the captive lessor's ability to exploit private knowledge about future vehicle depreciation, because captive lessors must write residual values above estimates to decrease lease prices. I also show that high residual values are used to signal high quality or confidence in new model designs, consistent with the economics literature on signaling (Schmalensee 1978). In a model's first year, captive lessors ignore proprietary knowledge on quality and durability because of market awareness of their access to this knowledge. Fearing low RVs might signal low quality, captives are discouraged from exploiting this information when it reflects poorly on the product.

Finally, in identifying leases where subsidization and signaling are unnecessary, I show that although captive lessors appear to exploit some knowledge advantages in anticipating redesigns, they also continue to support low-quality vehicles even while less-informed independent lessors reduce the RV. Although I cannot observe the internal mechanisms driving this finding, these results are consistent with agency explanations from anecdotal field research, models of multitasking in financial services (Holmstrom and Milgrom 1991, Kanatas and Qi 1998, Ross 2012), and studies of internal politics and transfer pricing within hierarchies (Eccles and White 1988). Captive residual value managers appear unwilling to condemn low-quality vehicles with accurately low residual values even when such action is almost certain to improve profitability.

This paper provides several important contributions to our understanding of the costs and benefits of vertical integration. First, it outlines how vertical integration creates conflicting incentives in the sharing and use of proprietary knowledge. Second, this paper provides evidence from multiple firms of the internal agency costs theorized in organizational economics that have to this point been largely limited to detailed case studies (e.g., Foss 2003). Although I am unable to directly observe how career incentives drive

[1] Statistics from the Association of Consumer Vehicle Lessors (2001). These statistics are concurrent with my data.

[2] The historical obsession with market share in the car industry was described by Jim O'Connor, Ford's group vice president for North American marketing. "You either stay in the game or you lose [market] share, and share is your long-term health" (Brown 2002).

individual workers to politick, trade favors, or make other suboptimal decisions, the persistent RV support of low-quality vehicles is highly consistent with an agency explanation. Finally, this paper is the first to empirically demonstrate that captive lessors, driven by the sales needs of their parent companies, subsidize residual values, suggesting existing economics models of lease contracting in the economics literature exclude critical internal implications of manufacturer leasing.

2. Theoretical Background

Vertical integration has broad implications for firm strategy and performance, impacting intellectual property protection (Novak and Stern 2009), supply chain management (Ahmadjian and Oxley 2006), quality (Jin and Leslie 2009), investment (Ciliberto 2006), marketing (Rindfleisch and Heide 1997), finance (Williamson 1985, 1988), regulation (Joskow 1996), and nonmarket strategy in foreign countries (Henisz 2002).[3] Potential conflicts and complementarities in these implications make the efficiency of organizational structure difficult to identify (Novak and Stern 2009), which helps explain the dearth of empirical evidence on the scope and limitations of knowledge-exchange advantages of vertical integration (Nickerson and Silverman 2003, Macher and Richman 2008, Nickerson and Zenger 2008).

The KBV suggests that vertical integration yields benefits in creating and exchanging the knowledge necessary to solve problems critical to the firm. Vertically integrated business units hold proprietary knowledge within their corporate umbrella, including knowledge on changing technology, products, and market characteristics, or from new combinations of existing knowledge that improve innovation or other performance within the organization (Fleming 2001, Nelson and Winter 1982). Because hierarchy presents weaker incentives for expropriation by individual actors (Nickerson and Zenger 2004), vertical integration promotes knowledge sharing across individuals and business units within the corporation that could not be accomplished across firm boundaries (Grant 1996, Kogut and Zander 1996, Monteverde 1995).

Recent work by Novak and Stern (2009) illustrates that the decision to vertically integrate specific activities can broadly impact how knowledge is shared across the firm. Building on Nickerson (1997) and Holmstrom (1999), they argue that firm boundary decisions involve interrelated choices that cross functional activities. Their focus is on complementarities in the vertical integration decision driven by incentives for cross-functional coordination. Vertically integrating an activity, however, can also produce conflicts across teams and divisions that limit cooperation by local managers (Foss 2003, Gulati 2007). Although the corporation may conceptually be able to balance these divisional trade-offs for profit maximization, such optimization requires accurate information and knowledge from local units as well as selective intervention from executives. Actions that improve the performance of one division may hurt another. Moreover, although bonuses tied to firm performance may motivate some cooperation, they do not resolve fundamental problems of influence activities among managers (Wulf 2002).

Internal agency concerns, where self-interested actors under imperfect information act in economically inefficient ways (Grossman and Hart 1983), are a common problem within firms. Although vertical integration can reduce agency problems through low-powered incentives and improved monitoring (Williamson 1985, Baker and Hubbard 2003, Azoulay 2004), remaining incentives and imperfect information within firms make agency problems a continuing concern (Rawley and Simcoe 2010). Under conditions of imperfect information, employees may misrepresent or distort information for internal political purposes (Milgrom and Roberts 1990, Prendergast 1999). Furthermore, managerial limitations may make efficient selective intervention impossible (Williamson 1996, Foss 2003).

This explanation is consistent with much of the literature on agency problems in transfer pricing, where information asymmetry generates adverse selection (Besanko and Sibley 1991), holdup through underinvestment (Holmstrom and Tirole 1991, Williamson 1985), and agents and divisions that negotiate suboptimal transfer prices (Eccles and White 1988). Managers may engage in behavior that benefits divisions or groups and supports managerial career prospects (Bradach and Eccles 1989). These behaviors may be motivated purely by financial or political concerns (Prendergast 1999), but they may also involve loyalties or emotional ties from psychological contracts (Osterloh and Frey 2000).

To summarize, although the knowledge-based view provides reasons why vertical integration can improve knowledge transfer, these benefits are in doubt when the agents responsible for the transfer and use of knowledge have incentives that conflict with one another or with firm objectives. The impact of organizational structure on knowledge transfer and exploitation is therefore highly dependent on its impact on the many actors within the firm. When the impact is complementary and conflicts are minimal, then benefits from hierarchy may occur. In this paper,

[3] For a broader review of the literature on vertical integration, see Lafontaine and Slade (2007) and Macher and Richman (2008).

however, I focus on an empirical setting where integration generates conflicting managerial interests that generate net losses for the firm.

3. Empirical Setting

My empirical setting is the consumer automobile leasing industry, which is well suited for studying knowledge-based implications of vertical integration for several reasons. First, the industry includes direct competition between manufacturer-owned captive lessors and independent lessors. Manufacturers held a 46% market share in 2000,[4] competing against pure lessors, banks, and dealer lessors. Second, knowledge distributed throughout the manufacturer is needed for the accurate estimation of future car values, or residual values. Third, lessor performance is highly varied, both across firms and within each lessor's portfolio, and is almost exclusively driven by lessors' use of knowledge to forecast vehicle depreciation.

