Corporate capital structure and product warranties *

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Abstract

We use a unique dataset of product warranty offerings by firms to investigate the relation between corporate debt levels and both the likelihood of warranty offering and the actual levels of firm warranty reserves. Our findings offer some new insights into the relations between explicit and implicit insurance contracts and firm financing decisions. We find that leverage is negatively related to the level of product warranties that the firm offers. We also find that firms that do not offer product warranties but operate in industries where other firms do also tend to have lower debt levels, which suggests that the presence of implicit claims is an important determinant of debt levels. Conditional on operating in a warranty-offering industry, firms that issue explicit warranties tend to have even lower debt levels. This finding implies that explicit contracts play a role over and above implicit contracts in determining debt level

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1. Introduction

There is ample theoretical and empirical research on corporate capital structure decisions that focuses on contracts by firms with financial stakeholders such as stockholders and bondholders. Firms often enter into contracts also with non-financial stakeholders such as employees, suppliers, and customers. An interesting feature of contracting with non-financial stakeholders is that the contracts can be explicit or implicit. In this article, we examine the impact on a firm's capital structure decision of one such contract, product warranty, which includes aspects of both explicit and implicit contracting between the firm and non-financial stakeholders, namely, customers. We collect a unique dataset of warranty offerings by firms to investigate the relation between corporate debt levels and both the likelihood that the firm will offer a product warranty and the actual levels of the firm's warranty reserves. Our findings offer some new and interesting insights into the interplay between explicit and implicit insurance contracts and firm financing decisions.

Many firms offer their customers product warranties, which explicitly outline the rights and responsibilities of the firm and the customer under various possible future scenarios with respect to the use of the product. One view in the economics and insurance literature is that warranties are provided to risk-averse customers as a form of *explicit* insurance against future product failure (see, e.g., Heal, 1977; Hollis, 1999). In addition, since some contracts have to be based on outcomes that may be prohibitively costly to specify ex ante, firms often enter into *implicit* contracts with non-financial stakeholders (see, e.g., Zingales, 2000; Baker, Gibbons, and Murphy, 2001). Some of these implicit agreements take the form of insurance contracts (see, e.g. Arnott and Stiglitz, 1985; Allen and Gale, 1999).[1] For instance, when a manufacturer sells a machine, it provides the customer with an implicit commitment to provide parts at reasonable prices for the

[1]Arnott and Stiglitz (1985) show that under asymmetric information about job quality, optimal wage structure entails implicit insurance to employees against job dissatisfaction. Allen and Gale (1999) suggest that long-term relationships that entail implicit insurance contracts between financial intermediaries and their customers can be effective substitutes for ex ante costly information acquisition.

life of the machine. This commitment on the part of the manufacturer serves as an implicit insurance contract to the customer against future product failure (Cornell and Shapiro, 1987).

The value of explicit and implicit contracts to stakeholders depends on the likelihood that the firm will honor them; this is especially so for insurance-like contracts with contingent payoffs far into the uncertain future. Thus, if the firm's capital structure affects its ability or incentive to honor future obligations, then the presence of such contracts has implications for the firm's optimal leverage. Titman (1984) suggests that if the firm's liquidation decision is causally linked to its bankruptcy status, then a firm selling unique products that require future servicing optimally chooses a lower level of debt. Choosing lower leverage allows the firm to commit itself to a liquidation policy that takes into consideration the effects on its customers. If the customers are not convinced about the availability of future servicing, they may either not buy the firm's product or may require significant price cuts. Even if liquidation is not likely, the firm's capital structure will affect the value of explicit and implicit contracts since the firm's incentives to renege on them are higher when the firm has high levels of debts (see, e.g., Cornell and Shapiro, 1984; Maksimovic and Titman, 1991).[2]

In this study, we examine the effect of the firm's explicit and implicit contracts with customers on the firm's capital structure. We take advantage of a recent interpretation of FASB's Statements No. 5, 57, and 107 that requires firms to disclose their warranty claims and warranty reserves for fiscal years ending after December 31, 2002 in their annual 10K reports. We collect this warranty data for a large sample of firms to examine whether firms that offer product warranties have lower debt levels to bond themselves to honor

[2]Anecdotal evidence suggests that firms are more likely to behave opportunistically when in financial distress. The following statements in an October 28, 2004 Washington Post article (Alexander, 2004)) illustrates Delta airlines' increased likelihood of reneging on existing contracts due to financial distress: "Delta is seeking $1 billion in pay and benefit cuts from its pilots. The nation's third-largest airline said that without the cuts, it would have to file for bankruptcy court protection."

these commitments. Further, we examine whether firms whose relationships with customer crucially depend on implicit contracts with customers have lower leverage even in the absence of explicit warranty contracts.

