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The asymmetric effect of warranty payments on firm value: The moderating role of advertising, R&D, and industry concentration ☆

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ABSTRACT

Changes in firms' warranty payments are informative signals that enable investors to form timely expectations about potential changes in product quality. The authors' survey shows that warranty payments affect potential investors' product quality assessments and stock investment likelihood. Their quantitative analysis reveals an asymmetric stock market reaction: unanticipated increases in warranty payments (which signal quality "losses") lower stock returns but unanticipated decreases do not affect stock returns. Two important factors moderate this relationship. First, boosting advertising spending attenuates the negative stock return effect of unanticipated increases in warranty payments. Second, unanticipated decreases in warranty payments, which signal quality "gains", translate into higher stock returns when the industry has become less concentrated. Interestingly, changes in R&D spending do not moderate investors' response to unanticipated increases or decreases in warranty payments. The authors advise firms to use advertising to lessen the harm from warranty payment increases and to strongly communicate warranty payment decreases in the face of intensified competition. The authors also caution that offering warranties in general does not ensure greater firm value as declining quality firms that myopically offer warranty programs experience lower firm value than those that do not provide warranties.
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1. Introduction

Many companies sell their products under quality assurance warranties (Chu & Chintagunta, 2011; Menezes & Currim, 1992), which typically cover the cost of repair or replacement of malfunctioning products and the cost of refund for defective products (Spiceland, Sepe, Nelson, & Thomas, 2015). While warranties serve as a risk-mitigating factor for consumers (Chu & Chintagunta, 2009), the downsides of warranty costs for firms have seen less research attention. Consider Tesla Inc., whose stock price dropped significantly after an article in *Consumer Reports* highlighted the widespread quality issues with Model X and raised questions about the company's large warranty payments (Korosec, 2016). However, it is unclear what

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managers could do to attenuate the potential harm from bad warranty news (or how they could successfully benefit from good warranty news). For instance, when facing unanticipated increases in warranty payments, should managers boost advertising spending (to counter with positive information) or R&D spending (to help overcome quality concerns by placing greater emphasis on innovation)? Our study aims to fill this gap in the literature.

We maintain that higher warranty payments are an indication of product quality issues and propose a contingency stock market response model incorporating both internal and external product market signals (i.e., advertising spending, R&D spending, and industry concentration; e.g., Bharadwaj, Tuli, & Bonfrer, 2011; Mizik & Jacobson, 2003). While the internal signals capture managers' potential supporting decisions in the face of product quality issues or improvements, the external signal focuses on the competitive pressure faced by managers. Our thesis is that changes in warranty payments are timely and informative signals for investors, who do not appear to exhibit a consistent negative reaction to negative product quality information such as product recalls (e.g., Chen, Ganesan, & Liu, 2009; Freedman, Kearney, & Lederman, 2012; Hoffer, Pruitt, & Reilly, 1988; Thirumalai & Sinha, 2011). However, we further propose that investors do not interpret this signal in isolation but consider it in conjunction with other product market signals when forming their expectations about product quality and its impact on firm value.

Previous research has found that firm value increases with unanticipated improvements in perceived quality based on survey evidence (Aaker & Jacobson, 1994; Bharadwaj et al., 2011; Luo, 2010). While perceived quality is a function of both tangible and intangible attributes of a product (e.g., Zeithaml, 1988), realized quality is an outcome of product performance such as reliability and durability (e.g., Kalaignanam, Kushwaha, & Eilert, 2013). For the purposes of our research, we define product quality as "reliability, durability, or non-breakdown performance" (Chu & Chintagunta, 2011, p. 85). We acknowledge that product quality is a multidimensional construct (Reeves & Bednar, 1994) and that our definition captures a single, albeit important, dimension of product quality.

By focusing on realized product quality through the case of warranty payments, we aim to isolate the potential impact of non-product-related factors in testing the link between product quality and firm value. Our empirical approach has two distinctive aspects. First, we use an objective, accounting-based metric to differentiate between signals of product quality improvement versus product quality deterioration. Warranty payments are an outcome-based signal of product quality (i.e., higher claims are paid by sellers as customers experience more quality issues) and differ from input-based signals such as warranty length and coverage, which are not reliably correlated with product quality (e.g., Balachander, 2001; Chu & Chintagunta, 2011, Cooper & Ross, 1985). Second, our sample is not restricted to well-known brands but also includes firms with relatively limited brand recognition, allowing generalizability of our findings. Warranty payment information is especially important to investors when other quality signals are lacking––most likely in industries such as machinery or electronic equipment manufacturing. We compiled a large data set of warranty payments for the period 2010–2016 using information obtained from public firms' annual reports filed with the Securities and Exchange Commission (SEC) in the eXtensible Business Reporting Language (XBRL) format. Our logic is that the higher (lower) the amount of warranty payments made by the manufacturer, the lower (higher) the product quality.[1] We validate our assumption by examining whether high versus low warranty payments negatively affect potential investors' product quality assessments and stock investment likelihood.

In motivating our main effect hypothesis, we rely on prospect theory (Kahneman & Tversky, 1979), which posits that the value function is concave in the domain of gains but convex in the domain of losses (i.e., investors are loss averse). The loss aversion phenomenon has been shown to explain different asymmetric market reactions documented in the finance literature (e.g., Low, 2004; Shefrin & Statman, 1984). Following this literature, we argue that investors' reaction to changes in product quality, as proxied by warranty payments, will be stronger when there are unanticipated increases versus decreases to warranty payments.

For the moderator effects, we select two internal product market signals––advertising and R&D––based on the value creation and appropriation framework (Mizik & Jacobson, 2003) and an external product market signal––industry concentration–– based on the notion of competitive threats (Bharadwaj et al., 2011). We do not propose directional predictions for the contingency model because previous literature suggests opposing views on the sign of potential interaction effects of advertising spending (e.g., Joshi & Hanssens, 2010; Xiong & Bharadwaj, 2013), R&D spending (e.g., Thirumalai & Sinha, 2011), and industry concentration (e.g., Basdeo, Smith, Grimm, Rindova, & Derfus, 2006; Bharadwaj et al., 2011).

Our study makes three key contributions. First, we validate warranty payments as a proxy for product quality information and demonstrate that investors react differentially to negative and positive news conveyed through changes in firms' warranty payments. Our methodology, which incorporates asymmetric response to increases and decreases in warranty payments, contrasts with the traditional approach of treating the test variable as a continuum ranging from negative to positive values and has the potential to yield more informative results.

Second, we add to the literature on information signals conveyed through quality issues. Recent related studies examining product recalls in different industries do not provide consistent evidence regarding investors' reaction to the negative

[1] A firm offering warranties with rich (vs. poor) coverage is more likely to have higher warranty payments. As such, an increase in warranty payments may send a positive signal about quality (e.g., Boulding & Kirmani, 1993; Wiener, 1985). If higher warranty payments indeed imply better customer service quality (i.e., offering better coverage and being more responsive to customer claims), there should be a positive relation between stock returns and unanticipated increases in warranty payments. Our results do not support this argument.

events such as the announcement of product recalls (e.g., Eilert, Jayachandran, Kalaignanam, & Swartz, 2017; Thirumalai & Sinha, 2011).[2] Also, others document no evidence of negative stock return impact of quality issues experienced by new car owners (e.g., Srinivasan, Pauwels, Silva-Risso, & Hanssens, 2009). This may be because investors anticipate future problems related to product quality by tracking changes in firms' warranty payments and already incorporate their expectations into stock prices prior to the announcement of major quality issues. Thus, our results obtained from a large number of firms across a broad set of industries highlights the relevance of information on warranty payments from an efficient capital markets perspective (Fama, 1965; Srinivasan & Hanssens, 2009).

Third, we extend the literature by proposing a contingency model of the relation between warranty payments and firm value. Our results shed light on the implications of warranty program outcomes for firms with varying emphasis on advertising and R&D, and facing different competitive conditions, underscoring the cost and benefits of resource allocation between product quality investments and supporting business functions.

2. Literature review and hypothesis development

2.1. Warranty payments and firm value

A key observation in product markets is that sellers have more information than buyers about the quality of a traded merchandise (Akerlof, 1970; Nelson, 1970). Hence, there exists information asymmetries between manufacturers and their potential customers (e.g., Kirmani & Rao, 2000) such that the level of product quality may be fixed but is ex ante unobservable to customers (i.e., adverse selection) or the level of product quality may be altered by the manufacturer from one transaction to another (i.e., moral hazard). Thus, risk-averse customers typically seek assurance that products they purchase would function properly, and if not, they expect that the company selling the product would fix or replace any defective items.

Many have argued that companies offer warranty contracts to signal the quality of their offerings to potential customers and differentiate themselves from competitors with poor quality products (e.g., Grossman, 1981; Spence, 1977). According to the economic signaling theory, a warranty contract is a costly signal in that only those firms with high quality products can afford to offer such contracts (Boulding & Kirmani, 1993; Cohen, Darrough, Huang, & Zach, 2011). While offering a warranty contract does not entail any immediate financial cost for the company, it comes with possible future monetary obligations expected to be honored by the company in case of a product failure. Consistent with the view that warranties signal positive quality, earlier papers have shown that appliances and automobiles with high coverage warranties have greater reliability than those with low coverage warranties (Kelley, 1988; Wiener, 1985). In parallel, analytical models have demonstrated that the high quality, but not the low quality, firm offers a money-back guarantee (Moorthy & Srinivasan, 1995) and a longer base warranty with a shorter optional extended warranty (Soberman, 2003).

In contrast, several studies have pointed out that warranty contracts send mixed signals about product quality (Agrawal, Richardson, & Grimm, 1996; Balachander, 2001; Cooper & Ross, 1985; Douglas, Glennon, & Lane, 1993; Etzion & Pe'Er, 2014; Gal-Or, 1989; Gerner & Bryant, 1981). For instance, Gal-Or (1989) shows that warranty coverage is not a reliable signal of product quality if the products offered by the high and low quality firms are either too similar or too different. In the two-sided moral hazard model of Cooper and Ross (1985), the cost of quality to sellers and the cost of care to buyers determine the correlation between warranty protection and product quality. Balachander (2001) argues that a new entrant would distinguish itself from other potential entrants by offering a longer warranty than the incumbent's. If the incumbent's product has higher quality than the entrant's, this would imply a negative association between warranty length and product quality. More recently, Chu and Chintagunta (2011, p. 75), who examine computer server and automobile industries, conclude: "Warranties are not used to signal product quality or to provide an incentive for manufacturers to reveal or improve product quality." In line with this conclusion, product quality in the automobile market has been shown to be inversely associated with warranty length (Guajardo, Cohen, & Netessine, 2016). Table 1 provides an overview of this literature.

