The laws governing bankruptcies in the United States (often referred to as the United States “Bankruptcy Code”) are specified in Title 11 of the United States Code.\textsuperscript{1} The bankruptcy cases in my study have been filed under Chapter 11 – Reorganization (sections 1101 to 1195 of the United States Code).\textsuperscript{2} After a firm enters bankruptcy, it files a disclosure statement and a debt reorganization plan with the court. The disclosure statement contains sufficient information about the bankrupt firm’s business and finances to enable a creditor to make an informed vote on the debt reorganization plan. The debt reorganization plan includes a classification of claims and specifies how each class of claims will be paid back under the plan.

According to the United States Courts website,\textsuperscript{3} plans generally classify claims as secured credit (e.g., bank credit), priority unsecured credit (e.g., bankruptcy administrative expenses, employee wages), unsecured credit (e.g., supplier credit), and equity security interest (investors). Investors generally do not get paid once a firm files for bankruptcy, nor do they play a prominent role in the bankruptcy process. As the U.S. Securities and Exchange Commission

\begin{footnotes}
\item[1] \url{https://uscode.house.gov}
\item[2] Other chapters in the Bankruptcy Code include Chapter 7 – Liquidation, Chapter 9 – Adjustment of debts of a municipality, Chapter 12 – Adjustment of debts of a family farmer or fisherman with regular annual income, Chapter 13 – Adjustment of debts of an individual with regular income, and Chapter 15 – Ancillary and other cross-border cases.
\item[3] \url{https://www.uscourts.gov/services-forms/bankruptcy/bankruptcy-basics/chapter-11-bankruptcy-basics}
\end{footnotes}
notes. “In most instances, the company’s plan of reorganization will cancel the existing equity
shares.”

Creditors who will receive less than the full value owed to them, or whose payment terms
are modified, under the debt reorganization plan are entitled to vote on the plan. An entire class
of claims is deemed to accept a plan if the plan is accepted by creditors who hold at least two-
thirds in amount and more than one-half in number of the claims in the class. Creditors who will
receive the full value owed to them under the original payment terms are deemed to have
accepted the plan.

After the votes are tallied, the bankruptcy court determines whether to approve the plan.
The court considers whether the plan is feasible, is compliant with the Bankruptcy Code, is not
likely to be followed by liquidation, and is not likely to need further debt reorganization.
Furthermore, the plan needs to pay creditors in order of their legal priority (e.g, those with
collateral are paid before unsecured creditors) and the expected value received by creditors under
the plan must be at least as large as the expected value that would be received if the bankrupt
firm’s assets were liquidated. If the plan meets these criteria and all classes have accepted the
plan, the bankruptcy court will approve the plan and the bankrupt firm will emerge from
bankruptcy. Otherwise, the bankruptcy court generally orders a liquidation sale of the bankrupt
firm’s assets. While the law (section 1129[b] of the United States Code) allows the bankruptcy
court to approve the debt reorganization plan even if one or more classes do not accept the plan
(as long as the plan does not “unfairly discriminate” and is “fair and equitable”), this is
uncommon in the cases of large, public firms (LoPucki and Whitford 1993).

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4 https://www.sec.gov/reportspubs/investor-publications/investorpubsbankrupthtm.html
Extant research has noted that banks generally require collateral whereas suppliers do not (e.g., Evans and Koch 2007) and has developed theories for why this is the case (e.g., Petersen and Rajan 1997). Evidence of this is provided in empirical research on bank loans, which has shown that the large majority of business loans in their data sets are secured with collateral (Bradley and Roberts 2015; Chava and Roberts 2008). However, research on supplier trade credit contracts has not presented evidence on whether collateral was required by suppliers, perhaps because no suppliers in their data set required collateral.