When a consumer leases a car, she pays the lessor for the right to drive it while the lessor retains ownership. The lessee pays a monthly fee that covers the two principal costs of the lease: vehicle depreciation and interest. Consider a model where a car manufacturer offers customers leases for car model a_i of term length T months. Because of the Federal Consumer Leasing Act, these leases must include explicit values for the contracted residual value r, the money factor f (the annual interest percentage rate (APR) divided by 2,400), the capitalized cost c (the new car price), and the monthly payment p. A consumer wishing to lease this car must pay the manufacturer p at the beginning of each of T months. After T months, the consumer lessee can either return the car to the lessor or purchase it for the contracted residual value r. With uncertainty about vehicle depreciation, there will exist a residual value error e that displaces r from the actual residual value v. Under these conditions, the lessor writes the contract

$$p = \frac{(c-r)}{T} + (c+r)f,$$

where $r = v + e$ such that

$$p = \frac{(c-(v+e))}{T} + (c+(v+e))f.$$

For a three-year lease on a \$30,000 vehicle with a residual value of \$10,000, the consumer must pay two components: (1) the \$20,000 depreciation and (2) three years of interest on the average value of the car during the term of the lease (calculated as the average of the \$30,000 capitalized cost and the \$10,000 RV). The consumer also typically has the option to purchase the vehicle at lease end for a price equal to the contracted RV. The consumer automobile lease is typically originated through a dealership. Once a customer has chosen the vehicle, the dealership's finance manager will solicit bids from lessors through an electronic market. The lessors that bid in the market include manufacturer-owned captive lessors and independent lessors that include banks, pure lessors, and other financial institutions.

3.1. Critical Knowledge for Residual Value Prediction

Although durable goods leasing can serve a number of strategic purposes for manufacturers,[5] car lessor profitability primarily depends on accurately predicting residual values.[6] Predicting residual values is difficult because of the many factors influencing depreciation, including general economic conditions, competition, customer preferences, new product pricing, innovation, and new product development. The information and knowledge of these factors resides throughout the industry and with key individuals and groups within the manufacturer. A market research group possesses knowledge about early consumer reactions to the product, and product testing engineers understand the likelihood of failure for many of the key parts. Production engineers may best understand quality control in production facilities, and design groups know the likely timing and nature of future redesigns. A RV manager must locate, identify, and acquire this knowledge from each place, often without cooperation from the knowledge owners.

Given the distribution of necessary knowledge, the KBV suggests that vertically integrated captive lessors should be better able to acquire proprietary knowledge to help solve the residual value. Two of the critical types of knowledge for depreciation are model redesigns and durability. Purohit (1992) found that car depreciation strongly depends on the timing and nature of model introductions and redesigns. Manufacturers, in planning model redesigns, can inform

[4] Data from CNW Marketing Research (http://www.cnwmr.com/).

[5] The economics literature primarily focuses on how monopolists and oligopolists use leasing to control competition between new and used goods (Coase 1972, Stokey 1981, Waldman 1993). Other work has focused on manufacturers' lease/sell ratio as a function of time inconsistency concerns (Waldman 1993) durability (Desai and Purohit 1998), adverse selection (Guha and Waldman 1997, Johnson and Waldman 2003, Gilligan 2004), or moral hazard (Johnson and Waldman 2010).

[6] The credit risk problem is easily resolved by using credit reports and FICO scores to set interest rates, thereby making residual value prediction the principal challenge for the lessor.

captive subsidiaries and thereby help them anticipate the consequential depreciation.[7]

Likewise, durability problems impact used vehicle values by accelerating deterioration. Closed-end leases with purchase options, standard in the automobile industry, only exacerbate this risk for the lessor because of problems of adverse selection and moral hazard (Hendel and Lizzeri 2002, Gilligan 2004, Johnson and Waldman 2010). As with model redesigns, the KBV suggests that the manufacturer's proprietary durability knowledge about part design and testing results could provide captive lessors advantages over independent competitors in anticipating depreciation. Although automobile magazines and other sources routinely publish information on durability and anticipated new model introductions in advance, this information is imperfect, as manufacturers protect design information.

It is important to note that market solutions to exploit superior manufacturer knowledge are infeasible in car leasing. If manufacturers were to outsource RV forecasting to independent lessors, they would have strong incentives to misrepresent vehicle and strategic planning information in order to understate expected depreciation, because higher residual values reduce lease prices and increase manufacturer sales. Such understatement is difficult to verify in a contractual setting without full access to manufacturer operations, which would create opportunities for independent lessors to sell proprietary information to competing manufacturers, similar to appropriability concerns in the literature on subcontracting (Pisano 1990, Oxley 1997, Mayer and Nickerson 2005). Indeed, Novak and Stern (2009) argue that trade secrecy is one important reason why vertical integration is critical to coordination in the automotive industry. With leasing, exclusive relationships with manufacturers cannot mitigate this risk because they would produce insufficient portfolio diversification for independent lessors, who would be highly susceptible to brand-based shocks such as manufacturer bankruptcy (Chrysler), safety scandals (e.g., Firestone/Ford, Toyota), or brand cancellations (e.g., Buick, Oldsmobile).

The empirical implications of knowledge-based advantages are clear. If manufacturers have such an advantage over independent lessors, we should observe them better anticipating future model introductions by adjusting residual values as redesigns approach. Similarly, although we might expect all lessors to account for durability variation across nameplates, variation within brands and models may be predictable only to the captive lessor. If this is true, the KBV suggests we should observe vertically integrated captive lessors reacting more strongly to variation in durability than independent lessors, as they correctly anticipate its impact on future deterioration and depreciation.

3.2. The Role of Residual Values in Vertically Integrated Firms

In car leasing, vertical integration introduces additional mechanisms through which RV impacts profitability, beyond the simple accounting of individual contracts. Whereas independent lessors simply forecast residual values, captive lessors must set residual values that maximize profits across the activities and divisions of the manufacturer parent. If an accurate residual value negatively impacts other corporate objectives, captive lessors may knowingly write leases with incorrect residual values, with the resulting RV losses reflecting interdivisional transfers rather than actual corporate losses.