In sum, a large body of literature shows that offering warranties does not necessarily mean high product quality, implying informational value of warranty payments, which vary with actual product quality (e.g., Mackelprang, Habermann, & Swink, 2015). It is also worth noting that firms with poor product quality may decide to offer product warranties due to managerial myopia stemming from a desire to boost sales and income in the short run. Myopic decision making, however, has been shown to hurt company performance in the long run (Kothari, Mizik, & Roychowdhury, 2016; Mizik, 2010).

In particular, increasing warranty payments may indicate issues with product quality and reliability (e.g., Mackelprang et al., 2015; Malshe, 2011). That is, one possible consequence of warranty programs is that investors may interpret rising warranty payments (per customer claims) as an evidence of declining product quality, resulting in lower firm value. This

[2] Thirumalai and Sinha (2011, p. 376) write: "Contrary to our expectations, the findings of the study indicate that at an aggregate level, the market penalties for medical device recalls are not significant." Eilert et al. (2017), who examine product recalls in the automobile industry write (p. 121): "We do not find a statistically significant abnormal return on the announcement day −0.12% ($p > .10$). We examined abnormal returns for a period of seven days around the event. The only time window with a significant CAR is [-2, 2]: −0.6% ($p < .05$)." Liu, Shankar, and Yun (2017), who also focus on the automobile industry, report a similar result. For a review of the earlier studies with mixed findings, see Chen et al. (2009).

Table 1
A summary of constructs and key findings from relevant prior research.

Paper	Construct	Summary of Key Findings	Warranty-Quality Signal?
Related Warranty Literature			
Wiener (1985)	Warranty Scope	Products with high coverage warranties have greater reliability than those with low coverage warranties.	Positive Quality
Cooper and Ross (1985)	Warranty Scope	The correlation between warranty scope and product quality may be positive or negative depending on the quality cost to the seller and the care cost to the buyer.	Positive Quality or Negative Quality
Gal-Or (1989)	Warranty Length	The high-quality firm offers a longer warranty than the low-quality firm only if the two products are moderately different.	Positive Quality or None
Boulding and Kirmani (1993)	Warranty Scope	When firm credibility is high (low), providing better warranty terms increases (decreases) perceived quality.	Positive Quality or Negative Quality
Moorthy and Srinivasan (1995)	Money-Back Guarantee	The high-quality, but not the low-quality, firm offers money-back guarantee when consumers are assumed to be homogenous.	Positive Quality
Balachander (2001)	Warranty Length	The low-quality new entrant offers a longer warranty than the high-quality incumbent to distinguish itself from other potential entrants.	Negative Quality
Soberman (2003)	Warranty Length	The high-quality firm offers a longer base warranty and a shorter optional extended warranty than the low-quality firm.	Positive Quality
Chu and Chintagunta (2011)	Warranty Length	Perceived quality is not associated with warranty length in the U.S. server industry or in the U.S. automobile industry.	None
Cohen et al. (2011)	Warranty Reserves (i.e., managers' estimation of future warranty expenses).	Some managers use warranty reserves to signal future earnings growth, whereas others use them to manage current period earnings.	Positive Quality or None
Kale, Meneghetti, & Shahrur (2013)	Warranty Reserves	Firms with higher warranty reserves maintain lower levels of financial leverage.	Positive Quality
Mackelprang et al. (2015)	Warranty Payments (i.e., actual incurred warranty costs per customer claims)	Higher R&D intensive firms experience greater product failure costs, which are negatively associated with earnings performance.	Not discussed
Guajardo et al. (2016)	Warranty Length	There is a negative correlation between warranty length and product quality. The positive effect of offering longer warranties on customer demand in the U.S. automobile industry decreases with product quality but increases with service quality.	Negative Quality
Aaker and Jacobson (1994)	Perceived Brand Quality	Stock returns are positively associated with unanticipated change in perceived brand quality.	Not applicable
Tellis and Johnson (2007)	WSJ New Product Quality Reviews	Investors react positively (negatively) to good (poor) quality reviews. There is no significant difference in the strength of investor reaction between positive and negative quality reviews.	Not applicable
Mizik and Jacobson (2008)	Perceived Brand Esteem (i.e., high quality, reliable, leader, personal regard)	Stock returns are not associated with unanticipated change in perceived brand esteem.	Not applicable
Luo (2010)	Perceived Product Competitiveness	The likelihood of beating analyst earnings estimates is positively associated with change in perceived product competitiveness.	Not applicable
Bharadwaj et al. (2011)	Perceived Brand Quality	Stock returns and systematic risk are positively associated with unanticipated change in perceived brand quality. Unanticipated changes in profitability and industry concentration moderate these effects.	Not applicable
The present research	Warranty Payments (i.e., Product Quality Proxy)	Higher warranty payments lower potential investors' product quality assessments and reduce their stock investment likelihood. There is an asymmetric investor reaction to unanticipated increases versus decreases in warranty payments (i.e., product quality "losses" versus "gains"). The advertising-R&D-competition contingency framework highlights the differential effects of moderators depending on whether firms experience unanticipated increases or decreases in warranty payments. Offering warranties is not associated with higher firm value.	Negative Quality or None

is due to two reasons. First, an unanticipated increase in warranty payments are signs of possible deterioration in product quality and hence of a potential loss in competitive advantage to the firm. Lower quality is expected to hinder future sales growth, jeopardize market share, and decrease future cash flows. Consider the following example. Once known for its exceptional product quality, Toyota has experienced a number of significant quality issues, resulting in recalls of millions of vehicles since 2009. The company's total warranty payments for a five-year period amount to $1.9 billion (Fickling, 2016). The quality issues experienced by Toyota tarnished the company's reputation, putting its future sales growth and profitability at risk. Second, unanticipated increases in warranty payments and thereby declines in product quality may signal hidden operational and/or managerial issues within the firm such as weakening relations with key suppliers and loss of qualified personnel. Hence, investors are likely to react negatively to unanticipated increases in warranty payments. Formally, we hypothesize:

H1a: Stock returns are negatively associated with unanticipated increases in warranty payments.

While increasing warranty payments signal possible quality "losses" to investors, decreasing warranty payments may imply potential quality "gains." However, there is one caveat to the latter argument. That is, decreasing warranty payments may not be immediately reflected in stock returns because quality as a marketing asset requires a long-term accumulation before it yields net benefits to the firm (Powell, 1995). In support of a positive predicted relation between firm value and decreasing warranty payments, the resource-based view of the firm postulates that firms can achieve a sustainable competitive advantage through having intangible assets that are difficult to obtain by their peers (e.g., Barney, 2001; Peteraf, 1993). Cho and Pucik (2005) point out that product quality is one such asset as it represents an important organizational resource that cannot be readily imitated by competitors. This is because achieving higher quality is costly, and necessitates a high level of technical expertise and know-how with organizational commitment and human capital at all levels.

A competitive advantage achieved through superior product quality (e.g., Luo, 2010) can contribute to firm performance in several ways. First, higher quality can enable firms to increase their prices without experiencing a decline in demand, thereby increasing total revenue (Jacobson & Aaker, 1987). Assuming that a significant part of the cost of quality is already borne by the firm in the short run, increased revenues would translate into higher profits in the long run. Second, superior quality may help firms shield themselves from non-price competition (i.e. less reliance on promotions). Thus, superior quality ensures a more stable customer demand for the firm's product and provides benefits in terms of avoiding costly promotion activities. Third, offering superior quality products facilitates positive word-of-mouth in the marketplace, boosting the firm's reputation. A stronger reputation likely makes it easier for the firm to generate demand for its new products and expand its customer-base, boosting future sales growth. Thus, we argue that improvements in product quality as measured by declining warranty payments are reflected positively in firm value. Formally:

H1b: Stock returns are positively associated with unanticipated decreases in warranty payments.

2.2. Prospect theory and the warranty payment-stock return relationship

We further predict that investors' response to changes in warranty payments will be asymmetric, with stock returns being more strongly associated with unanticipated increases versus decreases in warranty payments. Our prediction derives from prospect theory (Kahneman & Tversky, 1979), which posits that investors exhibit greater sensitivity to losses than gains because the disutility of a loss exceeds the utility of a same magnitude gain, as a result of the convexity of value function in the losses domain. Thus, one should interpret the consequences of monetary changes from a reference point based on the direction of the change. A classic demonstration of loss aversion is the endowment effect, which shows that when people are asked to part with an item, they ask more than others are willing to pay for it (e.g., Kahneman, Knetsch, & Thaler, 1991).

Empirical evidence in the finance and marketing literatures supports the loss aversion phenomenon. For instance, investors appear to have longer holding periods for losing stocks than winning stocks (Shefrin & Statman, 1985). Further, investors react more unfavorably to dividend cuts than they react favorably to dividend increases (Shefrin & Statman, 1984). More relevant to our study, based on prospect theory, Luo (2007) maintains that negative word-of-mouth is likely to be more important than positive word-of-mouth in driving firm value.[3] Relatedly, Tirunillai and Tellis (2012) find that negative, but not positive, online chatter about brands predicts stock returns and trading volume. In parallel, we argue that investors will react more strongly when there are unanticipated increases versus decreases to warranty payments. Formally:

H2: Stock returns are more strongly associated with unanticipated increases in warranty payments than unanticipated decreases in warranty payments.

[3] Tellis and Johnson (2007) analyze investors' reaction to the review of quality of a new product assessed by the Wall Street Journal. Inconsistent with the asymmetric investor reaction argument, their regression results reveal no evidence that the announcement returns for poor reviews of quality are more negative and larger in absolute value than those for good reviews of quality. Also, Oh, Bae, Currim, Lim, and Zhang (2016), who examine the relationship between stock returns and corporate social responsibility (CSR) find that while stock returns increase with CSR strengths, they do not decrease with CSR weaknesses.