Therefore, I collected data from two sources to provide some evidence for my contention, as well as the contention in extant trade credit research, that suppliers generally do not require collateral. First, I searched for suppliers that mentioned “trade credit” and “collateral” in their annual reports. I chose a random sample of ten suppliers and captured their relevant statements in the first table below. I found that each of these suppliers explicitly stated that they do not generally require collateral from their customers. Second, I chose a random sample of ten bankrupt firms from my data set and requested their court documents from the relevant bankruptcy court. Each firm had filed a petition when they filed for bankruptcy that listed their largest unsecured creditors (i.e., creditors that did not have collateral). I captured the number of suppliers and banks that each bankrupt firm listed in their petition (summarized in the second table below). I found that their lists of largest unsecured creditors are predominantly composed of suppliers and not banks, which provides some additional evidence that suppliers generally do not require collateral whereas banks do.
## STATEMENTS REGARDING COLLATERAL FROM SUPPLIERS’ ANNUAL FINANCIAL REPORTS (FORM 10-K)

| Supplier (Fiscal Year) | Statement |
|------------------------|-----------|
| American Tire Distributors (2013) | “The Company performs ongoing credit evaluations of its customers’ financial condition and does not normally require collateral…” |
| Beacon Roofing Supply (2015) | “We perform periodic credit evaluations of our customers and typically do not require collateral…” |
| Emrise Corporation (2014) | “The Company extends credit to its customers based upon an evaluation of the customer’s financial condition and credit history and generally does not require collateral.” |
| Fairmount Santrol Holdings (2018) | “Credit is extended based on evaluation of a customer’s financial condition and, generally, collateral is not required.” |
| Handy & Harman Ltd. (2013) | “The Company extends credit to customers based on its evaluation of the customer's financial condition. The Company does not require that any collateral be provided by its customers.” |
| Mediware (2014) | “The Company extends payment terms to customers who meet pre-established credit requirements. Generally, the Company does not require collateral when trade credit is granted to customers.” |
| Micron Technology (2018) | “We perform ongoing credit evaluations of customers worldwide and generally do not require collateral from our customers.” |
| Norcraft Companies (2013) | “We generally do not require collateral from our customers, but do maintain allowances for the estimated uncollectibility of accounts receivable based on historical experience and specifically identified at-risk accounts.” |
| NOW Inc. (2019) | “We perform ongoing credit evaluations of our customers and do not generally require collateral in support of our trade receivables.” |
| Trio-Tech International (2016) | “We generally do not require collateral from customers.” |
NUMBER OF UNSECURED CREDITORS THAT THE BANKRUPT FIRM LISTED AS HAVING THE LARGEST AMOUNT OF DEBT OWED TO THEM

| Bankrupt Firm                        | Business Description | Suppliers with Trade Debt Owed to Them | Banks with Loan Debt Owed to Them |
|--------------------------------------|----------------------|---------------------------------------|-----------------------------------|
| Circuit City                         | Electronics retailer | 48                                    | 0                                 |
| Fedders                              | Air treatment products | 21                                    | 1                                 |
| Kona Grill                           | Restaurants          | 26                                    | 0                                 |
| MediCor                              | Plastic surgery products | 17                                   | 2                                 |
| National Steel Corporation           | Steel producer       | 45                                    | 1                                 |
| Oasys Mobile                         | Mobile phone software | 19                                    | 0                                 |
| Pierre Foods                         | Processed food manufacturer | 28                                   | 0                                 |
| Quiksilver                           | Apparel manufacturer | 21                                    | 1                                 |
| The Bon-Ton Stores                   | Furniture store      | 39                                    | 0                                 |
| Wellman                              | Resin manufacturer   | 30                                    | 0                                 |
| Wickes                               | Building materials supplier | 15                                   | 0                                 |
| Study                        | Predictors | Effect on Bankruptcy Survival |
|------------------------------|------------|--------------------------------|
|                             | Leverage   | Liquidity | Profit | Size | Industry Effects | Advertising | R&D | Significantly Positive | Significantly Negative | Not Significant |
| Campbell (1996)             | ✓          | ✓         | ✓      | ✓    | ✓                |             |     | profit, size            |                           |                |
| Casey, McGee, and Stickney  | ✓          | ✓         |        |      |                   |             |     | profit, size            |                           |                |
| Casey, McGee, and Stickney  | ✓          | ✓         |        |      |                   |             |     | profit, size            |                           |                |
| Dahiya et al. (2003)        | ✓          | ✓         | ✓      | ✓    | ✓                |             |     | size                    | liquidity                | leverage |
| Denis and Rodgers (2007)    | ✓          | ✓         | ✓      | ✓    | ✓                |             |     | leverage                | profit, size             |                |
| LoPucki (1983)              | ✓          | ✓         |        |      |                   |             |     | size                    |                           |                |
| LoPucki and Doherty (2015)  | ✓          | ✓         | ✓      | ✓    | ✓                |             |     | leverage, profit, size  |                           |                |
| Moulton and Thomas (1993)   | ✓          | ✓         |        |      |                   |             |     | profit, size             |                           |                |
| Current study               | ✓          | ✓         | ✓      | ✓    | ✓                | ✓           | ✓   | leverage, size          | liquidity                | profit  |
BANKRUPTCY DURATION