I focus on two such mechanisms: signaling and pricing. Much like advertising (Milgrom and Roberts 1986), branding (Rao et al. 1999), pricing (Cooper and Ross 1984), and warranties (Balachander 2001), a low RV from a captive lessor sends a signal about both the quality and expected success of the vehicle. Even if a manufacturer knows a car to be of low durability, it may be unwilling to let the leasing subsidiary signal these attributes through a low RV. Consumers, industry experts, and financial institutions, recognizing the captive's private information, interpret low residual values as quality revelations, motivating scrutiny by industry and press, and encouraging independent lessors to further reduce their own residual values. If these signals are credible, manufacturers may selectively write high residual values on low durability products. This signaling, however, would provide less benefit after the first year of a model design, when low-quality and unpopular vehicles would have been identified in publications like Consumer Reports or J.D. Power. Consequently, captives are unlikely to try to use residual values for signaling after the initial model design year because of its cost and inefficacy.

The second mechanism through which residual values impact profitability is the pricing and inventory management of new vehicles. Manufacturers frequently direct captive subsidiaries to intentionally write residual values above estimates in order to lower the lease price, thereby increasing sales and reducing inventory. Busse et al. (2006) show that because car manufacturers rarely lower retail prices during a model year (for signaling reasons), they instead use cash incentives and captive finance arms

[7] When asked if he had an information advantage over outside finance companies, a captive residual value manager replied that "he certainly hoped so" or else they were not protecting vital planning information from competitors (personal interview with author via telephone call in the summer of 2002).

to reduce inventory, provide financial accessibility to consumers, and increase market share. Busse et al. (2006) focused on loan subsidization, but lease subsidization targets different consumers, many of whom lease because of short vehicle replacement cycles or cash constraints. Lease subsidization is primarily accomplished through increasing residual values, which the industry refers to as subvention. Although manufacturers could alternatively subsidize leases by reducing interest rates, RV subsidization allows them to report losses at the end of the lease, rather than at the point of sale. Although it is unclear if delaying such losses improves profits, it could benefit managers seeking improved short-term financial statements.[8]

The empirical implications of signaling and subsidization are clear. If captive lessors, like independents, solely focus on RV prediction, we should observe them reacting similarly to independents. If they are instead using signaling, we should observe captives using higher RVs on low durability cars in their initial design year, in spite of proprietary knowledge of durability problems. Because signaling grows less useful as durability is revealed over time, this RV inflation should disappear. Similarly, if captives are pursuing subsidization, we should observe them setting higher residual values than independents specifically on low market share and high inventory vehicles. We also should expect to observe them raising residual values as new model designs approach, particularly for major redesigns. Subsidization should not generate different responses by captives and independents to unrevealed durability, nor does the KBV propose strong predictions for response to market share or inventory, but a conflict exists in the KBV and subsidization stories for how captives might respond to model redesigns. If captive lessors, despite anticipating the timing and nature of redesigns, must instead maintain or raise residual values to support soon-to-be obsolete vehicles, we will not observe them exploiting any knowledge advantages. Rather than seeing increased anticipation of redesigns through lowered RVs, we would instead see a decreased response in order to subsidize these vehicles as their popularity wanes.

[8] The Financial Accounting Standards Board (FASB) Rule 13 is intended to prevent this practice, requiring manufacturers to account for subsidized operating leases and lending in financial statements. Yet lending and leasing are bundled and not independently observable. Whereas promotions based in interest or rebates would be immediately observable and verifiable in an audit, residual value subsidies would not, and are therefore viable ways to manipulate profitability across years. A high residual value representing nondeclared subsidization could always be justified as confidence in the vehicle's future success.

3.3. Agency Issues in Vertically Integrated Lessors

Vertical integration creates additional and conflicting profit implications for residual values. Although the corporate problem of balancing signaling, marketing, and financing concerns may seem conceptually simple, it is practically difficult because product and brand managers in automotive firms may exert internal political pressure or use subterfuge to alter product, marketing, and consumer demand information that either reflects negatively on them or impacts division profits. Manipulating these data or pressuring the leasing division's decision makers can lead to residual values on some vehicles that not only fail to reflect superior internal knowledge but are also inconsistent with maximizing overall corporate profitability. Furthermore, the manipulation of this knowledge may only be revealed by residual value losses near the end of the lease, and these losses can be explained away by managers as simple errors or as confidence in the firm's products.

Product sales teams, for example, have strong incentives to encourage high residual values on their cars, as RV affects their product's affordability. Residual values are particularly important for luxury vehicles, which have higher leasing rates due to both leasing preferences from high-income customers as well as cash constraints from those seeking increased social status from luxury cars. Expensive lease rates would cripple these products, and most potential lessees would choose to lease a different vehicle rather than buy the car. Although the RV manager at an independent lessor would lower residual values to account for the increased risk of a low durability vehicle, their counterparts at captive lessors may be unable or unwilling to do so, despite recognizing the eventual cost of this inaction several years later.

Within an automobile manufacturer, the RV manager at a captive lessor may face a difficult decision. Whereas the costs or rewards of avoiding RV losses may not be realized for up to five years, the political costs of displeasing sales teams and executives are immediate. With the focus of the manufacturer on market share and immediate earnings, RV managers may simply find it easier to relieve internal political pressure now and suffer residual value losses later. This problem would be exacerbated by managers expecting to change positions or companies within the term of the lease. Such managers may have strong incentives to curry favor with other divisions, believing this would improve their job mobility.

Captive lessors may suffer worse performance than independent competitors in adjusting residual values to durability concerns because of the unwillingness of residual value managers to punish low-quality vehicles. Whereas quality signaling may explain high captive residual values in the first design year, continued

high RVs after the first year are more likely to reflect agency concerns. Like the signaling argument, the agency explanation therefore conflicts with the KBV prediction that captive residual values will be more sensitive in anticipating future revelation of durability. But it further suggests that captives will maintain RVs on low durability cars long after durability is known to independent lessors.