2.3. A contingency model

For the contingency model, we examine three key product market signals emerging from the prior marketing literature and apply them to a product quality signaling framework. In that sense, our focus is on theory application rather than theory building. Our selection of the moderating effects for the contingency model is motivated by the value creation and appropriation framework of Mizik and Jacobson (2003), which focuses on internal product market signals, with the addition of competitive threats in product markets as an external signal (Bharadwaj et al., 2011). Advertising expenditures signal emphasis on value appropriation by directing investors' attention to existing products. In contrast, R&D expenditures signal emphasis on value creation by product improvements and new product development, albeit they may lead to a loss of focus in production (Thirumalai & Sinha, 2011). Finally, changes in industry concentration signal transformations in a firm's competitive landscape. Below, we discuss the possible moderating role of each signal in detail (see Fig. 1).

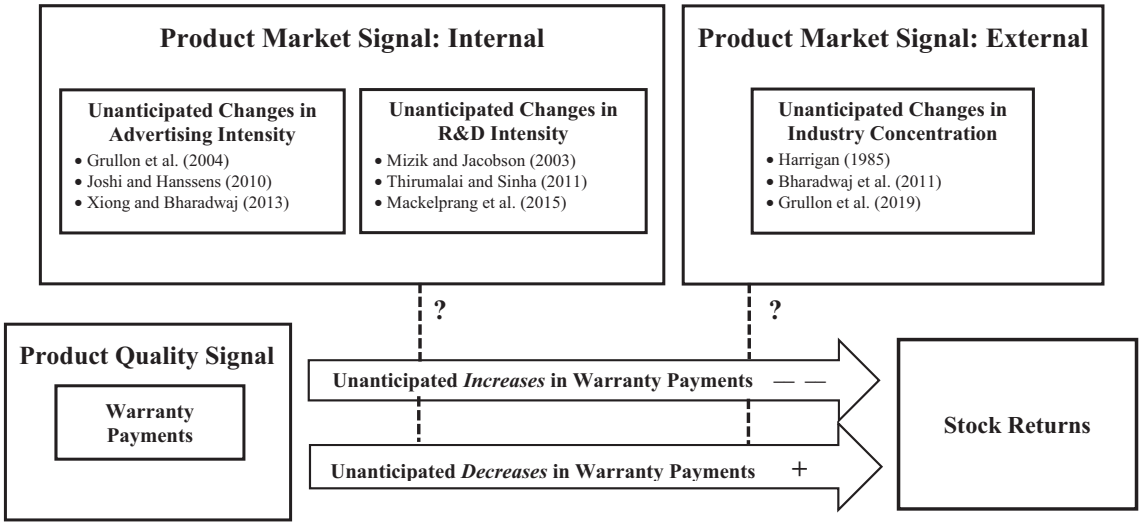

Fig. 1. A Contingency model of the relation between warranty payments and firm value.

2.3.1. Moderating role of advertising intensity

Higher advertising spending enables firms to strengthen their brand and customer equity (e.g., McAlister, Srinivasan, & Kim, 2007; Mizik & Jacobson, 2003; Srinivasan & Hanssens, 2009), which may lower vulnerability to temporary shocks stemming from warranty issues. In particular, one would expect that investors view heightened customer retention efforts through advertising positively in the face of quality problems. Relatedly, previous research finds that advertising helps firms dampen investors' reaction to current bad news (Xiong & Bharadwaj, 2013). Hence, in the case of rising warranty payments, firms can mitigate the predicted negative effect of investors' potential concerns about product quality on stock returns by boosting their advertising spending. In the case of decreasing warranty payments, advertising can play a complimentary role because launching new advertising campaigns conveys managers' optimism about improved prospects of the firm in pertinent markets and underscores the firm's willingness to expand its customer base (Villanueva, Yoo, & Hanssens, 2008).

While above discussion supports the prediction that advertising will positively moderate the relation of stock returns with unanticipated increases and decreases in warranty payments, the opposite may also be true. Prior research has shown that advertising boosts a firm's visibility and increases investor attention (Grullon, Kanatas, & Weston, 2004; Lou, 2014). Thus, advertising in this context is a double-edged sword (Xiong & Bharadwaj, 2013). When a company is experiencing negative events such as increasing warranty payments, higher advertising spending may lead investors to pay more attention to changes in the company's operations and financials, possibly magnifying the predicted negative stock return effect of increasing warranty payments. Further, because investors tend to hold higher expectations as firms spend more money on advertising (Joshi & Hanssens, 2010), unanticipated decreases in warranty payments may actually generate less positive investor reaction when advertising intensity is higher. Overall, unanticipated changes in advertising spending may have either a positive or negative moderating effect in our research setting. Because, ex ante it is difficult to predict which effect will dominate, we motivate our examination as a research question instead of a hypothesis.

RQ1: How do unanticipated changes in advertising intensity moderate investors' reaction to unanticipated increases and decreases in warranty payments?

2.3.2. Moderating role of R&D intensity

R&D intensity is a second potential moderator of the relationship between stock returns and warranty payments. On the one hand, unanticipated changes in R&D intensity may have a positive moderating effect because higher R&D spending signals a greater focus on product development and reliability (e.g., Daughety & Reinganum, 1995; Mizik & Jacobson, 2003). Specifically, enhanced product focus may help address investors' concerns about potential product quality issues in the face of rising warranty payments. Also, when warranty payments are declining, increased R&D investments may communicate to investors that the company places emphasis on continued product improvements.

On the other hand, a negative moderating effect is also likely since R&D investments involve considerable levels of risk and uncertainty (Mackelprang et al., 2015; Murthy, 2006). Thirumalai and Sinha (2011), for instance, find that the likelihood of a product recall among medical device manufacturers increases with R&D intensity. They point out that putting high emphasis on developing new products increases the likelihood of errors in production and could result in product recalls. They also find that firms that experience a negative stock price reaction upon a product recall announcement have higher R&D intensity than those that experience a non-negative stock price reaction. Prior research also shows that the extent to which firms engage in quality management practices is negatively associated with R&D intensity (Ettlie, 1997). Given the opposing views on the sign of the interaction effect for R&D intensity, we ask the following research question.

RQ2: How do unanticipated changes in R&D intensity moderate investors' reaction to unanticipated increases and decreases in warranty payments?

2.3.3. Moderating role of industry concentration

Finally, we consider industry concentration–– an important factor in determining the level of competition among industry rivals––as a possible moderator of investors' response to unanticipated changes in a company's warranty payments. A stream of literature supports an attenuating moderating effect. Bharadwaj et al. (2011), for instance, point out that as industry concentration increases, brand quality changes matter less to investors due to reduced competitive threats for incumbent firms. In other words, the marginal benefit of improved quality becomes lower as industry competition eases. Further, if incumbent firms experience quality-related issues, increased industry concentration (i.e., lower competitive pressure) provides them with greater strategic flexibility to improve their products (e.g., Harrigan, 1985), which can help lessen investors' potential concerns linked to rising warranty payments.

However, a magnifying moderating effect is also possible. When declining warranty payments are accompanied by lessened competition due to increased industry concentration, investors may be more optimistic about firms' ability to capitalize on and profit from quality improvements (e.g., Chen, Ho, & Ik, 2005; Grullon, Larkin, & Michaely, 2019). Also, from an information processing perspective, as industries become more concentrated, external stakeholders tend to be more attentive to firm-level signals (Basdeo et al., 2006). As a result, increased industry concentration may actually magnify investors' reaction to unanticipated changes in warranty payments. Since both views are plausible, we present the following research question.

RQ3: How do unanticipated changes in industry concentration moderate investors' reaction to unanticipated increases and decreases in warranty payments?

3. Sample and methodology

3.1. Data

Warranty payments reflect the actual warranty cost incurred based on customer claims (Siebert, 2015; Spiceland et al., 2015) and include the cost of repair or replacement of the product as well as refunds issued to customers for defective products (Stice & Stice, 2012; Wahlen, Jones, & Pagach, 2013).[4] Relevant data on warranty payments of public companies are reported in the notes to companies' financial statements. This information, however, is not available through traditional financial databases such as Compustat. We obtained a data set containing warranty payments of all public firms traded in the U.S. between 2009 and 2016 from Calcbench, an emerging provider of financial data (e.g., Hoitash & Hoitash, 2018). The underlying data are supplied directly by reporting companies in the XBRL format as required by the SEC's interactive data rule adopted in 2009. Calcbench, which extracts XBRL tags (e.g., ProductWarrantyAccrualPayments, StandardProductWarrantyAccrualPayments) and data directly from the SEC filings, reports the information on warranty

[4] Warranty payments are different from warranty reserves, which are managers' estimation of future warranty liabilities (Cohen et al., 2011). Because warranty reserves are recorded based on managers' estimations, they can be used as an earnings management tool. That is, managers may underestimate (overestimate) future warranty expenses for current sales to boost (depress) current period earnings. In contrast, warranty payments are actual, realized costs per customer claims. Our results are robust to controlling for unanticipated changes in warranty reserves (see Table WB7 in Web Appendix B).

Table 2
Variable definitions.