- < 6 months
- 6 - 12 months
- 1 - 2 years
- 2 - 3 years
- 3 - 4 years
- 4 - 6 years
- 6 - 8 years
- > 8 years
DATA SAMPLE

I obtain bankruptcy data from New Generation Research’s BankruptcyData database. There are 2,166 cases of public firms that filed under Chapter 11 of the U.S. Bankruptcy Code from January 1, 1996 to November 8, 2019. I matched the firms in this database with the firms in Compustat. Compustat includes firms that file a 10-K report with the Securities and Exchange Commission and that are in at least one of the following categories: (1) has an equity security that is included in the S&P 500, S&P 400, S&P 600, S&P/TSX Composite, or Russell 3000 indices; (2) has an equity security that is actively traded on the NYSE, AMEX, NASDAQ, TSX, or NYSE/Arca exchanges; (3) has a high-profile, red-herring IPO or Pro-Forma filing; or (4) is requested by Compustat clients and has active market activity as evidenced by prices, turnover, or timely disclosure of business and financial information materials affecting listed issues.\(^5\) I eliminated the bankruptcy cases that did not have data in Compustat, which resulted in a data set of 1,929 bankruptcy cases. I further eliminated the cases that were missing any of the data needed to calculate the financial control variables, which resulted in a final data set of 1,672 bankruptcy cases.

The 1,672 bankruptcy cases in the final data set compare favorably with the 48 to 604 bankruptcy cases in extant bankruptcy survival research data sets (48 [LoPucki 1983], 72 [Moulton and Thomas 1993], 113 [Casey, McGee, and Stickney 1986], 120 [Denis and Rodgers 2007], 121 [Campbell 1996], 440 [Dahiya et al. 2003], and 604 [LoPucki and Doherty 2015]). Nevertheless, to control for bias that may result from selecting a sample of 1,672 cases from the full population of 2,166 bankruptcy cases, I follow recent marketing research on bankruptcies

\(^5\) Source: [https://wrds-www.wharton.upenn.edu/pages/support/data-overview/wrds-overview-compustat-north-america-global-and-bank/](https://wrds-www.wharton.upenn.edu/pages/support/data-overview/wrds-overview-compustat-north-america-global-and-bank/)
(Antia, Mani, and Wathne 2017) and use Heckman’s (1979) two-stage procedure. The first stage is a probit estimation on the selection equation. The inverse Mills ratio is calculated from this estimation and included as a control variable in the second stage (i.e., the logit and competing risks bankruptcy survival models).