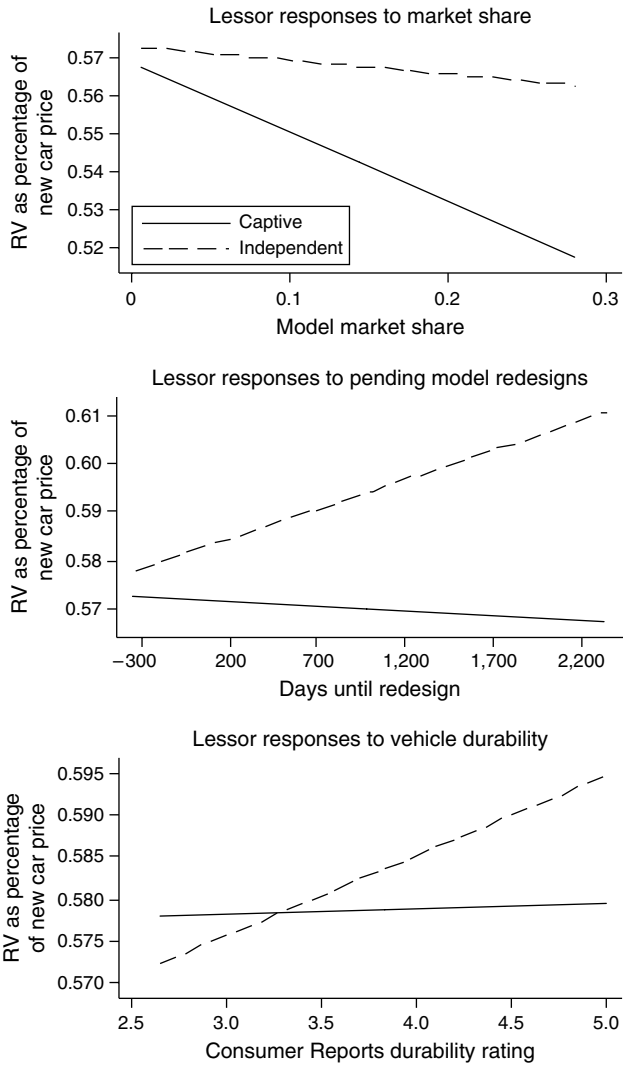
4. Empirical Analysis

My empirical analysis focuses on identifying how captive lessors react differently than independents to factors influencing residual values. Subsidization, knowledge advantages, signaling, and agency issues provide conflicting predictions about how captives and independents will respond to the factors of durability, sales, and model redesign. Identifying differences in these responses will shed light on the importance of these issues in captive lessors' contracting.

I present the basic RV difference between captive and independent lessors in Figure 1, which represents the RV percentage (of new car price) for all 48-month leases by captive (20,408 leases) and independent (13,768) lessors.[9] Although these graphs do not control for many other contract and vehicle factors, they demonstrate considerable differences in how captive and independents set residual values. Consistent with subsidization, captives increase RV as market share falls, and do not reduce RV as redesigns approach. In response to durability, captives maintain RVs on even the lowest durability cars, despite independents decreasing RV. These responses are in sharp contrast to a knowledge-based argument, where captive lessors should exploit superior knowledge to anticipate durability and model redesigns through residual values, and suggest both signaling and agency issues as possible explanations. Although independent RV is on average higher than captive RV, this difference largely represents the quite different samples of 48-month leases written by independents and captives.[10] Regardless of why independent residual values are higher in Figure 1, the change in this RV difference as a function of durability, model redesign, and market share is consistent with captive subsidization.

Despite this evidence, we cannot empirically separate strategic and performance differences here because pervasive lease subsidization by captive lessors obscures other ways in which vertical integration may influence residual value prediction. I therefore first identify subsidization using all leases in my sample. I then take a sample of vehicles where no subsidization should occur, and test for signaling and knowledge-based explanations for differences in forecasting performance. I also study this sample for behavior consistent with agency problems in transfer pricing.

Figure 1 **Variation in 48-Month Residual Values by Organizational Structure**



4.1. Data

The primary data set for this study involves approximately 180,000 consumer lease transactions from California dealerships between 1997 and 2001. These data come from a major marketing research firm and identify vehicles by model, model year, and detailed options. Most importantly, each case lists detailed terms of the vehicle's financing, including the APR,

[9] I use 48-month leases because they are the most common leases in my data set and thus present sufficient observations for comparison. The lines represent simple linear predictions without controls. I will compare leases across different term lengths in later regression analysis.

[10] Furthermore, Pierce (2009) showed that most independents overestimated residual values during this period.

capitalized cost, and residual value. The data include other detailed lease terms, including lessor name, down payment, term, monthly payment, rebates, and the buy rate, or the markup-free interest rate lessors offer dealers on leases. Dealers will sometimes mark up this rate and offer the consumer a higher APR, pocketing the difference. Because the data are based on information collected at the dealership, I cannot observe off-dealership financing. Leases written away from dealerships, like loans written away from dealerships, appear only as cash transactions in the database.[11]

Vehicle durability data is from Consumer Reports (http://www.consumerreports.org/cro/cars/index.htm) for each vehicle model in years 1997–2002. These data are used to represent vehicle quality, including ex post measures of reliability for 14 vehicle characteristics on a five-point scale. Consumer Reports constructs these measures from repairs reported by survey respondents. A high rating of five indicates few problems, while a rating of one represents frequent problems. The durability measure is taken from the date of lease termination, and is publicly known at that point. This durability information is imperfectly and asymmetrically known, however, at the time of lease origination, with private information likely known only inside the manufacturer. Vehicle sales and market share data are from the *Automotive News* Market Data Books, years 1999–2002. Using these data, I calculated total segment sales and market share for market segments defined by the supplier of the contract data. Monthly vehicle inventory data are also from *Automotive News* and represent the number of sales days worth of inventory for a given model in the preceding month. Low inventory represents high demand relative to production capacity. High inventory represents under-performing sales. Unfortunately, these data are only available at the model level for American manufacturers.

Finally, I use new model introduction and redesign data from Intellichoice.com. These data identify when a manufacturer redesigned or introduced a model as well as the redesign characteristics. These data included dummy variables identifying if the model change involved a new platform, which I designate as a major update. Minor updates involved primarily cosmetic changes. The individual contract data identifies the date when the first unit of a new model or model update was sold, which allows me to identify the number of days between lease origination and the model redesign. For example, if a lease was originated March 1, 2000, and the first redesigned vehicle appeared March 1, 2001, the number of days until redesign for this lease would be 365. These data sets were compiled with the unit of analysis as the individual lease contract. Thus for each of approximately 180,000 vehicles, the data include the contract terms, lessor, the realized durability of the model year, and the timing and nature of the next redesign.

4.1.1. Summary Statistics. I present summary statistics for two samples in Table 1. The primary sample, which will be used in the larger market share model, includes 178,979 leases. The mean capitalized cost is \$30,201, with a mean residual value of \$15,216 or roughly 61% of the mean invoice price of \$24,938.[12] The average term was 44.5 months. Fifty-two percent of the vehicles were trucks or sports utility vehicles. Leases originated on average 2.5 years before a model redesign, with major redesigns accounting for 83% of these changes. The second sample, which I will use in the smaller inventory model, includes 31,578 American cars from 2000 to 2001. This sample has more trucks, lower residual values, and slightly shorter term lengths. The most important difference between these samples, however is that the inventory model includes only American captive lessors (Ford, General Motors, and Chrysler). The captive lessors in this sample are therefore a unique subset of the larger set of vertically integrated lessors.