Controlling for other determinants of capital structure, we find that leverage is negatively related to the level of product warranties that the firm offers. We measure this level of warranty by the warranty reserve that a firm maintains. We then examine whether the negative relation between leverage and warranty level obtains only when the firm issues explicit warranty contracts or is also present if the warranty contract is implicit. Firms that use warranties typically operate in industries where firm-customer relationships are long-term in nature and where implicit contracting with customers should be more prevalent. We hypothesize that the relation between leverage and implicit contracting is more likely to exist in such industries. In support, we find that firms that do not offer product warranties but operate in industries where other firms issue warranties (warranty-offering industries) also tend to have lower debt levels. This result suggests that the presence of implicit claims is an important determinant of debt levels. However, conditional on operating in a warranty-offering industry, firms that issue explicit warranties tend to have even lower debt levels. This finding implies that explicit contracts play a role over and above implicit contracts in determining debt levels.

Our results are robust to different measures of warranty levels and leverage ratios and are economically significant. For instance, we find that the market leverage of the average firm that offers only implicit warranties, that is, it does not offer explicit warranties but operates in a warranty-offering industry, is lower by about 19% than that of the average firm in our sample. On the other hand, the market leverage of a firm that offers explicit warranties and is in the 75^{th} percentile of our warranty measure is lower by about 28% than the average firm. Thus, it appears that both explicit as well as implicit contracts with customers have an economically significant negative effect on optimal leverage.

Our paper is closely related to research that studies the relation between financial structure and explicit and implicit contracting with non-financial stakeholders, especially customers. For example, Titman (1984) demonstrates that the firm can commit to a liquidation policy that takes into consideration the effect of firm liquidation on customers by choosing a lower debt level. Maksimovic and Titman (1991) develop this idea further and show that customers may be unwilling to conduct business with a highly levered firm because higher debt reduces the firm's willingness to invest in reputation and produce high-quality products. On the empirical side, Titman and Wessels (1988) use research and development expenditures (R&D) as a proxy for the uniqueness of a firm's product and document that firms with high R&D have lower leverage. Opler and Titman (1994) find that highly leveraged firms with specialized products are more vulnerable to financial distress in industry downturns (see also Zingales, 1998). Kale and Shahrur (2006) find that firms whose suppliers and customers are expected to undertake relationship-specific investments tend to carry lower levels of debt. By being the first to examine the link between leverage and product warranties, our study contributes to this literature by providing direct evidence on the link between insurance-like contracts with customers and capital structure. Our research design allows us to study the relative importance of explicit versus implicit contracts on optimal leverage.

The rest of the paper proceeds as follows. In Section 2, we provide details of the sample, warranty data, and the dependent and independent variables. We provide the empirical results in Section 3. Section 4 concludes the paper.

2. Data and variable descriptions

2.1. Sample

We follow the literature and exclude financial firms (SIC codes between 6000 and 6999) and utilities (SIC codes between 4900 and 4999) and firms headquartered in a foreign country (see. e.g., Kale and

Shahrur, 2006). We conduct our analysis on two samples. In the first sample, we only have firms operating in 2003, for which we can collect the warranty data. The 2003 sample consists of 3,607 observations. We extend our analysis to a larger sample that includes all firms covered by *Compustat* during the period 1984 to 2003 and use the warranty data for 2003 to identify industries that are more likely to offer warranties. This larger sample consists of 76,160 firm-year observations for which we can compute all our variables. Except for the warranty data, we obtain firm-specific data required to construct the variables used in our tests from the *Compustat* database.

2.2 Warranty Data

We collect the warranty data from 10K reports for all firms in our sample for the fiscal years ending between January 1st, 2003 and December 31, 2003. This sample consists of 3,607 firms that were operating as of the end of the 2003 fiscal year and for which we can compute all the control variables. Table 1 shows descriptive statistics on the warranty data for two-digit SIC code industries that form our sample. We provide statistics on the warranty reserve balance at the beginning of the fiscal year normalized by total assets, denoted by *Beginning Warranty Reserves*. Unreported summary statistics that are based on warranty reserves for the fiscal year normalized by total assets (*Period Warranty Reserves*) show a similar pattern. We assign zero reserves to firms that do not report any warranty reserves and thus assume that they do not offer product warranties to their customers.

We find that 574 firms (15.91% of the sample) have non-zero *Beginning Warranty Reserves*. For these firms, the mean (median) value of *Beginning Warranty Reserves* is equal to 1.38% (0.85%), while the maximum (minimum) value is 23.12% (0.02%). The maximum value seems to be an outlier relative to the mean and median. Thus, in our regression analysis, we winsorize the warranty variables, *Beginning Warranty Reserves* and *Period Warranty Reserves*, at the 1st and 99th percentiles in order to reduce the

influence of outliers on our results. Results that are based on the unwinsorized variables are qualitatively similar.

As shown in Table 1, we find that the industries *Building Construction General Contractors* (SIC code 15), *Industrial and Commercial Machinery and Computer Equipment* (SIC code 35), and *Measuring, Analyzing, and Controlling Instruments* (SIC code 38) have the three highest percentages of firms with non-zero warranty reserves (64%, 45%, and 43%, respectively). The mean values of *Beginning Warranty Reserves* for firms that offer warranties in these industries are 0.96, 1.91, and 1.21, respectively. Further, out of the 52 two-digit SIC code industries covered by our sample, 27 industries do not have any firm with non-zero warranty reserves. As expected, warranty-offering firms cluster in industries that sell durable products for which the availability of parts and future servicing are important.