Variable Name	Variable Definition [Source]
ADV	Advertising intensity calculated as advertising expense divided by total assets. [Compustat data XAD/data AT]. If XAD is missing, it is set to 0.
Assets	Total assets. [Compustat data AT]
Concentration	Four-firm concentration ratio calculated as the sum of the market shares of the top four firms in an industry. Industries are defined based on the Fama-French 48 industries. [Compustat data SALE]
Dividend	Ratio of dividend payments to total assets. [Compustat data DVC/data AT]
Growth	Annual industry sales growth rate. Industries are defined based on the Fama-French 48 industries. [Compustat data SALE]
LegalPay	Total payments for legal settlements. [Calcbench data Payments For Legal Settlements]
Leverage	Ratio of total debt to total assets. [Compustat (data DLC + data DLTT)/data AT)
Market value	Number of common shares outstanding multiplied by the fiscal year-end stock price [Compustat data CSHO × data PRCC_F].
R&D	R&D intensity calculated as research and development expense divided by total assets. [Compustat data XRD/data AT]. If XRD is missing, it is set to 0.
ROA	Ratio of operating income before depreciation to total assets. [Compustat data OIBDP/data AT]
Safety	Dummy equal to 1 if the firm is reported to have a product safety issue in a given year, and 0 otherwise. [MSCI ESG data PRO_CON_A]
Sales	Total revenue. [Compustat data SALE]
StockReturn	Annual stock return calculated by compounding twelve monthly stock returns in a fiscal year. [CRSP data RET]
Turbulence	Ratio of the standard deviation of industry sales over the past four years to the average of industry sales during the same period. Industries are defined based on the Fama-French 48 industries. [Compustat data SALE]
WarrantyPay	Product warranty payments made during the year divided by total assets. [Calcbench data Product Warranty Payments/Compustat data AT]
MKT	Annual compounded excess return on the market–– value-weighted return of all CRSP firms incorporated in the US and listed on the NYSE or NASDAQ.
SMB	Annual compounded return on the three small portfolios minus the average return on the three big portfolios.
HML	Annual compounded return on the two value portfolios minus the average return on the two growth portfolios.
UMD	Annual compounded return on the two high prior return portfolios minus the average return on the two low prior return portfolios.

payments under a single variable (i.e., Product Warranty Payments). We use this variable in our analysis. Table 2 presents a detailed description of all the variables and their database item codes.[5]

Because we need information on lagged warranty payments in our analysis, we limit our sample period to 2010–2016. Our initial data set contains 3482 firm-year observations with warranty payments data. We obtain annual accounting data from the Compustat database and stock return data from the Center for Research in Security Prices (CRSP) database. We exclude 69 observations due to no matches in Compustat database. We further exclude 238 observations due to missing CRSP data. We also exclude financial firms (SIC: 6000–6999) and transportation firms and utilities (SIC: 4000–4999), whose warranties are unrelated to our examination (e.g., warranties for mortgage banking loan sales). This filter eliminates 65 observations. We also discard firms with assets less than $1 million, with non-positive sales, with zero common shares outstanding, and with stock price less than $1, eliminating 54 observations. These filters help minimize the impact of small, thinly-traded stocks on our analysis (e.g., Jegadeesh & Livnat, 2006; Lou, 2014). Finally, excluding 42 observations that have missing independent variables yields a final sample with 3014 firm-year observations for 666 unique firms.

Table 3 presents sample characteristics for our sample (Web Appendix B presents additional descriptive statistics; see Tables WB1 and WB2). The ratio of warranty payments to total assets, on average, is 0.0086 (i.e., 0.86%). Over the sample period, this ratio increased from 0.74% in 2010 to 0.89% in 2013 and then declined slightly to 0.86% in 2016. The correlation between current and lagged warranty payments scaled by total assets is 0.89 ($p < .01$).[6]

Total assets and market value, on average, are $5.99 billion and $6.08 billion, respectively. Advertising intensity, R&D intensity (both scaled by total assets), and four-firm industry concentration ratio, on average, are 0.0082, 0.0642, and 0.4544, respectively. We define industries using the Fama-French 48 industry classification. Our sample includes observations from a wide range of industries from machinery to construction materials to consumer goods. Electronic equipment, machinery, and measuring and control equipment account for, respectively, 17.32%, 14.63%, and 8.96% of the overall sample.

[5] Like other marketing-related data (e.g., advertising expenditures, R&D expenditures), warranty payments are reported in firms' quarterly and annual financial reports. Consistent with prior literature (e.g., Erickson & Jacobson, 1992; Mizik & Jacobson, 2003), we measure all the variables contemporaneously (including stock returns) on an annual fiscal year basis. We obtain similar results if we cumulate stock returns for the 12-month period ending three months after a company's fiscal year-end.

[6] The average of warranty reserves as a percentage of total assets is 1.16%. Over the sample period, the average annual warranty reserves ranges from 1.03% (in 2010) to 1.32% (in 2016). The correlation between current and lagged warranty reserves is 0.93 ($p < .01$).

Table 3
Sample characteristics.

Panel A: Firm characteristics

	Mean	Median	SD	Min	Max
Assets (in million $)	5990.01	1028.60	17284.98	12.39	164687.00
Market value (in million $)	6076.79	1254.70	16588.88	9.05	199450.68
Warranty Payment Intensity	0.0086	0.0051	0.0101	0.0001	0.0629
Advertising Intensity	0.0082	0.0000	0.0219	0.0000	0.1698
R&D Intensity	0.0642	0.0361	0.0759	0.0000	0.4644
Industry Concentration	0.4544	0.4216	0.1437	0.2291	0.9156

Panel B: Industry distribution

Fama-French 48 Industry Code	Fama-French 48 Industry Name	Number of observations	% Freq.
6	Recreation equipment	35	1.16%
9	Consumer goods	91	3.02%
12	Medical equipment	245	8.13%
14	Chemicals	58	1.92%
17	Construction materials	120	3.98%
18	Construction	119	3.95%
21	Machinery	441	14.63%
22	Electrical equipment	183	6.07%
23	Automobiles and trucks	250	8.29%
24	Aircraft	58	1.92%
25	Shipbuilding, railroad equipment	40	1.33%
34	Business services	47	1.56%
35	Computers	267	8.86%
36	Electronic equipment	522	17.32%
37	Measuring and control equipment	270	8.96%
38	Business supplies	46	1.53%
42	Retail	52	1.73%
	Other industries	170	5.64%

Panel C: Year distribution

Year	Average of Warranty Payment Intensity	Number of observations	% Freq.
2010	0.0074	159	5.28%
2011	0.0081	373	12.38%
2012	0.0089	516	17.12%
2013	0.0089	527	17.49%
2014	0.0087	526	17.45%
2015	0.0086	500	16.59%
2016	0.0086	413	13.70%

3.2. Validation tests

At the beginning of our analysis, we seek to validate warranty payments as a proxy for product quality information. To this end, we recruited online survey panel participants from Prolific and conducted an experiment to test whether their assessment of product quality and stock investment likelihood differ based on high versus low levels of warranty payments reported by a company. Given our study's specific context, we used Prolific's pre-screening filter and limited the initial pool of potential participants in our study to those who indicated that they read a company's annual report when evaluating the company's stock as a potential investment.[7] One hundred twenty-nine participants completed our survey (46.5% female; M_{Age} = 42.9; M_{Income} = $67,132). We excluded 14 participants who have never bought or sold shares in the stock market (the results are similar regardless of this additional filter), yielding a final sample size of 115 participants.

The participants were first presented with selected financial information for an actual publicly traded company (under a fictional company name), with warranty payments (as a % of revenue) changing between the two experimental conditions.[8] In the high warranty payments condition, the participants read that the company's warranty payments per customer claims were 6.00% of revenues. In the low warranty payments condition, this figure was 1.00%. Then, we asked the participants to assess the company's financial performance (1 = "very bad", 5 = "very good") and product quality (1 = "very low", 5 = "very high"), and also indicate their likelihood of investing $1000 into the company's stock (1 = "very unlikely", 5 = "very likely").

[7] Specifically, Prolific asks its participants the following question: "When evaluating a company's stock as a potential investment, how often do you examine a company's financial statements (for example, through its annual report or SEC filings) as part of your evaluation?" Using this filter, we pre-selected participants whose answer to the question was "Always", "Most of the time", or "Sometimes" (excluding those who selected "Rarely" and "Never").

[8] The experimental material is available in Web Appendix A. The company description and financial information used in the survey belong to Netgear Inc.

As shown in Panel A of Table 4, we find that the participants in the high versus low warranty payments condition rated the company's product quality to be lower (M_{High} = 3.30, SD_{High} = 0.70 vs. M_{Low} = 3.76, SD_{Low} = 0.64, $t(113) = 3.71$, $p < .01$; $d = 0.70$) and were less likely to invest in the company's stock (M_{High} = 2.95, SD_{High} = 1.14 vs. M_{Low} = 3.47, SD_{Low} = 0.92, $t(113) = 2.69$, $p < .01$; $d = 0.51$). Equally important, the results in Panel B of Table 4 reveal that participants' product quality assessments mediate the negative impact of the warranty payment manipulation on their stock investment likelihood (i.e., 95% bootstrapped CI for the indirect effect: [−0.5428, −0.1284]). These results lend credibility to our assumption that investors perceive warranty payments as a signal of product quality, affecting their stock investment decisions. Further, it is worth noting that there was no significant difference in participants' assessments of the company's financial performance between the two conditions (M_{High} = 3.72, SD_{High} = 0.76 vs. M_{Low} = 3.89, SD_{Low} = 0.66, $t(113) = 1.31$, $p = .19$; $d = 0.25$).

Table 4
The effect of warranty payments on product quality assessments and stock investment likelihood.

Panel A: Cell means and differences

	Low Warranty Payments Condition (n = 55)	High Warranty Payments Condition (n = 60)	t-stat.	p-value	Cohen's d
Financial Performance (1 = "very bad", 5 = "very good")	3.89 (0.66)	3.72 (0.76)	1.31	0.19	0.25
Product Quality (1 = "very low", 5 = "very high")	3.76 (0.64)	3.30 (0.70)	3.71	< 0.01	0.70
Stock Investment Likelihood (1 = "very unlikely", 5 = "very likely")	3.47 (0.92)	2.95 (1.14)	2.69	< 0.01	0.51

Panel B: Mediation model

	Dependent Variable =		
	Product Quality A.	Stock Investment Likelihood B.	Stock Investment Likelihood C.
Warranty Payment Prime	−0.464*** (−3.71)	−0.523*** (−2.69)	−0.210 (−1.13)
Product Quality			0.674*** (5.08)
Constant	3.764*** (41.74)	3.473*** (24.73)	0.937* (1.82)
Bootstrapped 95% CI for the indirect effect of warranty payment prime on the stock investment likelihood through product quality			[−0.5428, −0.1284]
Observations	115	115	115
F-value	13.80	7.23	17.30
Prob. > F	0.000	0.008	0.000
Adjusted R-square	0.101	0.052	0.222

Notes: In Panel A, the standard deviations are reported inside the parentheses. *Warranty Payment Prime* is a dummy variable that equals 1 for the high warranty payments condition, and 0 for the low warranty payments condition. In Panel B, t-statistics are reported inside the parentheses. The 95% confidence interval (CI) for the mediation model was obtained via bootstrapping with 5000 resamples (Hayes, 2013). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

We performed two ancillary validation tests reported in Web Appendix A. First, we examined whether warranty payments predict the occurrence of management's discussion of quality issues and related problems in the company's annual report published in the following year. Second, we performed the same test for analysts' future reports on the company. We predict that the higher the warranty payments, the greater the discussion about quality-related issues in the subsequent period. The results presented in Table WA1 support these predictions and provide supplementary evidence regarding the link between higher warranty payments and potential quality problems. Overall, our validation tests demonstrate that warranty payments are a useful proxy for assessing product quality.