I use the following first-stage selection equation:

$$\text{probit}(\text{Selection}_i) = \sum_{a} \psi_a \text{Asset}_{s_a} + \sum_{s} \Omega_s \text{Stock exchange}_s + \sum_{j} \Gamma_j \text{Industry}_j + \sum_{y} \theta_y \text{Year}_y,$$

where \(\text{Selection}_i\) is a binary variable that equals one if the bankruptcy case was selected to be in the data set sample and zero otherwise. The predictor variables include the assets of the bankrupt firm, the stock exchange on which the firm’s equity is traded, the bankrupt firm’s industry, and the year in which the firm filed for bankruptcy. Because Compustat data is not available for all the bankruptcy cases, I use the value of assets provided in the BankruptcyData database, which is a nominal variable with the 12 asset-size categories that are listed on the official petition form of the U.S. bankruptcy courts. The equation is estimated using data for the 2,166 bankruptcy cases in the full population.

References (that are not in the paper)

Heckman, James J. (1979), “Sample Selection Bias as a Specification Error,” *Econometrica*, 47 (1), 153–61.
### ADDITIONAL DATA INFORMATION

#### DESCRIPTIVE STATISTICS BY BANKRUPTCY OUTCOME

| Survived (n = 934) | Supplier influence | Leverage | Liquidity | Profit | Size | Supplier influence | Leverage | Liquidity | Profit | Size | Supplier influence | Leverage | Liquidity | Profit | Size |
|-------------------|--------------------|----------|-----------|--------|------|--------------------|----------|-----------|--------|------|--------------------|----------|-----------|--------|------|
| Mean              | .03                | .20      | .13       | .36    | −.44 | −1.17             | 4.44     | .06       | .39    | .02  | .13                | .04      | .26       |        |      |
| SD                | .10                | .67      | .14       | .44    | 1.20 | 6.03              | 2.17     | .14       | .92    | .07  | .53                | .07      | .39       |        |      |
| Min               | .00                | .00      | .00       | .00    | −7.61| −52.69            | −1.43    | .00       | .00    | .00  | .00                | .00      | .00       |        |      |
| Max               | .78                | 4.47     | .71       | 1.99   | .75  | .49               | 8.78     | .78       | 4.47  | .78  | 4.47               | .00      | .00       |        |      |

| Did Not Survive (n = 577) | Supplier influence | Leverage | Liquidity | Profit | Size | Supplier influence | Leverage | Liquidity | Profit | Size | Supplier influence | Leverage | Liquidity | Profit | Size |
|---------------------------|--------------------|----------|-----------|--------|------|--------------------|----------|-----------|--------|------|--------------------|----------|-----------|--------|------|
| Mean                      | .05                | .29      | .20       | .29    | −.19 | −1.86             | 3.53     | .06       | .28    | .04  | .31                | .02      | .03       |        |      |
| SD                        | .13                | .73      | .16       | .37    | .93  | 6.67              | 1.77     | .14       | .65    | .11  | .79                | .03      | .14       |        |      |
| Min                       | .00                | .00      | .00       | .00    | −7.61| −52.69            | −1.43    | .00       | .00    | .00  | .00                | .00      | .00       |        |      |
| Max                       | .78                | 4.47     | .71       | 1.99   | .75  | .49               | 8.78     | .78       | 3.93  | .78  | 4.47               | .00      | −.54      |        |      |

| Dismissed (n = 139) | Supplier influence | Leverage | Liquidity | Profit | Size | Supplier influence | Leverage | Liquidity | Profit | Size | Supplier influence | Leverage | Liquidity | Profit | Size |
|---------------------|--------------------|----------|-----------|--------|------|--------------------|----------|-----------|--------|------|--------------------|----------|-----------|--------|------|
| Mean                | .05                | .13      | .21       | .25    | −.48 | −2.76             | 2.73     | .07       | .19    | .03  | .08                | .04      | .11       |        |      |
| SD                  | .13                | .45      | .15       | .35    | 1.45 | 9.61              | 1.82     | .15       | .62    | .10  | .20                | .05      | .42       |        |      |
| Min                 | .00                | .00      | .00       | .00    | −7.61| −52.69            | −1.43    | .00       | .00    | .00  | .00                | .00      | .00       |        |      |
| Max                 | .78                | 4.47     | .71       | 1.90   | .75  | .49               | 8.78     | .78       | 4.47  | .78  | 1.05               | .00      | 3.42      |        |      |