2.3. Leverage and control variables

We use two measures of leverage, *Market Leverage* and *Book Leverage. Market Leverage* is equal to the sum of book values of long-term debt and debt in current liabilities (Compustat items 9 and 34) divided by the sum of book value of debt and market value of common equity (item 25* item 199). *Book Leverage* is the sum of the book values of long-term debt and debt in current liabilities divided by the book value of assets (item 6). In order to examine the effect of the warranty measures on leverage, we include other determinants of leverage as control variables. Thus, following the literature (see, e.g., Kale, Noe, and Ramirez, 1991; Berger, Ofek, and Yermack, 1997; Mackay and Phillips, 2006), we use the following control variables:

1. Firm Size is the log of total assets (item 6).

2. Return on Assets is operating income (item 13) divided by total assets.

3. Asset Collateral Value is net property, plant, and equipment (item 8) divided by total assets.

4. *Volatility* is the standard deviation of operating income divided by total assets. We require at least three consecutive observations to construct this variable.

5. Nondebt Tax Shields is equal to investment tax credits (item 51) divided by total assets.

6. R&D Intensity is equal to total research and development expenditures (item 46) divided by total assets (item 12).

7. SE Intensity is equal to selling, general, and administrative expenses (SE) (item 189) divided by total assets.

8. Tobin's q is equal to the book value of assets plus the market value of common equity minus the book value of common equity (item 60) divided by the book value of assets.

9. Industry Concentration is the sales-based Herfindahl Index of the firm's primary industry.

10. Industry and year dummy variables. The industry dummy variables are based on the firm's two-digit historical SIC code.

Since the firm's characteristics that are captured by the warranty variables are likely to be related to its input and output markets, we also include as controls the variables used in Kale and Shahrur (2006) to capture the characteristics of the firm's supplier and customer industries. Thus, we include measures of the R&D intensities, concentrations of, and the sales growth in the firm's supplier and customer industries. These variables are, respectively: *Supplier Industries R&D, Customer Industries R&D, Supplier Concentration, Customer Concentration, Supplier Change in Sales, Customer Change in Sales*. Simply put, these variables represent, respectively, weighted averages of the R&D intensities, concentrations, and change in sales of the firm's supplier and customer industries, where the weights represent the importance of the supplier and customer industries to the firm's operations. We also include a measure that captures the firm's human capital intensity, denoted by *Compensation of Employees*, which is the dollar amount spent on employee compensation in the firm's industry divided by the industry's total output.

To construct the customer and supplier variables, we rely on two data sources, the *Use* table of the benchmark input-output (IO) accounts for the U.S. economy and the Compustat database. For any pair of supplier and customer industries, the *Use* table reports estimates of the dollar value of the supplier industry's output that is used as an input in the production of the customer industry's output. The *Use* table enables us to identify the firm's customer and supplier industries and the importance of each supplier/customer industry to the firm. We compute the R&D intensities, industry concentrations, and change in sales of supplier/customer industries from Compustat. For the sake of brevity, we refer the reader to Appendix A in Kale and Shahrur (2006) for additional details regarding the construction of these variables.

In the construction of our variables, we assume that a firm spends zero dollars on R&D (SE) if the R&D (SE) expense for a firm is missing.[3] We find that for most of the control variables, some firms have extremely high values. For example, while the median value of the selling expense variable is 0.23, its maximum value is 2,343. We winsorize all dependent and independent variables at the 1st and 99th percentiles in order to reduce the effect of outliers on our results. Using the unwinsorized variables does not alter the main results and the conclusions of this paper. We present descriptive statistics for the winsorized leverage and control variables in Table 2. The mean and median values for *Market Leverage* are 0.187 and 0.132, respectively. The mean and median values for *Book Leverage* are 0.266 and 0.204, respectively. The descriptive statistics of the independent variables presented in the table show wide ranges of values for all these variables, suggesting that the firms in our sample differ considerably with regard to the characteristics captured by these measures.

3. Empirical findings

3.1. Regression analysis of leverage on warranty variables

[3] We follow Loughran and Ritter (1997) and verify the validity of this assumption by checking the R&D of biotech firms and retailers. We find that almost all biotech firms had a nonzero value for the R&D variable while most retailers had missing values for this variable.

Table 3 present results of ordinary least squares (OLS) regression analysis of *Market Leverage* and *Book Leverage* on the warranty and control variables. In Model 1, which pertains to *Market Leverage*, the coefficient on *Beginning Warranty Reserves* is negative and statistically significant at the 5% level, which implies that market leverage decreases in the warranty reserve level. We find a negative but statistically insignificant coefficient on *Beginning Warranty Reserves* in the *Book Leverage* regression reported in Model 4. As an alternative measure, we measure the firm's warranty level with *Period Warranty Reserves*, which is the warranty reserve for the fiscal year normalized by total assets. The coefficients on this variable, reported in Model 2 for *Market Leverage* and Model 5 for *Book Leverage*, are both negative and significant at conventional levels.