3.3. Empirical models and results

Next, we turn to our main analyses. Following previous research (e.g., Aaker & Jacobson, 1994; Mizik & Jacobson, 2008; Srinivasan et al., 2009), we use a stock return response model to test the relation between firm value and warranty payments. Our dependent variable is changes in firm value measured by annual stock return. We calculate annual stock return by compounding 12 monthly returns over a fiscal year as shown in the following equation. *Ret* represents monthly holding period returns, *i* represents individual firms, *T* represents fiscal years, and *t* represents months in a fiscal year.

$$\text{StockReturn}_{iT} = \prod_{t=1}^{12}(1 + Ret_{it}) \tag{1}$$

Because investors respond to unanticipated changes in accounting information, our tests use unanticipated changes in warranty payments and firm-level control variables. Following previous research (e.g., Kurt & Hulland, 2013; Srinivasan & Hanssens, 2009), we estimate first-order autoregressive models with firm fixed effects to calculate unanticipated changes.[9] Specifically, we estimate the following model separately for each variable using all observations in our sample.

$$X_{iT} = \alpha_0 + \alpha_1 X_{iT-1} + \textit{firm fixed effects} + \varepsilon_{iT} \tag{2}$$

The residuals obtained from Eq. (2) enter into our main regression model as unanticipated changes. To test H1 and H2, we estimate the following stock return response model adapted from Bharadwaj et al. (2011).[10] Note that all the variables are measured contemporaneously.[11]

$$\begin{aligned}\text{StockReturn}_{iT} = {} & \beta_0 + \beta_1 \text{U}\triangle\text{IncWarrantyPay}_{iT} + \beta_2 \text{U}\triangle\text{DecWarrantyPay}_{iT} + \beta_3 \text{U}\triangle\text{ROA}_{iT} \\ & + \beta_4\ \text{U}\triangle\text{Sales}_{iT} + \beta_5 \text{U}\triangle\text{Dividend}_{iT} + \beta_6 \text{U}\triangle\text{Leverage}_{iT} + \beta_7\ \text{U}\triangle\text{Safety}_{iT} + \beta_8 \text{U}\triangle\text{LegalPay}_{iT} \\ & + \beta_9 \text{U}\triangle\text{Turbulence}_{iT} + \beta_{10} \text{U}\triangle\text{Growth}_{iT} + \beta_{11}\text{MKT}_{iT} + \beta_{12}\text{SMB}_{iT} + \beta_{13}\text{HML}_{iT} + \beta_{14}\text{UMD}_{iT} \\ & + \text{fiscal year dummies} + \text{industry dummies} + \delta_{iT}\end{aligned} \tag{3}$$

where, *U△IncWarrantyPay* is equal to unanticipated change in warranty payments (scaled by total assets) if the change is positive, and 0 otherwise; *U△DecWarrantyPay* is equal to the absolute value of unanticipated change in warranty payments (scaled by total assets) if the change is negative, and 0 otherwise; *U△ROA* is unanticipated change in operating income (scaled by total assets); *U△Sales* is unanticipated change in the natural logarithm of annual revenue; *U△Dividend* is unanticipated change in dividends (scaled by total assets); *U△Leverage* is unanticipated change in total debt (scaled by total assets); *U△Safety* is an indicator that equals 1 if the firm is reported to have a product safety concern in the MSCI ESG database this year but not previous year, and 0 otherwise; *U△LegalPay* is unanticipated change in the natural logarithm of legal settlement payments; *U△Turbulence* is unanticipated change in industry turbulence (Fang, Palmatier, & Steenkamp, 2008); *U△Growth* is unanticipated change in industry sales growth; *MKT* is the annual compounded return on all stocks traded on the US stock exchanges in excess of the risk free rate; *SMB* is the annual compounded return on a portfolio with a long position in small stocks and a short position in large stocks; *HML* is the annual compounded return on a portfolio with a long position in value stocks and a short position in growth stocks; *UMD* is the annual compounded return on a portfolio with a long position in stocks with high prior returns and a short position in stocks with low prior returns.[12]

When examining RQ1, RQ2, and RQ3, we modify Eq. (3) by including the moderating variables–– *U△ADV, U△R&D*, and *U△Concentration*–– and their interactions with both *U△IncWarrantyPay* and *U△DecWarrantyPay*. Unanticipated changes in the moderating variables are calculated as described before.

3.3.1. Main results

Table 5 presents the summary statistics and correlation matrix. The average annual stock return for sample firms is 14.5%, whereas the average annual return on the market during the sample period is 13.5%. The annual average for *U△IncWarrantyPay* (*U△DecWarrantyPay*) during the sample period ranges between 0.07% (0.07%) and 0.10% (0.09%).

The univariate results provide partial support for H1. Consistent with H1a, we find a negative and statistically significant correlation between stock returns and unanticipated increases in warranty payments ($\rho = -0.065$, $p < .01$). That is, firm value decreases when warranty payments rise unexpectedly, suggesting that investors view such increases negatively as signals of a possible deterioration in product quality. However, there is no significant correlation between stock returns and unanticipated decreases in warranty payments ($\rho = 0.016$, $p = .368$). This is inconsistent with H1b.

[9] Our first-order auto-regressive models with firm fixed effects have high explanatory power. For instance, the adjusted R-squared for the warranty payments model is 87.9%. Adding lagged warranty reserves or an indicator of product safety issues to the model does not change our conclusions. Of note, operationalizing warranty payments as unanticipated changes instead of levels and including firm fixed effects in equation (2) helps, to some extent, control for potential factors that may impact warranty payments other than product quality.

[10] We also separately estimate and report the results for a stock return response model with firm fixed effects, replacing "industry dummies" shown in equation (3) with firm fixed effects.

[11] To mitigate the potential influence of outliers on estimated coefficients and model fit, we winsorize all the continuous variables (throughout the paper) annually at the 1% and 99% levels. We also standardize all the continuous independent variables (by subtracting their respective means and then dividing by respective standard deviations) to facilitate the interpretation of estimated coefficients.

[12] We checked the variance inflation factors (VIF) to test for possible multicollinearity. All VIFs are below 10, with the average VIF being 1.58. This suggests that multicollinearity is not a significant concern for our statistical inferences.

Table 5
Summary statistics and correlation matrix.

		Mean	S.D.	1.	2.	3.	4.	5.	6.	7.	8.	9.
1.	StockReturn	0.145	0.473	1.00								
2.	U△IncWarrantyPay	0.001	0.002	**−0.07**	1.00							
3.	U△DecWarrantyPay	0.001	0.002	0.02	**−0.22**	1.00						
4.	U△ADV	0.000	0.002	**−0.05**	**0.08**	**−0.06**	1.00					
5.	U△R&D	0.000	0.015	**−0.10**	**0.16**	**−0.18**	**0.13**	1.00				
6.	U△Concentration	0.000	0.032	0.01	0.02	−0.02	0.03	0.04	1.00			
7.	U△ROA	0.000	0.041	**0.20**	**−0.05**	0.03	**−0.06**	**−0.31**	**−0.05**	1.00		
8.	U△Sales	0.000	0.144	**0.07**	−0.04	**0.05**	**−0.05**	**−0.16**	**−0.06**	**0.49**	1.00	
9.	U△△Dividend	0.000	0.012	0.01	−0.01	−0.02	0.02	0.04	0.03	0.04	**−0.06**	1.00
10.	U△Leverage	0.000	0.056	**−0.13**	−0.04	0.04	−0.03	−0.04	−0.01	**−0.20**	0.01	**0.08**
11.	U△Safety	0.017	0.130	0.01	0.00	−0.02	−0.01	−0.02	−0.04	0.02	0.00	0.02
12.	U△LegalPay	−0.002	0.562	0.00	0.02	0.00	0.00	−0.02	0.00	0.00	0.00	0.02
13.	U△Turbulence	0.000	0.045	0.02	0.03	−0.02	0.01	0.01	**0.10**	0.03	−0.02	−0.02
14.	U△Growth	0.000	0.115	−0.03	0.02	−0.01	0.01	−0.02	**0.36**	0.05	**0.05**	**−0.07**
15.	MKT	0.135	0.110	**0.41**	−0.02	0.00	−0.03	0.01	**−0.05**	−0.02	−0.01	0.00
16.	SMB	−0.002	0.057	**0.32**	0.00	0.00	−0.02	−0.02	**−0.06**	0.01	−0.04	−0.02
17.	HML	0.007	0.092	**0.18**	0.04	0.00	0.02	**0.06**	−0.04	−0.04	−0.03	**0.08**
18.	UMD	0.037	0.102	**−0.13**	−0.02	−0.01	0.00	−0.05	**0.13**	0.03	0.01	0.00

		Mean	S.D.	10.	11.	12.	13.	14.	15.	16.	17.	18.
1.	StockReturn	0.145	0.473									
2.	U△IncWarrantyPay	0.001	0.002									
3.	U△△DecWarrantyPay	0.001	0.002									
4.	U△ADV	0.000	0.002									
5.	U△R&D	0.000	0.015									
6.	U△Concentration	0.000	0.032									
7.	U△ROA	0.000	0.041									
8.	U△Sales	0.000	0.144									
9.	U△Dividend	0.000	0.012									
10.	U△Leverage	0.000	0.056	1.00								
11.	U△Safety	0.017	0.130	0.01	1.00							
12.	U△LegalPay	−0.002	0.562	0.02	−0.03	1.00						
13.	U△Turbulence	0.000	0.045	**−0.08**	**−0.07**	−0.03	1.00					
14.	U△Growth	0.000	0.115	**−0.11**	−0.04	−0.03	**0.32**	1.00				
15.	MKT	0.135	0.110	**−0.10**	−0.01	0.00	**0.06**	**−0.07**	1.00			
16.	SMB	−0.002	0.057	**−0.09**	−0.01	−0.03	0.04	**−0.06**	**0.58**	1.00		
17.	HML	0.007	0.092	**0.05**	−0.03	0.01	**0.12**	**−0.15**	**0.38**	**0.42**	1.00	
18.	UMD	0.037	0.102	−0.03	0.00	0.00	**−0.10**	**0.05**	**−0.29**	**−0.32**	**−0.84**	1.00

Notes: U△ represents unanticipated change in a particular variable. *U△IncWarrantyPay* is equal to unanticipated change in warranty payments (scaled by total assets) if the change is positive, and 0 otherwise. *U△DecWarrantyPay* is equal to the absolute value of unanticipated change in warranty payments (scaled by total assets) if the change is negative, and 0 otherwise. Correlation coefficients in bold are statistically significant at the 1% level. All variables are measured contemporaneously (i.e., for the fiscal year *T*) and winsorized annually at the 1% and 99% levels.