| Ongoing (n = 22) | Supplier influence | Leverage | Liquidity | Profit | Size | Supplier influence | Leverage | Liquidity | Profit | Size | Supplier influence | Leverage | Liquidity | Profit | Size |
|------------------|--------------------|----------|-----------|--------|------|--------------------|----------|-----------|--------|------|--------------------|----------|-----------|--------|------|
| Mean             | .06                | .41      | .12       | .33    | −.52 | −3.33             | 4.51     | .18       | .15    | .01  | .54                | .17      | .39       |        |      |
| SD               | .17                | 1.14     | .12       | .50    | 1.18 | 11.43             | 2.25     | .28       | .39    | .02  | 1.36               | .26      | .97       |        |      |
| Min              | .00                | .00      | .02       | .00    | −5.47| −51.26            | −2.21    | .00       | .00    | .00  | .00                | .00      | .00       |        |      |
| Max              | .78                | 4.47     | .41       | 1.86   | .28  | .49               | 8.78     | .78       | 1.02  | .05  | 4.47               | .73      | −3.45     |        |      |
## BANKRUPTCIES BY YEAR

| Year | Number of Bankruptcies | Average Value of Assets in Bankruptcy (1980 million dollars) |
|------|------------------------|------------------------------------------------------------|
| 1996 | 53                     | 113.41                                                     |
| 1997 | 54                     | 103.78                                                     |
| 1998 | 75                     | 83.52                                                      |
| 1999 | 102                    | 203.60                                                     |
| 2000 | 132                    | 244.77                                                     |
| 2001 | 202                    | 340.36                                                     |
| 2002 | 159                    | 449.76                                                     |
| 2003 | 115                    | 231.22                                                     |
| 2004 | 67                     | 135.98                                                     |
| 2005 | 58                     | 569.94                                                     |
| 2006 | 39                     | 203.81                                                     |
| 2007 | 41                     | 54.87                                                      |
| 2008 | 67                     | 198.31                                                     |
| 2009 | 110                    | 489.24                                                     |
| 2010 | 38                     | 148.10                                                     |
| 2011 | 42                     | 526.43                                                     |
| 2012 | 34                     | 568.40                                                     |
| 2013 | 36                     | 198.52                                                     |
| 2014 | 29                     | 503.73                                                     |
| 2015 | 51                     | 440.25                                                     |
| 2016 | 63                     | 596.43                                                     |
| 2017 | 43                     | 478.48                                                     |
| 2018 | 31                     | 417.83                                                     |
| 2019 | 31                     | 656.42                                                     |
### BANKRUPTCIES BY INDUSTRY

| Industry                                      | Number of Bankruptcies |
|-----------------------------------------------|------------------------|
| Agriculture, Forestry and Fishing             | 3                      |
| Apparel and Textiles                          | 63                     |
| Automotive                                    | 47                     |
| Aviation                                      | 38                     |
| Banking and Finance                           | 12                     |
| Chemicals and Allied Products                 | 99                     |
| Computers and Software                        | 159                    |
| Construction and Supplies                     | 37                     |
| Education                                     | 6                      |
| Electronics                                   | 62                     |
| Energy                                        | 20                     |
| Entertainment                                 | 44                     |
| Food, Beverage and Tobacco                    | 35                     |
| Healthcare and Medical                        | 104                    |
| Hotel and Gaming                              | 21                     |
| Insurance                                     | 7                      |
| Manufacturing (Misc.)                         | 132                    |
| Mining                                        | 34                     |
| Oil and Gas                                   | 138                    |
| Other                                         | 34                     |
| Packaging and Paper                           | 22                     |
| Publishing and Printing                       | 41                     |
| Real Estate                                   | 4                      |
| Restaurant                                    | 40                     |
| Retail                                        | 154                    |
| Steel and Metals                              | 56                     |
| Supermarket                                   | 21                     |
| Telecommunications                            | 179                    |
| Transportation                               | 41                     |
| Waste Management / Environmental              | 19                     |
I consider random forests for bankruptcy survival prediction because random forests have been shown to perform well in predicting outcomes (Barboza, Kimura, and Altman 2017; Breiman 2001). While random forests have not been directly applied to bankruptcy survival prediction, they have been shown to perform better than other techniques such as logistic regression, discriminant analysis, support vector machines, and neural networks in predicting the risk of entering bankruptcy (Barboza, Kimura, Altman 2017).