Next, we use a dummy variable specification where the variable *Warranty Dummy* equals one if the firm has a non-zero value for *Beginning Warranty Reserves*, and zero otherwise. As reported in the models pertaining to market and book leverage (Models 3 and 6, respectively), the coefficients on this variable are negative and statistically significant at conventional levels. In summary, the results from Table 3 suggest that firms that offer warranties tend to carry lower debt levels. This finding is consistent with the use of debt as a commitment tool to assure customers that the firm will be around when future warranty claims are due.

The results pertaining to the control variables are largely consistent with the extant literature on capital structure (see, e.g, Berger, Ofek, and Yermack, 1997; Mackay and Phillips, 2006; Kale and Shahrur, 2006). For instance, the coefficients on *Size, Asset Collateral Value,* and *Customer Concentration* are generally positive and significant. The coefficients on *Non-debt Tax Shield, Return on Assets, R&D Intensity, SE Intensity, Supplier Industries R&D,* and *Customer Industries R&D* are generally negative and significant. The largely insignificant or mixed coefficients on the variables *Volatility, Tobin's Q, Industry Concentration, Supplier Change in Sales, Customer Change in Sales* are likely due to the small sample size, as it is evident from the results reported in Table 5 below, which are based on a much larger sample.

It is important to note that the results pertaining to the warranty variables are also economically significant. For instance, if we consider the dummy variable specifications in Models 3 and 6, the coefficient on *Warranty Dummy* is equal to -0.025 in the market leverage regression and -0.04 in the book leverage regression. These results imply that the average firm that issues warranties has a market (book) leverage that is lower by 0.025 (0.04) than the leverage of the average firm that does not use warranties. Relative to the mean value of *Market Leverage* (*Book Leverage*) of 0.187 (0.266), this change represents an 11% (15%) decline in the leverage ratio.

Next, we examine whether the decreased leverage is the result of issuing explicit contracts (warranties) or whether it is due to the fact that firms that use warranties operate in industries where implicit contracting is important. In the latter case, the firm may use decreased leverage to commit itself to honor its implicit contracts. For example, when a customer buys a car from an auto manufacturer, she expects to be able to buy parts for her car even if it is sold without an explicit warranty. Thus, the manufacturer can choose to have low leverage to signal to the customer its commitment to honor this implicit claim in the future.

To test this hypothesis, we construct a dummy variable, *Warranty Industry Dummy*, which equals one if the firm operates in a four-digit SIC code industry with at least one firm offering warranties (warranty-offering industry), and zero otherwise.[4] We then regress our measures of leverage on *Warranty Industry Dummy*, the interaction term *Warranty Industry Dummy* Beginning Warranty Reserves*, and the control variables. We suggest that firms that operate in warranty-offering industries are likely to sell products that involve implicit contracts with customers. Thus, if only explicit contracts such as warranties matter to the leverage decision, we should expect the coefficient on *Warranty Industry Dummy* to be insignificant since the coefficient on this variable represents the relation between leverage and *Warranty Industry Dummy* for firms with zero *Beginning Warranty Reserves*. The results reported in Table 4 suggest otherwise. In both the

[4] As alternative specification we set *Warranty Industry Dummy* equal to 1 if at least 5% of industry firms issue warranties, and zero otherwise. The results from this specification are qualitatively similar to those reported here.

market and book leverage regressions (Models 2 and 4), we find that the coefficients on *Warranty Industry Dummy* are negative and highly significant, suggesting that implicit contracting, which is likely to be important for firms operating in warranty-offering industries, have a negative effect on optimal leverage.

Further, the negative and significant coefficient on *Warranty Industry Dummy* Beginning Warranty Reserves* in the market leverage regression suggests that the use of explicit warranties have an additional negative effect on optimal debt levels. The negative coefficient on this variable in the book leverage regression further supports this conclusion, although the coefficient is statistically insignificant at conventional levels. To capture the relative economic significant of explicit vs. implicit contracts, we compare the drop in market leverage for a firm that operates in a warranty-offering industry but does not itself offer warranties (that is, has zero *Beginning Warranty Reserves)* to a firm that is in the 75^{th} percentile of *Beginning Warranty Reserves.* Keeping all other independent variables at their industry means, we find that the market leverage of the firm with no warranties is lower by 0.036 than the average firm in the sample that does not operate in a warranty-offering industry. On the other hand, a firm in the 75^{th} percentile of *Beginning Warranty Reserves* has a market leverage level that is lower by 0.052. Thus, it appears that both implicit as well as explicit contracts have an economically significant negative effect on leverage.

3.2. Robustness checks

Do the results reported in Tables 2 and 3 suffer from an endogeneity bias? For example, it is possible that the warranty decision is endogenous to the leverage decision. One argument is that a firm that has high leverage can offer explicit warranties to affect the perception of customers regarding its ability to honor future obligations. This is possible if warranty contracts are enforceable in a court of law, and thus provide the holder a claim on the firm's assets in the case of liquidation. This line of reasoning, however, predicts a positive relation between leverage and warranty offering, which is the opposite of what we report in Tables 3 and 4.