4.2. Identifying Lease Subsidization

I first identify subsidization by estimating how captive lessors raise residual values relative to independent lessors under conditions where subsidies are likely necessary: as redesigns near, market share falls, and inventory rises. Using a manufacturer fixed-effects ordinary least squares (OLS) model, I examine differences between captive and independent contracts for all vehicles in the population. The key to identifying subsidization is to interact market share and inventory variables with a captive lessor dummy. The coefficients on the noninteracted market share or inventory represent independent lessor behavior. The coefficients on the interacted variables represent the difference in captive lessor behavior. This model is

$$\textit{Residual value}_i = \alpha_i + \beta K_i + \gamma N_i + \phi X_i + \Psi P_i + \omega D_i + \varepsilon_i,$$

[11] These data represent leases originated at dealerships and do not include leases arranged directly with banks. Given the 45% national market share of captives, and the 60% market share in my California sample, one can infer that a significant number of independent leases are missing from the data. These missing independent leases are likely to be priced much higher because they are less likely to be compared directly against competing leases, as in my dealership data.

[12] The capitalized cost reflects dealer-based price negotiations, and the invoice price, the price paid by dealers to manufacturers, is constant across all dealers. For this reason, residual value percentage is more accurately reflected by using the invoice.

Table 1 Full Sample Summary Statistics

	Market share model					Inventory model				
	Obs.	Mean	Std. dev.	Min	Max	Obs.	Mean	Std. dev.	Min	Max
Residual value	178,979	15,216	6,881	135	69,359	31,578	13,884	4,562	135	39,394
Capitalized cost	178,979	30,201	12,063	10,116	169,684	31,578	30,527	10,304	10,288	98,356
Truck dummy	178,979	0.52	0.50	0	1	31,578	0.74	0.43	0	1
Invoice	178,979	24,938	9,054	6,894	102,230	31,578	24,734	6,656	8,437	56,504
Term	178,979	44.50	11.29	4.00	84.00	31,578	42.65	12.05	4.00	84.00
Durability	178,979	4.26	0.52	2.64	5.00	31,578	4.42	0.31	3.50	5.00
Month	178,979	6.37	3.23	1.00	12.00	31,578	5.27	3.00	1.00	12.00
Market share	178,979	0.07	0.06	0.00	0.57					
Inventory (days)						31,578	78.54	23.73	18.00	297.00
Captive dummy	178,979	0.60	0.49	0	1	31,578	0.62	0.48	0	1
Days until redesign	178,979	937	522	−363	2,467	31,578	853	396	−358	1,787
Major redesign dummy	178,979	0.83	0.37	0	1	31,578	0.80	0.40	0	1
Credit risk	178,979	8.70	1.23	0.90	20.31	31,578	8.47	1.35	1.06	20.31
Total portfolio	178,979	15,989	8,194	1	28,039	31,578	18,930	7,527	1	28,039

where K represents a set of car variables, including vehicle invoice, dealer sales price, a truck dummy, and vehicle durability (prior work suggests light trucks have unique leasing losses; Desai and Purohit 1998); N contains new product introduction variables: time until model redesign and redesign significance dummy; X consists of the car model's market share in its vehicle segment; P includes variables describing the lessor's portfolio of leases: total vehicle portfolio size, annual portfolio, specific make/model/model-year portfolio size, and a consumer credit proxy that is the average interest rate offered on (nonlease) loans at the originating dealership; and D represents interaction terms from the captive dummy variable for identifying the effect of organizational structure on the coefficients of the independent variables. The interaction terms are included to separate the variables' effects on captive lessors from their effects on independent lessors. Also included in the model are year and term-length dummies. The variable definitions are listed in Table 2. The unit of analysis is an individual vehicle lease contract, of which I use 178,809. Because of the dummy variables and manufacturer fixed effects, all variation in the model is within leases of a specific term length written in a specific year on vehicles from a specific manufacturer.

4.2.1. Baseline Model. I first present a baseline model without interactions that identifies how all lessors respond to vehicle and market characteristics. The results, presented in column (1) in Table 3, show that lessors increase residual values as durability rises and that captives on average write lower residual values. I find a negative relationship between RV and days until redesign, major redesigns, and market share, although because we expect different responses to each from captives and independents, the results are hard to interpret. These results are generally consistent, however, with the 48-month leases in Figure 1. To separate independent from captive behavior, we move to the interacted model in column (2).

4.2.2. Independent Lessor Behavior. Independent lessors serve as a baseline from which to compare captive lessor behavior. Their contracting behavior is identified by coefficients on variables not interacted with the captive dummy. I expect to find several relationships between independent residual values and the explanatory variables. To reflect increased

Table 2 Variable Definitions

Residual value	The estimated value of the vehicle at lease end; also the price at which the lessee can purchase the vehicle at lease end
Capitalized cost	The negotiated new price of the vehicle; the total amount financed
Truck dummy	1 if the vehicle is a light truck or SUV, 0 otherwise.
Invoice	The fixed price paid by the dealership for the vehicle
Term	The length in months of the lease
Durability	The Consumer Reports durability score measured at lease end through consumer repairs
Month	The calendar month
Market share	The model family market share in its vehicle segment (e.g., compact)
Captive dummy	1 if the lessor is captive, 0 otherwise
Days until redesign	The number of days until the model redesign is introduced
Major redesign dummy	1 if the redesign is major, 0 otherwise
Credit risk	The credit risk proxy calculated at the dealership level
Total portfolio	Total number of vehicles leased by the lessor in the data set
Year portfolio	Total number of vehicles leased by the lessor of that model year
Model portfolio	Total number of leases of that model/model-year held by the lessor
Monthly inventory	Number of sales days in the national inventory for that model in the preceding month
First dummy	1 if the vehicle is the first design year