A random “forest” is a combination of decision “trees” (Breiman 2001). The random forests approach is a machine learning algorithm that creates multiple decision trees and then combines the output generated by each of the decision trees. Each decision tree partitions a data set into successively smaller groups and then fits a simple model for each subgroup. While a single decision tree may predict well on a training data set, it often overfits the data, which leads to poor prediction performance on other data. Therefore, machine learning algorithms combine the output from multiple decision trees to improve the out-of-sample predictive performance (often referred to as “bagging” [bootstrap aggregating] decision trees [Breiman 1996]).

Random forests seek to improve out-of-sample prediction performance by reducing the correlation between the decision trees. First, each decision tree uses different data. The algorithm grows each decision tree by training it on a subsample of the training data set that is obtained by bootstrapping (i.e., random sampling with replacement). Second, the variables that are considered vary from tree to tree. Each time a tree is partitioned, the variable that is used to split the tree into the two partitions is chosen from a random subset of all the predictor variables.
For bankruptcy survival prediction, I train the random forest algorithm on the estimation data set, which covers bankruptcy cases from 1996 to 2015. To tune the parameters of the algorithm, I first run multiple iterations of the algorithm using different numbers of decision trees. I find that the error rate lowers as the number of decision trees grows and stabilizes at approximately 150 decision trees. Using a similar procedure to tune the size of the random subset of predictor variables from which the partitioning variable is chosen, I find that a subset size of six predictor variables provides the lowest error rate for the estimation data set. I then use these parameter values to train the random forest algorithm on the estimation data set. Finally, to assess the out-of-sample bankruptcy survival performance of random forests, I use the random forests algorithm to predict bankruptcy survival in the validation data set, which covers bankruptcy cases from 2016 to 2019.

Further information on random forests is provided in Breiman’s (2001) detailed discussion, a review of machine learning methods in marketing appears in Dzyabura and Yoganarasimhan (2018), and an application of random forests in marketing is offered in Schwartz, Bradlow, and Fader (2014).

References (that are not in the paper)

Breiman, Leo (1996), “Bagging Predictors,” *Machine Learning*, 24 (2), 123–40.

Breiman, Leo (2001), “Random Forests,” *Machine Learning*, 45 (1), 5–32.

Dzyabura, Daria and Hema Yoganarasimhan (2018), “Machine Learning and Marketing,” in *Handbook of Marketing Analytics: Methods and Applications in Marketing Management, Public Policy, and Litigation Support*, Natalie Mizik and Dominique M. Hanssens, eds. Cheltenham, UK: Edward Elgar Publishing, 255–79.

Schwartz, Eric M., Eric T. Bradlow, and Peter S. Fader (2014), “Model Selection Using Database Characteristics: Developing a Classification Tree for Longitudinal Incidence Data,” *Marketing Science*, 33 (2), 188–205.
BANKRUPTCY REFILING

NUMBER OF FIRMS THAT REFILED FOR BANKRUPTCY AFTER EMERGING FROM BANKRUPTCY

Years Survived Before Refiling for Bankruptcy

<1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 >20