For the sake of completeness and to address the possibility of reserve causality, we repeat our analysis where we regress our measures of leverage on the lagged values of warranty variables. In other words, for firms included in the 2003 sample, we construct their leverage measures for 2004. This process results in a sample of 3,205 firms for which we have the leverage data. For the sake of brevity, we report the results pertaining to the specification used in Table 4. The results from the specifications used in Table 3 are qualitively similar. As shown in the first two columns of Table 5, the results of this analysis are identical to those reported in Table 4. This evidence further supports our conclusions.

Finally, we extend our analysis to the sample that includes all firm-year observations in the 20-year period 1984 to 2003. We conduct this analysis to check the robustness of some of our results and check if our conclusions can be generalized. Since we have warranty data only for 2003, we use this data to classify the industries between warranty-offering industries and those industries that do not offer warranties. Thus, similar to our previous analysis, we construct the variable *Warranty Industry Dummy* using the 2003 warranty data but extend this classification over the whole sample period. We report these results in Columns 3 and 4 of Table 5. We find that the coefficients on *Warranty Industry Dummy* are negative and highly significant. In addition, the coefficients on this dummy variable are economically significance (-0.020 and -0.032 for the market leverage and book leverage, respectively), although the economic significance is somewhat lower than that pertaining to the coefficients from the 2003 sample.

4. Conclusion

Our research adds to the growing body of literature that examines the effects of firms' contracting arrangements on their financial decisions. The existing literature considers how firm financing decisions are affected by contracting with financial stakeholders such as shareholders and debtholders as well as contracting with non-financial stakeholders such as employees, suppliers, and customers. Our paper

contributes the latter stream of contracting with non-financial stakeholders by considering the effect of explicit and implicit insurance offered through product warranties on corporate debt levels.

We collect a unique dataset of warranty reserves for a large sample of firms for our investigation. We examine the effect on corporate debt levels of explicit and implicit insurance contracts offered by firms. With respect to the effect of explicit insurance contracts, we investigate the relation between firm debt levels and (i) a dummy variable that measures whether a firm offers product warranties or not and (ii) the level of warranty reserves. We find that the relation between firm leverage and both these variables is negative. We also investigate the impact of implicit insurance contracts on firm leverage. We argue that firms that do not offer explicit warranties but operate in an industry where other firms offer warranties are likely to have implicit contracts with their customers. We find that such firms tend to have lower debt level, suggesting that firms use decreased leverage to signal their willingness to honor their implicit obligations. Further, we show that in industries where some firms offer product warranties, firms that offer explicit warranties carry lower debt than those that do not. This finding indicates that the effect of explicit insurance contracts is over and above that of implicit insurance.

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Table 1
Descriptive statistics: warranty reserves

This table shows descriptive statistics for a sample of 3,607 firms during 2003. The warranty data is collected from 10K reports for the fiscal years ending between January 1st , 2003 and December 31, 2003. *Beginning Warranty Reserves* is the warranty reserve balance at the beginning of the fiscal year normalized by total assets.

					Descriptive statistics of *Beginning Warranty Reserves* – only firms with non-zero warranty reserves are included					
Industry Description	SIC code	# of industry firms	# of industry firms with non-zero warranty	% of industry firms with non-zero warranty	mean	median	max	75th Perct.	25th Perct.	min
Agricultural Production Crops	1	12	1	8.33%	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
Agricultural Production Livestock	2	1	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Agricultural Services	7	3	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Forestry	8	2	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Fishing, Hunting, & Trapping	9	1	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Metal Mining	10	16	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Coal Mining	12	6	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Oil And Gas Extraction	13	153	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mining and Quarrying of Nonmetallic Mineral	14	6	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Building Construction General Contractors	15	25	16	64.00%	0.0096	0.0087	0.0237	0.0118	0.0057	0.0008
Heavy Construction	16	11	1	9.09%	0.0327	0.0327	0.0327	0.0327	0.0327	0.0327
Construction Special Trade Contractors	17	11	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Food and Kindred Products	20	87	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tobacco Products	21	5	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Textile Mill Products	22	19	2	10.53%	0.0025	0.0025	0.0034	0.0034	0.0017	0.0017
Apparel and other Finished Products	23	42	1	2.38%	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Lumber and Wood Products	24	18	3	16.67%	0.0332	0.0054	0.0940	0.0940	0.0002	0.0002
Furniture and Fixtures	25	23	8	34.78%	0.0076	0.0086	0.0114	0.0105	0.0042	0.0026
Paper and Allied Products	26	36	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Printing, Publishing, and Allied Industries	27	52	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Chemicals and Allied Products	28	404	11	2.72%	0.0063	0.0025	0.0326	0.0081	0.0018	0.0006
Petroleum Refining and Related Industries	29	18	1	5.56%	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
Leather Products	31	21	0	0.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Stone, Clay, Glass, and Concrete Products	32	25	6	24.00%	0.0062	0.0064	0.0080	0.0077	0.0055	0.0032