Table 6 reports the multiple regression results with control variables. Supporting H1a, the estimated coefficient on unanticipated increase in warranty payments is negative and statistically significant ($\beta_1 = -0.025$, $p < .01$; Column A).[13] The relationship between the two variables is economically significant as well. A one standard deviation increase in unanticipated increase in warranty payments is associated with a 2.5 percentage points decline in annual stock return. Given that the average annual stock return for sample firms is 14.5%, this figure implies a 17.2% reduction in stock return for the average firm (i.e., 2.5%/14.5%). The documented result is robust to controlling for firm fixed effects ($\beta_1 = -0.022$, $p < .05$; Column B).[14]

The estimated coefficient on unanticipated decrease in warranty payments is not significant ($\beta_2 = 0.001$, $p = .871$; Column A). Thus, H1b is not supported. One potential explanation for the lack of support for H1b is that investors may perceive product quality as a "must" attribute. Previous research points out that while the absence of "must" attributes such as customer satisfaction is detrimental to firm performance, the presence of such attributes simply may not be strongly linked to performance (e.g., Anderson & Mittal, 2000; Witell & Löfgren, 2007). Therefore, while investors punish losses in product quality, they do not appear to unconditionally reward positive developments in this attribute.[15]

[13] When we use unanticipated changes in warranty payments (*U△WarrantyPay*) in the model instead of *U△IncWarrantyPay* and *U△DecWarrantyPay*, the variable enters the model with a negative and significant sign (coefficient = −0.022, $p < .01$).

[14] Controlling for firm fixed effects mitigates endogeneity concerns stemming from possible omitted variables that are time invariant. To further alleviate potential endogeneity concerns due to time variant factors, we implement an instrumental variable (IV) regression approach (see Table WC1 in Web Appendix C). Our results are robust to the use of IV regression approach. Moreover, to test whether our results are affected by a potential sample selection bias (i.e., our sample includes only warranty offering firms), we applied a Heckman (1979) two-step approach (see Table WC2 in Web Appendix C). We found no evidence of a sample selection bias.

[15] As an additional analysis, we re-estimated equation (3) separately for each of the top three industries in our sample and obtained consistent results. We also separately examined the auto manufacturers included in our sample (i.e., Ford, GM, and Tesla). For these firms (n = 20), the rank correlation between stock returns and unanticipated increases in warranty payments is negative but not statistically significant ($\rho = -0.151$; p = .525).

Nevertheless, the results are consistent with our proposed asymmetric investor reaction to unanticipated increases and decreases in warranty payments. To formally test H2, we compare the absolute value of the estimated coefficients on β_1 and β_2. An F-test confirms the predicted difference ($F(1, 2964) = 3.86$, $p < .05$; Column A). Thus, H2 is supported, suggesting that investors' response to unanticipated increases in warranty payments are stronger than their response to unanticipated decreases in warranty payments.

Table 6
Relation between stock returns and warranty payments.

	DV = *StockReturn*	
	A.	B.
UΔIncWarrantyPay	−0.025***	−0.022**
	(−3.26)	(−2.01)
UΔDecWarrantyPay	0.001	0.005
	(0.16)	(0.45)
U△ROA	0.098***	0.098***
	(10.94)	(10.70)
U△Sales	−0.013	−0.013
	(−1.46)	(−1.45)
U△Dividend	0.002	0.002
	(0.30)	(0.26)
U△Leverage	−0.023***	−0.024***
	(−2.93)	(−2.86)
U△Safety	0.027	0.024
	(0.46)	(0.35)
U△LegalPay	0.003	0.002
	(0.43)	(0.31)
U△Turbulence	−0.005	−0.006
	(−0.58)	(−0.67)
U△Growth	0.002	0.005
	(0.28)	(0.61)
MKT	0.159***	0.142***
	(8.06)	(6.58)
SMB	−0.003	0.009
	(−0.15)	(0.42)
HML	−0.006	−0.004
	(−0.26)	(−0.19)
UMD	−0.017	−0.017
	(−0.67)	(−0.59)
Constant	0.748***	0.245***
	(3.89)	(4.17)
Year FE	Yes	Yes
Industry FE	Yes	No
Firm FE	No	Yes
Observations	3014	3014
F-value	20.75	40.54
Prob. > F	0.000	0.000
Adjusted R-squared	0.243	0.203

Notes: U△ represents unanticipated change in a particular variable. All variables are measured contemporaneously (i.e., for the fiscal year *T*) and are winsorized annually at the 1% and 99% levels. To facilitate the interpretation of the estimated coefficients, we standardized continuous independent variables by subtracting their respective means and then dividing by their respective standard deviations. t-statistics are reported inside the parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

3.3.2. Moderated model results

Next, we analyze possible interaction effects to answer our research questions regarding the proposed moderators of the relation between stock returns and unanticipated changes in warranty payments. Table 7 presents the results of the regression model with the full set of interaction effects. We find that the *U△IncWarrantyPay* × *U△ADV* interaction enters the model with a positive and significant sign (coefficient = 0.020, $p < .01$; Column A). That is, investors react less negatively to unanticipated increases in warranty payments when firms increase their advertising efforts. In contrast, the estimated coefficient on the *U△DecWarrantyPay* × *U△ADV* interaction is not significant (coefficient = 0.005, $p = .512$; Column A).[16]

[16] Our sample includes a large number of business-to-business companies, which may prefer to expend resources on personal selling and related marketing resources rather than advertising. Hence, we tested a possible moderating role of marketing spending that is not related to advertising in our contingency model. These results appear in Table WB10 in Web Appendix B.

Table 7
Relation between stock returns and warranty payments: Contingency model.

	DV = StockReturn	
	A.	B.
UΔIncWarrantyPay × UΔADV	0.020***	0.018***
	(3.65)	(2.84)
UΔIncWarrantyPay × UΔR&D	−0.008	−0.006
	(−1.52)	(−0.88)
UΔIncWarrantyPay × UΔConcentration	−0.003	−0.002
	(−0.32)	(−0.19)
UΔIncWarrantyPay	−0.021**	−0.023**
	(−2.52)	(−1.96)
UΔDecWarrantyPay × UΔADV	0.005	0.004
	(0.66)	(0.40)
UΔDecWarrantyPay × UΔR&D	0.010*	0.004
	(1.71)	(0.58)
UΔDecWarrantyPay × UΔConcentration	−0.022***	−0.025***
	(−2.65)	(−2.65)
UΔDecWarrantyPay	0.003	0.000
	(0.36)	(0.03)
UΔADV	−0.015*	−0.013
	(−1.96)	(−1.63)
UΔR&D	−0.016*	−0.016*
	(−1.89)	(−1.79)
UΔConcentration	0.023***	0.025***
	(2.68)	(2.81)
U△ROA	0.094***	0.094***
	(10.04)	(9.75)
U△Sales	−0.011	−0.012
	(−1.29)	(−1.31)
U△Dividend	0.003	0.003
	(0.41)	(0.36)
U△Leverage	−0.025***	−0.026***
	(−3.17)	(−3.09)
U△Safety	0.019	0.016
	(0.31)	(0.24)
U△Legal	0.000	−0.000
	(0.05)	(−0.01)
U△Turbulence	−0.003	−0.004
	(−0.38)	(−0.42)
U△Growth	−0.008	−0.006
	(−0.81)	(−0.61)
MKT	0.160***	0.145***
	(8.08)	(6.70)
SMB	−0.004	0.007
	(−0.21)	(0.32)
HML	0.006	0.007
	(0.28)	(0.30)
UMD	−0.008	−0.009
	(−0.31)	(−0.30)
Constant	0.744***	0.277***
	(3.88)	(4.65)
Year FE	Yes	Yes
Industry FE	Yes	No
Firm FE	No	Yes
Observations	3014	3014
F-value	18.40	29.18
Prob. > F	0.000	0.000
Adjusted R-squared	0.251	0.210

Notes: U△ represents unanticipated change in a particular variable. All variables are measured contemporaneously (i.e., for the fiscal year *T*) and winsorized annually at the 1% and 99% levels. To facilitate the interpretation of the estimated coefficients, we standardized the continuous independent variables by subtracting their respective means and then dividing by their respective standard deviations. t-statistics are reported inside the parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

To facilitate the interpretation of the significant $U\triangle IncWarrantyPay \times U\triangle ADV$ interaction, we apply the post hoc probing procedure suggested by Aiken and West (1991). Following their approach, we assess the relation between stock returns and unanticipated increases in warranty payments when unanticipated change in advertising intensity is one standard deviation above and below the mean. The results reveal that the simple slope for unanticipated increases in warranty payments is insignificant when unanticipated change in advertising intensity is one standard deviation above the mean (b = −0.001, t = −0.11, p = .914). In contrast, the simple slope is negative and statistically significant when unanticipated change in advertising intensity is one standard deviation below the mean (b = −0.042, t = −3.88, p < .01). Fig. 2 visualizes the results of the post hoc probing. The simple slopes for the two lines are statistically different (t = 3.65, p < .01).