Table 3 Tests for Lease Subsidization

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	*RV*	*RV*	Log*RV*	Log*RV*	*RV*	*RV*	Log*RV*	Log*RV*
Dealer invoice	0.648**	0.691**			0.545**	0.585**		
	(0.00341)	(0.00343)			(0.0066)	(0.00540)		
Log(*invoice*)			0.731**	0.783**			0.615**	0.692**
			(0.0047)	(0.00534)			(0.0119)	(0.0118)
Durability	273.83**	259.6**	−0.0002	−0.00547	1004.9**	627.8**	0.138**	0.148**
	(55.13)	(61.96)	(0056)	(0.00576)	(116.2)	(150.4)	(0.0134)	(0.0155)
Durability × *Captive*		85.08		−0.00205		381.4+		−0.0520**
		(62.08)		(0.00545)		(201.3)		(0.0196)
Model market share	−1076.5**	2422.3**	−0.244**	0.104**				
	(320.34)	(336.4)	(0.0362)	(0.0382)				
Market share × *Captive*		−3486.9**		−0.495**				
		(472.0)		(0.0491)				
Monthly inventory					6.02**	−1.780	0.0007**	0.000124
					(1.73)	(1.928)	(0.00015)	(0.000175)
Inventory × *Captive*						6.667**		0.000520*
						(2.505)		(0.000255)
Days until redesign	−0.038	0.294**	−0.00002**	0.00001**	−0.106	0.231*	−0.00003**	−0.0000071
	(0.037)	(0.0335)	(0.000003)	(0.000003)	(0.082)	(0.0905)	(0.0000078)	(0.0000094)
Days redesign × *Captive*		−0.358**		−0.00004**		−0.521**		−0.00004**
		(0.0657)		(0.000006)		(0.138)		(0.000014)
Major redesign	−133.5**	6.238	−0.015*	0.00009	−260.31*	−168.2	−0.016	0.0092
	(51.53)	(49.28)	(0.0061)	(0.0049)	(110.8)	(101.6)	(0.013)	(0.0114)
Major redesign × *Captive*		−424.2**		−0.0211*		−257.1		−0.0239
		(94.87)		(0.0104)		(178.9)		(0.0183)
Captive dummy	−420.6**	154.5	−0.042**	0.0601*	−410.7+	550.0	−0.0562**	0.136
	(40.3)	(304.9)	(0.0062)	(0.0265)	(222.7)	(969.6)	(0.0088)	(0.0926)
Term-length dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Truck dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lessor porfolio controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	178,979	178,979	178,979	178,979	31,578	31,578	31,578	31,578
R-squared	0.883	0.929	0.672	0.745	0.833	0.867	0.633	0.669

Note. Robust errors clustered at the lender/model/year level.
$^{+}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$.

depreciation, independents should lower RV as durability decreases. Similarly, as redesigns near, independents should lower RV to reflect the effect of redesigns on used car values. If the redesign magnitude is anticipated by independent lessors, we should also expect forthcoming major redesigns to lower residual values. Furthermore, vehicles with higher market share should suffer less depreciation for two reasons. First, high market share reflects the popularity of the current design, and the expected popularity of the design on the future used car market. Second, high market share reflects that the vehicle was not overpriced. An overpriced vehicle would depreciate more quickly on the used market, as used car prices are not fixed in the same way that invoice price is.

Column (2) in Table 3 presents the results from the OLS fixed-effects regression. All errors are clustered at the lender/model/year combination.[13] As expected, the coefficients on durability (259.6) and days until redesign (0.294) are both positive and statistically significant, indicating independent lessors raise residual values in response to increases in these factors. The coefficients indicate that these variables are not only statistically significant, but also economically significant as well. An increase from low durability (3) to high durability (5) on average increases the RV by \$519. This is a considerable effect given the imperfect information held by lessors when writing contracts. Moving one year closer to the model redesign would decrease the RV by \$107. The coefficient for the major

[13] Lessors do not continuously change residual values across time. In other words, there is some stickiness in the residual values set, such that lessor A's residual value on a 48-month lease for a 1998 Taurus written March 12 is likely to be the same as the one written on March 16.

redesign dummy (6.24) is approximately zero and not statistically significant. The coefficient on market share is positive (2,422) and highly significant.[14]

4.2.3. Manufacturer Subsidization. To identify captive RV subsidization, we must observe the interaction between the captive dummy variable and market share, inventory, and days until redesign. If subsidization is occurring, manufacturers should set higher residual values than independents as the days until redesign decrease, with low market share or high inventory, and when major redesigns are pending.

The results on subsidization are presented in column (2) of Table 3 as the coefficients on the captive interaction variables. The coefficient of −0.358 for the days until redesign/captive interaction variable shows that as the time until redesign decreases by one day, captives raise the RV by \$0.36 relative to independent lessors.[15] The market share/captive interaction coefficient of −3,486 indicates that as market share increases 10%, captives lower their RV by \$348 relative to independent lessors. Both results are consistent with manufacturers subsidizing poor selling and increasingly obsolete models. Subsidization is not reflected in redesign magnitude. In fact, manufacturers write comparatively lower residual values on vehicles with pending major redesigns, with the captive/redesign interaction having a coefficient of −424. This result is consistent with the knowledge-based predictions and may reflect that details of redesigns are not widely known to independent lessors or consumers. Although industry publications provide imperfect information on the expected timing of redesigns, manufacturers may ultimately succeed in keeping details of these redesigns secret. Columns (3) and (4) repeat columns (1) and (2), using logged residual values and logged dealer invoice. These results are generally consistent with the primary specification, although the unidentified durability coefficients cast some doubt on its sensitivity to misspecification.

4.2.4. Subsidization to Reduce Inventory. Although market share may be the principal objective of the car manufacturer, annual data provides little variation within car model; a manufacturer may be content with a 10% market share in one segment while viewing equivalent market share for another vehicle as insufficient. Inventory data instead reflect model sales relative to the production capacity of the manufacturer. Models that sell above expectations exhibit low inventory whereas under performing sales will result in excess inventory. We therefore expect high inventories to motivate sales incentives, including lease subsidization through inflated residual values. The inventory level is measured in the number of days of sales for a model in the preceding month. For a vehicle leased in February, 2001, this value would be the inventory of that model from February 1.[16]

The results of the interacted inventory model, presented in column (6) in Table 3, also show strong evidence of subsidization. Although the coefficients on inventory are not statistically significant across models, captive lessors raise RVs relative to independent lessors as inventory rises, as demonstrated by the positive coefficient (6.67) on the inventory/captive interaction. Furthermore, coefficients on the redesign variables are similar to those in the market share model, further supporting subsidization. The primary explanatory variables remain consistent across the logged specification in column (8), with some control variables losing statistical significance across models.

5. Residual Value Losses in the Absence of Subsidization

Evidence from the total population of leases shows that captives indeed subsidize leases, suggesting that vertical integration creates corporate goals that conflict with the exploitation of internal knowledge transfers. Given the widespread use of lease subsidization, identifying other implications of vertical integration is difficult. Consequently, I sample only those vehicles for which there should be no reason to subsidize the leases—vehicles with high dealer profit. High dealer profit indicates that demand for the vehicle is high relative to supply, allowing the dealer to charge high markups over vehicle invoice. Because manufacturer invoice prices are fixed over the year (Busse et al. 2006), dealers reap most profits when vehicles are in short supply, which allows them to sustain high retail prices to customers.[17] One concern with this sample is that dealers may trade lower lease prices for higher sales prices, but because dealers have no control over the residual values offered in the lease contracts, RVs are independent of dealer action. Another concern is that the discounted financing provided by high residual values is captured by dealers who might negotiate

[14] Alternate models that included a control for the Herfindahl index of model segment concentration have no impact on the primary variables of interest, but do create volatility across models in the coefficient for independent lessor market share due to high correlation (0.67) between these variables.