Continued on next page

Table 2
Descriptive statistics: dependent and control variables

This table reports descriptive statistics for the dependent and control variables. The sample includes 76,160 firm-year observations from the period 1984 to 2003. *Market Leverage* is book value of long-term debt and debt in current liabilities divided by the sum of book value of debt and market value of common equity. *Book Leverage* is book value of long-term debt and debt in current liabilities divided by the book value of assets. *Firm Size* is the log of total assets. *Asset Collateral Value* is net property, plant, and equipment divided by total assets. *Volatility* is the standard deviation of operation income divided by total assets. *Non-debt Tax Shields* is investment tax credits divided by total assets. *Return on Assets* is operation income divided by total assets. *Tobin's q* is book value of assets minus book value of common equity plus market value of common equity divided by book value of assets. *R&D Intensity* is R&D expenditures divided by total assets. *SE Intensity* is selling, general, and administrative expenses divided by total assets. *Industry concentration* is the sales-based Herfindahl index of the firm's industry. *Supplier Industries R&D* (*Customer Industries R&D)* is the weighted average of the R&D intensities of all supplier (customer) industries. *Supplier Concentration* (*Customer Concentration*) is the weighted average of the Herfindahl indices of all supplier (customer) industries. *Supplier (Customer) Change in Sales* is a weighted average of the change in sales for supplier (customer) industries. *Compensation of Employees* is total compensation paid to employees divided by total output, constructed at the industry level. All variables are winsorized at the 1st and 99th percentiles.

	Mean	Median	Maximum	Minimum	Std Dev.
Dependent Variables					
Market Leverage	0.187	0.132	0.750	0.000	0.189
Book Leverage	0.266	0.204	1.882	0.000	0.294
Control variables					
Firm Size (log of total assets)	4.280	4.146	10.115	-1.139	2.188
Asset Collateral Value	0.294	0.235	0.917	0.001	0.226
Volatility	0.201	0.091	2.963	0.010	0.381
Non-debt Tax Shield	0.001	0.000	0.0168	0.000	0.002
Return on Assets	0.015	0.104	0.439	-2.284	0.344
Tobin's q	2.283	1.459	18.561	0.528	2.558
R&D Intensity	0.058	0.005	0.732	0.000	0.115
SE Intensity	0.332	0.250	2.374	0.000	0.354
Industry Concentration	0.223	0.179	0.865	0.043	0.163
Supplier Industries R&*D*	0.009	0.006	0.040	0.000	0.007
Supplier Concentration	0.090	0.085	0.250	0.029	0.039
Supplier Change in Sales	0.098	0.096	0.308	-0.050	0.066
Customer Industries R&D	0.017	0.009	0.081	0.000	0.017
Customer Concentration	0.167	0.167	0.321	0.068	0.058
Customer change in Sales	0.081	0.082	0.217	-0.030	0.047
Compensation of Employees	0.303	0.299	0.818	0.022	0.116

Table 3
Regression analysis: leverage and warranty

This table reports results of ordinary least squares regressions of market and book leverage on the warranty and control variables. *Market Leverage* is book value of long-term debt and debt in current liabilities divided by the sum of book value of debt and market value of common equity. *Book Leverage* is book value of long-term debt and debt in current liabilities divided by the book value of assets. *Beginning Warranty Reserves* is the warranty reserve balance at the beginning of the fiscal year normalized by total assets. *Period Warranty Reserves* is the warranty reserve for the year normalized by total assets. *Warranty Dummy* is a dummy variable that equals 1 if the firm reports warranty reserves at the beginning of the period, and zero otherwise. The control variables are described in Table 2. Lagged values of firm-specific control variables are used. The reported t-values in the OLS regressions reflect White's heteroskedasticity correction. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Market Leverage			Book Leverage		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Intercept	0.027	0.027	0.027	-0.035	-0.035	-0.035
	(0.67)	(0.66)	(0.66)	(-0.42)	(-0.42)	(-0.42)
Variables of Interest						
Beginning Warranty Reserves	-1.062**			-0.969		
	(-2.31)			(-1.03)		
Period Warranty Reserves		-1.082**			-1.700*	
		(-2.40)			(-1.85)	
Warranty Dummy			-0.025***			-0.040**
			(-3.14)			(-2.44)
Control variables						
Firm Size	0.004**	0.004***	0.004	0.003	0.004	0.004
	(2.54)	(2.61)	(2.79)	(1.11)	(1.21)	(1.36)
Asset Collateral Value	0.201***	0.200***	0.200***	0.282***	0.279***	0.279***
	(12.99)	(12.92)	(12.94)	(8.95)	(8.87)	(8.88)
Volatility	-0.003	-0.004	-0.004	0.058***	0.058***	0.058***
	(-0.45)	(-0.47)	(-0.47)	(3.71)	(3.69)	(3.69)
Non-debt Tax Shield	-3.008**	-2.962**	-2.919**	-7.355***	-7.256***	-7.188***
	(-2.43)	(-2.39)	(-2.35)	(-2.91)	(-2.88)	(-2.85)
Return on Assets	-0.049***	-0.050***	-0.049***	-0.164***	-0.165***	-0.164***
	(-5.58)	(-5.64)	(-5.58)	(-9.16)	(-9.20)	(-9.16)
Tobin's q	-0.005***	-0.005***	-0.005***	0.026***	0.026***	0.026***
	(-3.89)	(-3.83)	(-3.87)	(10.02)	(10.06)	(10.03)
R&D Intensity	-0.121***	-0.121***	-0.120***	-0.235***	-0.236***	-0.234***
	(-5.59)	(-5.63)	(-5.58)	(-5.35)	(-5.36)	(-5.33)
SE Intensity	-0.011	-0.012*	-0.012*	0.021	0.020	0.021
	(-1.63)	(-1.71)	(-1.66)	(1.45)	(1.42)	(1.46)
Industry Concentration	0.013	0.013	0.015	-0.017	-0.018	-0.016
	(0.76)	(0.76)	(0.85)	(-0.49)	(-0.52)	(-0.46)