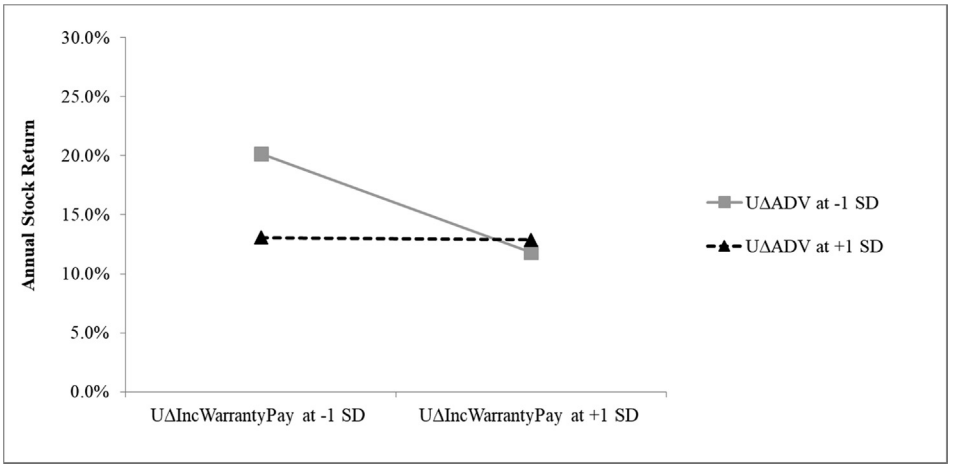

Fig. 2. Interaction of increasing warranty payments and advertising intensity.

Regarding the moderating role of R&D intensity, the estimated coefficient on the $U\triangle IncWarrantyPay \times U\triangle R\&D$ interaction is insignificant (coefficient = −0.008, p = .130; Column A). In contrast, the $U\triangle DecWarrantyPay \times U\triangle R\&D$ interaction is positive and marginally significant (coefficient = 0.010, p = .086; Column A). Thus, overall, we do not find strong evidence that R&D intensity plays an important moderating role in the stock return-warranty payment relation. A possible explanation is that unlike value appropriation, value creation involves significant uncertainty and takes more time to show effects, if any, on a company's financial performance (March, 1991). Hence, changes in R&D spending may not have a significant moderating effect in the short run.[17]

Our examination of the moderating role of industry concentration reveals no significant interaction between $U\triangle IncWarrantyPay$ and $U\triangle Concentration$ (coefficient = −0.003, p = .751; Column A). However, the estimated coefficient on the $U\triangle DecWarrantyPay \times U\triangle Concentration$ interaction is negative and significant (coefficient = −0.022, p < .01; Column A), implying that unanticipated decreases in warranty payments translate into higher firm value when industry concentration has decreased (i.e., industry competition has intensified). Specifically, when unanticipated change in industry concentration is one standard deviation below the mean, the simple slope for unanticipated decrease in warranty payments is positive and statistically significant (b = 0.025, t = 2.21, p < .05). However, when unanticipated change in industry concentration is one standard deviation above the mean, the simple slope is negative and statistically insignificant (b = −0.019, t = −1.56, p = .118). The interaction is depicted in Fig. 3, with the two lines having statistically different simple slopes (t = −2.65, p < .01). Note that our conclusions on the interaction effects remain unchanged when we control for firm fixed effects (see Column B of Table 7).

[17] We estimated a supplementary contingency model in which we operationalize R&D spending as a stock variable cumulated over the past three years (Dutta, Narasimhan, & Rajiv, 1999; see Table WB11 in Web Appendix B). There is a negative interaction between $\triangle IncWarrantyPay$ *and R&D-Stockvar* (coefficient = −0.013, p < .05), suggesting that R&D intensive firms experience more negative stock returns in the face of unanticipated increases in warranty payments.

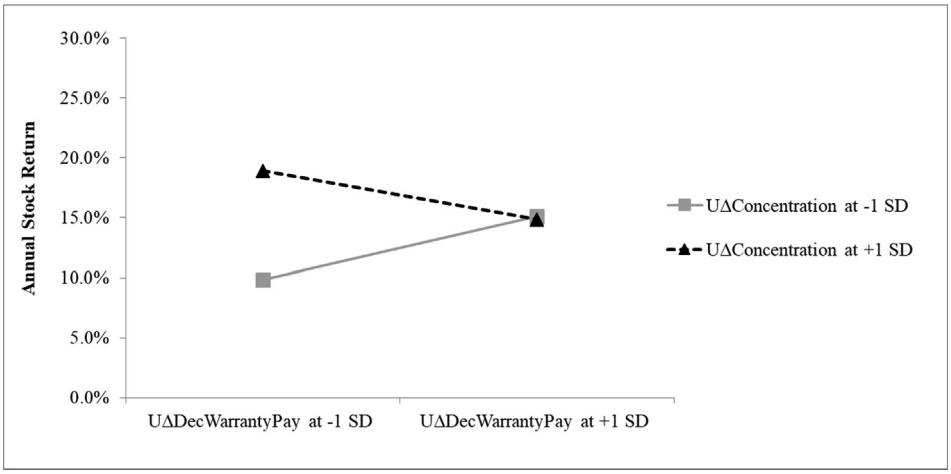

Fig. 3. Interaction of decreasing warranty payments and industry concentration.

4. Additional analysis

To provide additional insights for managers and other stakeholders, we compare firm value across three different types of firms that: (1) do not provide warranties, (2) do provide warranties and have an unanticipated increase in warranty payments, and (3) do provide warranties and have an unanticipated decrease in warranty payments. Respectively, 13274, 1375, and 1573 firm-years are in each category.[18] Since the choice of offering warranties is not random, we employ a propensity score matching (PSM) approach to perform our analysis.[19]

To estimate propensity scores, we run a logistic regression of an indicator for offering warranties on *ROA*, *Sales*, *Dividends*, *Leverage*, *Safety*, *LegalPay*, *ADV*, *R&D*, and industry dummies.[20] Then, using a 0.01 caliper, we perform a no-replacement matching within each fiscal year and industry. The final sample includes a total of 2708 observations (i.e., 621 observations from the 2nd category and their non-warranty offering matches plus 733 observations from the 3rd category and their non-warranty offering matches).[21]

In this case, we run a firm-value-level model using Tobin's Q (see Edeling, Srinivasan, & Hanssens, 2020) instead of stock returns as a dependent variable because there are no warranty payments and thereby no "unanticipated changes in warranty payments" for non-warranty offering firms. Specifically, we estimate an OLS regression of Tobin's Q (e.g., Hoitash, Hoitash, & Kurt, 2016) on two indicators for warranty offering firms (*Increase_dummy* and *Decrease_dummy*) and control variables. The base category includes observations for the matching non-warranty offering firms. The untabulated results show that there is no difference in Tobin's Q between firms with decreasing warranty payments and non-warranty offering firms ($\beta_{Decrease\_dummy} = -0.007$, $t = -0.13$, $p = .893$). However, firms with increasing warranty payments exhibit lower Tobin's Q than non-warranty offering firms ($\beta_{Increase\_dummy} = -0.184$, $t = -3.36$, $p < .01$). These findings suggest that offering a warranty program by itself is not associated with a higher firm value.[22] If anything, poor quality firms that myopically offer warranty programs (possibly to boost sales in the short-run) experience lower firm value than those that do not provide warranties. Thus, in the absence of product quality investments, warranty programs have the potential to undermine rather than boost firm value.

5. Discussion and implications

Despite its potential costs, the use of warranty contracts is a common practice across industries. In particular, warranty payments include the cost of fixing or replacing any defective items sold to customers (e.g., Spiceland et al., 2015; Wahlen et

[18] We classify a firm as a non-warranty offering firm if the firm does not report XBRL data on warranties.

[19] PSM aims to pair each treatment observation (i.e., warranty offering firms with increasing and decreasing warranty payments) with a control observation (i.e., non-warranty offering firms) that has similar observable characteristics, which helps obtain an unbiased estimate of the treatment effect (Dehejia & Wahba, 2002).

[20] These variables are from our regression models. We do not include *Turbulence*, *Growth* and *Concentration* in the logistic regression model because we perform the matching within each year and industry. So, by construction, there would be no difference in these covariates between the treatment and matching firms. Similarly, *MKT*, *SMB*, *HML*, and *UMD* are not firm-level variables. Hence, they are not included in the model.

[21] The post-matching covariate balance test shows that none of the covariates except for *Safety* is significantly different at the 5% level between the treatment and matching observations, suggesting that our matching procedure generated a balanced sample in general. Note that our regression model for Tobin's Q includes all the covariates from the PSM model as well as *Turbulence*, *Growth*, *Concentration*, year and industry fixed effects.

[22] Consistent with this conclusion, our Heckman two-step model results reveal an insignificant coefficient on the inverse Mills ratio ($\beta = -0.004$, $p = .787$; Table WC2), suggesting that there is no systematic difference in stock returns between warranty offering and non-warranty offering firms. These findings highlight the importance of making judicious warranty decisions.

al., 2013). While many argue that warranty programs are relevant for firms' competitive strategy (Guajardo et al., 2016; Udell & Anderson, 1968) and that consumers perceive warranty contracts as a risk-mitigating mechanism (Shimp & Bearden, 1982), firm value implications of customers' warranty claims are not clear. By examining investors' response to changes in firms' product warranty payments made to existing customers, we aim to fill this void in the literature. An important part of our examination is the validation of warranty payments as a proxy for product quality information. Our findings collectively have important implications for theory and practice.

5.1. Implications for research

The signaling role of product warranties has received significant attention in prior research. The logic behind the signaling argument is straightforward. Because product warranties are costly, only firms with good quality products can afford to satisfactorily manage warranty programs and bear any related costs. There has been limited empirical research challenging this view (e.g., Chu & Chintagunta, 2011). Specifically, our results highlight an often overlooked but significant negative consequence of warranty programs: increasing warranty payments signal to investors that the firm is possibly experiencing serious quality issues. This negative signaling aspect of product warranties extends the current state of signaling-based research on warranty programs. More research is needed to understand why firms with lower quality products offer better warranty terms than those with higher quality products (Balachander, 2001), eventually paying more to cover customers' warranty claims and disappointing investors. Managerial myopia, resulting in a tendency to boost revenue and profitability in the short run, may explain this puzzling observation. This is a promising avenue for future research. Another surprising observation is that investors do not consider unanticipated decreases in warranty payments as an informative signal unless there is an unanticipated change in the industry's competitive landscape.