[15] Alternative models that use year dummies or days from the end of the lease (instead of the beginning) in place of days-until-redesign variable find similar results.

[16] These data were only available at the model level for American cars in years 2000 and 2001. This reduces the sample from 178,809 to 31,578 vehicles, but provides greater variation in the independent variable.

[17] Interviews with captive lessors and dealers verified high dealer profit as an appropriate sampling criterion.

Table 4 No-Subsidization Summary Statistics

	High-profit sample			No-rebate sample		
	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.
Residual value	19,021	20,521	9,312	18,839	19,948	10,337
Capitalized cost	19,021	37,163	15,630	18,839	35,711	17,480
Truck dummy	19,021	0.62	0.49	18,839	0.11	0.31
Invoice	19,021	30,331	11,875	18,839	30,347	14,240
Term	19,021	45.04	11.28	18,839	42.61	9.45
Durability	19,021	4.06	0.45	18,839	4.30	0.47
Month	19,021	6.33	3.16	18,839	6.55	3.01
Market share	19,021	0.08	0.07	18,839	0.05	0.05
Captive dummy	19,021	0.54	0.50	18,839	0.66	0.47
Days until redesign	19,021	978	551	18,839	759	473
Major redesign dummy	19,021	0.63	0.48	18,839	0.78	0.41
Credit risk	19,021	8.47	1.10	18,839	8.49	0.93
Total portfolio size	19,021	14,689	8,624	18,839	12,876	7,023

differently, leading to higher prices and thus higher dealer profits. Yet given that Busse et al. (2006) found that 70%–90% of customer rebates pass through to customers, dealer profits are unlikely to be highly impacted by consumer subsidies.

I calculate the average dealer profit on all vehicles and selected the top 10% of transactions. Summary statistics from this sample are listed in Table 4. As expected, the sample has major differences from the general population. Price levels and durability is slightly lower (4.06 to 4.296), perhaps reflecting the higher proportion of trucks (0.62 to 0.48). Whereas term lengths from the two groups are nearly identical, the mean residual value percentage (of invoice) is much higher in the high-profit sample (67.7% to 61.0%). This is consistent with earlier results that higher market share vehicles have higher residual values.

Using the high-profit sample, I repeat my OLS fixed-effects analysis for 19,021 contracts. The results from the OLS model, presented in column (1) in Table 5, show evidence that captive lessors are able to exploit at least some knowledge-based advantages in predicting residual values, but these appear to be limited to knowledge surrounding redesign timing. Whereas independents appear to anticipate redesigns by lowering residual values as days until redesign decreases, captives are more sensitive to new model timing. I observe no knowledge-based advantage for captive lessors in anticipating the magnitude of the redesign. This could reflect the inability of manufacturers to keep knowledge on redesign proprietary because of press coverage anticipating these events.

Although captives appear to have some knowledge-based advantages over independents regarding model redesign timing, they react very differently to variation in product durability. Independents predictably raise the RV as durability increases. Captives, however, show a very different response to durability variation. The captive/durability interaction coefficient of -178 indicates that captives raise RV as durability falls. This difference also exists in the first design year. In fact, in the first design year, captives lower RV by considerably less than independents ($\beta = 1{,}894$). This result suggests captive lessors are unwilling to lower residual values on low-quality vehicles because of signaling concerns. The continued effect after the first year is also consistent with agency concerns, although we cannot rule out continuing value in signaling. Results from the logged function are presented in column (2) in Table 5 and are generally consistent.

I used a second sampling criterion for unsubsidized vehicles consisting of cars for which no customer cash rebate was offered on vehicle purchases. Manufacturers who subsidize leases are also likely to subsidize sales through manufacturer rebates. Those vehicles without manufacturer rebates in a given year are likely to have no need for lease subsidization. Table 4 presents summary statistics for the no-rebate sample, which is heavily correlated ($p = 0.43$) and similar to the high-profit sample, although more heavily dominated by foreign producers. Results using the no-rebate sample, listed in columns (3) and (4) in Table 5, are mostly consistent with those from the high-profit sample, supporting signaling and agency considerations. One difference is the captive/durability interaction coefficient of $-1{,}938$, which shows that captives actually decrease residual values as durability increases, even stronger evidence that captive lessors are unwilling to set low residual values on low durability vehicles.

Although I eliminate subsidization by only using vehicles in high demand, I still see stark differences in how captives and independents write residual values. In the first year, manufacturers release high residual values even on their lowest durability cars, consistent

Table 5 Unsubsidized Leases

	(1)	(2)	(3)	(4)
Sample:	High-profit	High-profit	No-rebate	No-rebate
Dependent variable:	*RV*	Log(*RV*)	*RV*	Log(*RV*)
Dealer invoice	0.671**		0.605**	
	(0.00781)		(0.00662)	
Log(*invoice*)		0.623**		0.485**
		(0.0153)		(0.0121)
Durability	389.8+	0.0763**	626.3*	0.158**
	(223.8)	(0.0218)	(313.7)	(0.0199)
Durability × *Captive*	−178.8*	−0.0535*	−1094.3**	−0.0227**
	(82.2)	(0.0213)	(294.5)	(0.0079)
Days until redesign	1.456**	0.0000680**	0.845**	0.0000987**
(from lease origination)	(0.116)	(0.0000105)	(0.146)	(0.0000105)
Days redesign × *Captive*	0.172*	0.0000417+	0.225**	0.0000564**
(from lease origination)	(0.078)	(0.0000224)	(0.084)	(0.0000012)
Major redesign	−91.26	−0.0293	−364.1*	−0.127**
	(185.3)	(0.0186)	(153.8)	(0.0107)
Major redesign × *Capdum*	45.22	0.0164	224.9	0.0202
	(150.6)	(0.0156)	(184.2)	(0.0127)
First model-year dummy	−2135.8*	−0.00193	−4,066.8**	−0.200+
	(853.2)	(0.0894)	(1,511.4)	(0.111)
First year × *Durability*	448.7*	0.0610**	943.3**	0.0456+
	(208.5)	(0.0218)	(343.4)	(0.0254)
First year × *Captive*	1,894.4**	0.134*	7,859.1**	0.367**
	(649.89)	(0.0529)	(1,770.7)	(0.137)
First year × *Durability* ×	−597.8*	−0.0238	−1,735.6**	−0.0876**
Captive	(278.7)	(0.0283)	(404.3)	(0.0319)
Model market share	−1,393.6	−0.233*	−740.7	−0.473**
	(1,199.7)	(0.124)	(1359.1)	(0.120)
Market share × *Captive*	−324.3	−0.185+	−353.3	−0.196
	(1,100.7)	(0.105)	(1,701.3)	(0.156)
Captive dummy	400.7	0.205*	939.2**	0.0398
	(1,042.3)	(0.104)	(122.5)	(0.0856)
Truck dummy	Yes	Yes	Yes	Yes
Term-length dummies	Yes	Yes	Yes	Yes
Lessor portfolio controls	Yes	Yes	Yes	Yes
Observations	19,021	19,021	18,839	18,839
R-squared	0.943	0.846	0.970	0.921