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Supplier Industries R&*D*	-0.526*	-0.520*	-0.509*	-1.062*	-1.127*	-1.147*
	(-1.89)	(-1.88)	(-1.86)	(-1.89)	(-1.94)	(-1.96)
Supplier Concentration	0.148	0.153	0.141	0.305	0.306	0.289
	(1.29)	(1.33)	(1.23)	(1.30)	(1.31)	(1.23)
Supplier Change in Sales	-0.187	-0.188	-0.181	-0.106	-0.116	-0.103
	(-0.85)	(-0.85)	(-0.82)	(-0.24)	(-0.26)	(-0.23)
Customer Industries R&*D*	-0.330**	-0.318*	-0.307*	-0.945*	-0.941*	-0.924*
	(-2.04)	(-1.90)	(-1.89)	(-1.80)	(-1.80)	(-1.76)
Customer Concentration	0.185*	0.182*	0.177*	0.158*	0.163*	0.155*
	(1.90)	(1.87)	(1.82)	(1.80)	(1.82)	(1.78)
Customer Change in Sales	0.313	0.310	0.309	0.176	0.173	0.171
	(1.62)	(1.60)	(1.59)	(0.45)	(0.44)	(0.43)
Compensation of Employees	-0.007	-0.005	-0.005	0.018	0.016	0.017
	(-0.17)	(-0.15)	(-0.13)	(0.22)	(0.20)	(0.21)
Industry Dummy Variables	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	3,607	3,607	3,607	3,607	3,607	3,607
Adjusted R-squared	0.23	0.23	0.24	0.23	0.23	0.23

Table 4
Leverage and warranty: interaction effects

This table reports results of ordinary least squares regressions of market and book and leverage on the warranty and control variables. *Market Leverage* is book value of long-term debt and debt in current liabilities divided by the sum of book value of debt and market value of common equity. *Book Leverage* is book value of long-term debt and debt in current liabilities divided by the book value of assets. *Beginning Warranty Reserves* is the warranty reserve balance at the beginning of the fiscal year normalized by total assets. *Period Warranty Reserves* is the warranty reserve for the year normalized by total assets. Warranty Dummy is a dummy variable that equals 1 if the firm reports warranty reserves at the beginning of the period, and zero otherwise. The control variables are described in Table 2. Lagged values of firm-specific control variables are used. The reported t-values in the OLS regressions reflect White's heteroskedasticity correction. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Market Leverage		Book Leverage	
	Model 1	Model 2	Model 1	Model 2
Intercept	0.055	0.055	0.004	0.004
	(1.34)	(1.34)	(0.05)	(0.05)
Variables of Interest				
Warranty Industry Dummy	-0.036***	-0.035***	-0.050***	-0.049***
	(-3.98)	(-3.88)	(-2.70)	(-2.65)
Warranty Industry Dummy* Beginning Warranty Reserves		-0.980**		-0.855
		(-2.13)		(-0.91)
Control. variables				
Firm Size	0.003**	0.003**	0.003	0.003
	(2.30)	(2.42)	(0.97)	(1.03)
Asset Collateral Value	0.204***	0.203***	0.286***	0.284***
	(13.22)	(13.13)	(9.08)	(9.04)
Volatility	-0.003	-0.003	0.059***	0.059***
	(-0.33)	(-0.35)	(3.78)	(3.77)
Non-debt Tax Shield	-2.923**	-2.889**	-7.219****	-7.190***
	(-2.36)	(-2.33)	(-2.86)	(-2.85)
Return on Assets	-0.049***	-0.049***	-0.165***	-0.164***
	(-5.60)	(-5.57)	(-9.17)	(-9.16)
Tobin's q	-0.005***	-0.005***	0.026***	0.026***
	(-3.90)	(-3.98)	(10.01)	(9.98)
R&D Intensity	-0.112****	-0.111***	-0.223***	-0.222***
	(-5.17)	(-5.14)	(-5.05)	(-5.03)
SE Intensity	-0.012*	-0.012*	0.020	0.020
	(-1.74)	(-1.67)	(1.40)	(1.43)
Industry Concentration	-0.003	-0.004	-0.040	-0.041
	(-0.14)	(-0.23)	(-1.09)	(-1.13)