Prior research on warranties has mainly focused on warranty scope and length as key constructs (e.g., Boulding & Kirmani, 1993; Kelley, 1988; Shimp & Bearden, 1982; Wiener, 1985). Unlike these input-based signals that appear to be ambiguous indicators of product quality (e.g., Chu & Chintagunta, 2011; Cooper & Ross, 1985), our study utilized a signal that captures companies' actual warranty outcomes per customer claims. Warranty payments are a more direct and less ambiguous measure of product reliability and quality than other warranty indicators. Also, it is a challenging task to create a composite measure of warranty scope and length based on publicly available information as companies sell a multitude of products with different levels of coverage. In contrast, warranty payments can meaningfully summarize the outcome of various warranty contracts.

In addition, our work complements and extends prior studies on perceived brand quality and firm value. Much of the previous work in this stream of literature has focused on surveys of managers and households to assess perceived quality and examine its performance implications. These studies have shown that firms perceived to have superior product quality than their rivals tend to have high market shares and profitability (e.g., Jacobson & Aaker, 1987; Phillips, Chang, & Buzzell, 1983) and that improvements in perceived brand quality translate into better stock returns (e.g., Aaker & Jacobson, 1994; Bharadwaj et al., 2011; Luo, 2010). Other aspects of quality such as product reliability (as captured by actual product usage and warranty claims) received limited attention from researchers presumably due to lack of relevant, standardized data. However, in recent years, the use of XBRL by public companies has increased the volume and quality of accounting data available to researchers. Using the XBRL data on warranty payments made to customers, we add new insights to traditional research on quality and the marketing-finance interface. In particular, our study highlights the value relevance of warranty payments as signals of product quality. Examining different aspects of product quality is essential to achieve a fuller understanding of the strategic role of quality.

Finally, testing the effect of warranty payments on firm value in isolation of key business functions such as advertising and R&D may paint an incomplete picture of how changes in warranty payments are evaluated by investors. Hence, our proposed contingency framework for the warranty payment-firm value relationship is an important step forward. We demonstrate that unanticipated changes in advertising intensity and industry concentration are key moderators in the present research setting.

5.2. Implications for practice

Many products are sold with product warranties, which are viewed as an important marketing tool by managers (Padmanabhan, 1995; White, 2002). Nevertheless, offering product warranties has a major downside: investors appear to perceive unanticipated increases to warranty payments as a sign of product quality issues. Anecdotal evidence is consistent with the product quality interpretation. Among the sample firms with the highest warranty payments are Motorcar Parts America Inc., Standard Motor Products Inc., Overland Storage Inc., Netgear Inc., and Thor Industries Inc. Several web sources and articles discuss significant quality issues experienced by these firms. For instance, Thor Industries, a large U.S. manufacturer of recreational vehicles, recalled different types of motor homes in 2015.[23] The company has also been involved in various on-going litigation cases based on state "lemon laws" and customer warranty claims (see Thor Industries, Inc. 2015 Annual

[23] Retrieved from http://www.consumersdigest.com/recalls/thor-motor-coach-issues-mass-recall-of-motor-homes. See also, https://sites.google.com/site/thorowners/things-you-can-do.

Table 8
Summary of findings and implications.

Findings	Implications
Warranty payments:	
• Stock returns are negatively associated with unanticipated increases in warranty payments (i.e., "loss" in product quality).	• Managers should try to avoid increases in warranty payments beyond expected levels to preserve firm value.
• Stock returns are not associated with unanticipated decreases in warranty payments (i.e., "gain" in product quality).	• However, overinvesting in product quality and reducing warranty payments beyond expected levels do not seem to be rewarded by the stock market.
• Investors react more strongly to unanticipated increases in warranty payments than unanticipated decreases in warranty payments.	• Increases in warranty payments matter more to investors than decreases in warranty payments.
Advertising intensity as a moderator:	
• The negative association between stock returns and unanticipated increases in warranty payments is attenuated as unanticipated advertising spending increases.	• Firms experiencing an unexpected rise in warranty claims can mitigate its negative firm value effects by boosting their advertising activity.
• Unanticipated changes in advertising spending do not play a moderating role in the case of decreasing warranty payments.	• Increasing advertising spending beyond expected levels does not help generate positive returns on improved warranty outcomes.
R&D intensity as a moderator:	
• Unanticipated changes in R&D spending do not moderate investors' reaction to unanticipated increases (or decreases) in warranty payments.	• Changes to R&D budget should not be of primary concern for managers of firms with rising warranty claims. In such cases, managers are advised to focus on the potential causes of product quality issues (e.g., material and labor) rather than innovation. Higher R&D spending neither mitigates nor magnifies investors' reactions to fluctuations in warranty payments. This may be due to uncertainties surrounding R&D investments of such firms.
Industry concentration as a moderator:	
• Unanticipated changes in industry concentration do not moderate the negative stock return effect of unanticipated increases in warranty payments.	• Firms with increasing warranty payments realize lower stock returns regardless of changes in the industry's competitive landscape.
• When there is an unanticipated decline in industry concentration, stock returns increase with unanticipated decreases in warranty payments.	• Stock market rewards firms with lower than expected warranty payments in the face of intensifying industry competition.

Report). Similarly, Netgear was sued in 2017 for selling defective cable modems.[24] As all of these firms offer some type of warranty for their products, warranty coverage does not necessarily imply product quality. Investors pay close attention to warranty outcomes as reflected in actual warranty payments made per customers' claims, which are used by some companies as early warnings of potential product quality issues (McKinsey & Company, 2017; Spector & Colias, 2017).

As summarized in Table 8, our findings are of relevance to production, marketing, and finance managers as well as to the C-suite. We document evidence suggesting that preserving and enhancing firm value in relation to warranty programs and related product quality issues require a coordinated effort among managers from different business functions. Cost efficiency is a major goal for many production and finance managers because it is an important source of profits and firm value, particularly in low-growth industries (e.g., Hoitash et al., 2016). Nonetheless, cost efficiency through cost-cutting tactics, such as using cheaper material and labor, is likely to increase defective product rate and lead to unanticipated increases in warranty payments, which translate into lower firm value. However, it is also worth noting that overinvestment in quality improvement efforts may not result in higher firm value as investors do not react positively to unanticipated decreases in warranty payments. Therefore, managers need to carefully consider the cost and benefits of allocating resources away from and to product quality investments.

Improving customer-relating capabilities is critical for firms that face rising warranty payments due to product quality issues. Unanticipated increases in warranty payments destroy value but marketing communication can help firms mitigate the negative implications of deteriorating quality. Increasing advertising efforts and undertaking new campaigns would signal firms' willingness to boost customer equity.[25] While advertising by itself may not always raise stock prices (e.g., Erickson & Jacobson, 1992), our evidence shows that it does counteract the negative news of lower quality. Investors' reaction to unexpected warranty payment increases is less severe when advertising spending is increased. Alternatively, firms that face quality issues may shift resources to new product development with the view to introduce different products to the market. Our results show that this strategy is not value enhancing. Unanticipated increases in R&D spending do not help attenuate the negative effect of rising warranty payments on stock returns. Investors appear to be skeptical about returns on firms' aggressive R&D investments when existing products of those firms are not of high quality. Finally, managers should note that unanticipated declines in warranty payments do translate into higher firm value when there is intensified industry competition. Consequently, managerial decisions affecting warranty program outcomes should be made in light of recent changes in a firm's competitive

[24] Retrieved from https://www.prnewswire.com/news-releases/netgear-faces-consumer-class-action-for-defective-cable-modems-300443897.html.

[25] Relatedly, Rubel, Naik, and Srinivasan (2011) propose that managers should increase advertising activity to aid recovery efforts following product-harm crises, particularly when the crisis damage rate is high.

environment. We advise managers to strongly communicate warranty payment decreases in competitive industries through multiple channels such as conference calls, news outlets, and social media.

Our findings also shed light on the question of whether offering warranties, by itself, helps improve firm value. Our evidence suggests that warranty programs, on average, cannot help generate value. If anything, rising warranty claims can be detrimental to firm value. Hence, we advise managers to carefully weigh the added costs and potential negative implications of offering warranty programs against the perceived short-term benefits of warranties.

5.3. Limitations and future research

There are some limitations of our research, which offer directions for future work. First, given the nature of our data, we cannot distinguish between firms that sell multiple products under different brands and firms that sell a few products under a single brand. One would expect that the negative effect of warranty payments on firm value would be more pronounced when a firm has a limited existing product portfolio. Future research should explore this possibility. Second, we do not have information regarding specific warranty terms and conditions (e.g., warranty length, limits on coverage, customer responsibilities, etc.). Warranty terms and conditions tend to differ across firms and industries (e.g., recreational vehicles vs. medical equipment). Such differences would be observed even across different products sold by a firm depending on the function and expected life of products (e.g., laptops vs. smart phones). While we control for industry and firm fixed effects in our regression models, we are unable to control for product-level differences in warranty contracts. Relatedly, the focus of our study––warranty payment information––may be less relevant as a quality signal where customer-perceived quality is available from third party sources at high frequency. Third, due to data limitations, our contingency model focuses on changes in advertising expenditure instead of advertisement content and message. Future studies may undertake a more detailed examination by performing a content analysis of firms' advertising campaigns. Finally, the warranty payment data used in our analysis is obtained from information released through companies' financial reports. It would be interesting to conduct an event study focusing on warranty-related news and announcements, which may allow for teasing out the signaling effects of changes in firms' warranty programs and warranty outcomes. We leave this examination for future research.

5.4. Conclusion

Keeping warranty payments under control is necessary for preserving shareholder wealth. Deteriorating product quality as evidenced by unanticipated increases in warranty payments signals poor future performance, leading to losses in firm value. Advertising can help firms mitigate the negative effect of adverse shocks to warranty payments on firm value. Managers should be cognizant of interactions between changes in warranty payments, advertising, and industry competition when designing warranty programs and allocating financial resources to product quality, new product development, and advertising.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijresmar.2021.05.002.

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