Note. Robust errors clustered at the lender/model/year level.
$^{+}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$.

with a signaling explanation. Although such signaling could potentially be effective to some parties, independent lessors react quite accurately to the first-year models. If the rest of the market responds to durability like independent lessors do, then the signaling may be ineffective. Regardless of this efficacy, it may still be unacceptable to the corporation for the captive lessor to admit the low quality of the vehicle.

The continued residual value support of low durability vehicles beyond the first year suggests that signaling may not be the sole explanation for this difference. Durability variation after the first year may provide some continued justification for signaling, but we would expect this effect to be weak. Although we cannot observe the internal mechanisms of the manufacturers, the continued captive lessor support of low-durability vehicles is consistent with the agency explanation presented here. We might, in fact, believe that the large difference in year one reflects stronger pressure from product managers to make new introductions successful, although we cannot differentiate this from profit-improving signaling.

6. Conclusion

The knowledge-based view of the firm argues that vertical integration can provide considerable benefits to knowledge exchange and transfer within the firm. Car leasing, where lessors face the principal problem of predicting residual values, seems an ideal place for the hierarchical form of captive lessors to

present knowledge-based advantages over independent competitors. The results of this paper show, however, that many of the knowledge-based benefits of vertical integration may become secondary to other interests within the firm. Although in theory the firm might optimally balance these interests, managers with parochial interests may withhold or distort knowledge for personal benefit.

The results from this paper suggest that vertical integration may not provide the clean solution to knowledge exchange problems observed in market relationships. Problems with incentive alignment remain in hierarchy, but are instead transferred within the boundaries of the firm. Such internal agency problems may in fact be greater than in market relationships because they are hidden behind the appearance of a common corporate identity. In market relationships, those exchanging information across firm boundaries have few illusions of common purpose. Furthermore, traditional competitive forces are unlikely to eliminate agency problems in markets like car leasing. Independent lessors entering the market cannot directly compete with captive lessors, regardless of agency problems, because their leases are priced below cost and likely to cause losses and exit (Pierce 2009). Entry would more effectively reduce agency costs in markets where they produce higher prices, or where entry and exit is more likely at the level of the manufacturer parent. Car manufacturers, who historically enjoy little threat of entry, can sustain broad inefficiencies for long periods of time without collapse.

The existence of agency costs within hierarchies does not imply that a market solution would be a more efficient mode for car leasing. As noted earlier, market solutions seem intractable in this market because of considerable contracting hazards. These results instead suggest that vertical integration is less beneficial than previously thought, and that its value in facilitating knowledge sharing should not be overstated. In other markets, when vertical integration involves an acquisition or startup costs, these agency concerns should certainly reduce the price the firm is willing to pay to set up a subsidiary.

The key focus for future work must be to understand under which conditions hierarchy might provide knowledge-transfer benefits, and when it will lead to the costly information manipulation we observe in car leasing. This paper suggests two particularly fruitful directions for such investigation. First, future research should target the relationship between the internal incentives of knowledge holders and the quantity and quality of knowledge sharing. Examining variation within firms and industries will better identify how firms might effectively choose when to integrate for knowledge-sharing rationale. This variation in internal incentives could stem from compensation systems, but it could also be based in market strategy or scope of the firm. In car leasing, where career incentives dominate, it is the activities of the firm that create conflicts, not the explicit compensation structure.

Second, future work should examine how the unobservability of performance might aggravate agency problems in knowledge sharing. Firms must be able to attribute performance to internal knowledge sources if they are to identify information manipulation. Furthermore, this paper suggests that agency problems are of particular concern when outcomes such as RV accuracy are not observed or accounted for until years after the decision. When the incubation period for such outcomes is even longer, such as in home mortgages, the financial impact of agency costs may be even more severe. This paper suggests that the ability to link outcomes to decisions and the average job tenure and delay of performance revelation are critical to any agency model of knowledge sharing.

This paper has implications well beyond the automotive industry. The findings of this paper are consistent with the Mullainathan and Scharfstein (2001) study of "organizational focus" among PVC producers, although my results provide evidence for the internal mechanisms (both profitable and inefficient) that might be driving this behavior. Similarly, there are obvious implications for these results in the home mortgage market, where knowledge manipulation, perverse incentives, and heavy leverage had disastrous economic consequences. One advantage in studying the home mortgage market is the tremendous variation in organizational structure across multiple activities in the market (e.g., construction, origination, underwriting, securitization, inspection, sales). Future work could exploit this variation to understand whether different organizational solutions can better facilitate knowledge sharing and minimize the information distortion that led to such widespread foreclosures and bank failures. Similarly, past work on agency theory in internal transfer pricing suggests these problems are widespread across industries and hold great potential for future studies.

Finally, I must note that although my results suggest both signaling and agency concerns, I cannot definitively prove this. The much higher captive residual values on low durability vehicles suggest manipulation by internal agents, but we cannot directly observe this behavior. Without data on internal labor markets or networks, it is difficult to prove an agency explanation. Furthermore, this market represents only thirteen corporations, with limited across- or within-firm variation. Although interviews

with two corporate residual value managers have verified that internal political pressure can drive up residual values, this field research in no way represents a proof generalizable across all firms. It does suggest, however, why we observe captive lessors writing unprofitably high residual values on their worst vehicles, long after signaling might justify such behavior.

Ultimately, the residual value risk manager of a captive automobile lessor is like an umpire—no matter what call he makes, someone will vocally question his judgment. High residual values move cars, and low residual values signal lack of confidence by the manufacturer and hurt product teams by making vehicles unaffordable. In markets like this, where there are strong managerial incentives to sell now and pay later, costly conflicts may occur. The agency problems presented in this paper are similar to those observed in mergers and acquisitions that produce short-term fees for investment bankers but long-term costs from diseconomies of scale and scope. Whenever the costs of agents' rent-seeking behavior are not revealed until years later, the potential for catastrophic losses, whether they are from residual values or housing market defaults, remains substantial.

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