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Supplier Industries R&*D*	-0.429*	-0.355	-1.236*	-1.300*
	(-1.73)	(-1.60)	(-1.83)	(-1.88)
Supplier Concentration	0.097	0.091	0.230	0.225
	(0.84)	(0.79)	(0.98)	(0.95)
Supplier Change in Sales	-0.175	-0.185	-0.094	-0.103
	(-0.79)	(-0.84)	(-0.21)	(-0.23)
Customer Industries R&*D*	-0.331*	-0.352**	-0.958*	-0.976*
	(-1.99)	(-2.02)	(-1.83)	(-1.86)
Customer Concentration	0.184*	0.198**	0.164*	0.176*
	(1.90)	(2.04)	(1.83)	(1.89)
Customer Change in Sales	0.310	0.314	0.174	0.177
	(1.60)	(1.62)	(0.44)	(0.45)
Compensation of Employees	-0.014	-0.018	0.005	0.002
	(-0.36)	(-0.44)	(0.07)	(0.03)
Industry Dummy Variables	Yes	Yes	Yes	Yes
Number of Observations	3,607	3,607	3,607	3,607
Adjusted R-squared	0.24	0.24	0.23	0.23

Table 5

Leverage and warranty: different samples

This table reports results of ordinary least squares regressions of market and book and leverage on the warranty and control variables. *Market Leverage* is book value of long-term debt and debt in current liabilities divided by the sum of book value of debt and market value of common equity. *Book Leverage* is book value of long-term debt and debt in current liabilities divided by the book value of assets. *Beginning Warranty Reserves* is the warranty reserve balance at the beginning of the fiscal year normalized by total assets. *Period Warranty Reserves* is the warranty reserve for the year normalized by total assets. Warranty Dummy is a dummy variable that equals 1 if the firm reports warranty reserves at the beginning of the period, and zero otherwise. The control variables are described in Table 2. Lagged values of firm-specific control variables are used. The reported t-values in the OLS regressions reflect White's heteroskedasticity correction. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	2004 Sample		1984-2003 Sample	
	Market Leverage	Book Leverage	Market Leverage	Book Leverage
Intercept	0.092*	0.016	0.196***	0.162***
	(2.20)	(0.19)	(24.72)	(12.72)
Variables of Interest				
Warranty Industry Dummy	-0.023**	-0.047**	-0.020***	-0.032***
	(-2.47)	(-2.43)	(-9.12)	(-9.60)
Warranty Industry Dummy* Beginning Warranty Reserves	-1.028**	-1.080		
	(-2.20)	(-1.14)		
Control. variables				
Firm Size	0.004***	0.009***	0.004***	0.008***
	(2.45)	(3.07)	(12.01)	(13.52)
Asset Collateral Value	0.226***	0.331***	0.194***	0.290***
	(14.04)	(10.16)	(47.43)	(40.86)
Volatility	0.007	0.028*	-0.009***	0.070***
	(0.87)	(1.77)	(-4.22)	(11.33)
Non-debt Tax Shield	-1.248	-5.477**	-4.365***	-6.101***
	(-1.12)	(-2.42)	(-18.62)	(-17.70)
Return on Assets	-0.076***	-0.250***	-0.109***	-0.233***
	(-8.21)	(-13.41)	(-37.93)	(-29.34)
Tobin's q	-0.011***	0.016***	-0.015***	0.000
	(-10.03)	(7.02)	(-55.79)	(-0.47)
R&D Intensity	-0.110***	-0.293***	-0.226***	-0.354***
	(-4.49)	(-5.90)	(-33.50)	(-17.75)
SE Intensity	0.013*	0.104***	-0.033***	0.026***
	(1.70)	(6.61)	(-15.66)	(4.35)
Industry Concentration	0.011	0.000	-0.004	-0.006
	(0.65)	(0.00)	(-0.96)	(-0.84)

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Supplier Industries R&*D*	-0.438*	-1.145*	-0.804***	-1.552***
	(-1.79)	(-1.84)	(-6.21)	(-6.86)
Supplier Concentration	-0.317	-0.013	0.040*	0.034
	(-0.14)	(-0.06)	(1.71)	(0.88)
Supplier Change in Sales	-0.301	-0.479	-0.143***	-0.098**
	(-1.34)	(-1.05)	(-5.17)	(-2.31)
Customer Industries R&*D*	-0.440*	-1.289**	-0.378***	-0.391***
	(-1.70)	(-2.46)	(-7.03)	(-4.20)
Customer Concentration	0.244**	0.331*	0.112***	0.183***
	(2.47)	(1.66)	(5.48)	(5.79)
Customer Change in Sales	0.272	0.452	-0.085***	-0.012
	(1.42)	(1.17)	(-4.73)	(-0.42)
Compensation of Employees	-0.085**	-0.103	-0.030***	-0.037***
	(-2.06)	(-1.23)	(-3.29)	(-2.72)
Industry Dummy Variables	Yes	Yes	Yes	Yes
Year Dummy Variables	No	No	Yes	Yes
Number of Observations	3,205	3,205	76,160	76,160
Adjusted R-squared	0.28	0.27	0.25	0.17