

The Duration of Bank Relationships

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Abstract

We analyze the duration of bank relationships using a unique panel data set of listed firms and their banks from the bank-dominated Norwegian market. We find that firms are more likely to leave a bank as the relationship matures. Small, profitable, and highly-leveraged firms maintain shorter bank relationships, as do firms with multiple bank relationships. These findings are robust to censoring, alternate specifications for the distribution of relationship duration, and other control variables relevant to the Norwegian market. Overall, our results cast doubt on theories suggesting that firms become locked into bank relationships.

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1. Introduction

Researchers argue that private information occupies a central place in bank-customer relationships, and that the extent of private information increases as a bank deals with any given customer over time. From the firm's perspective, strong bank relationships are generally considered valuable assets because they lower the cost and increase the availability of credit. For example, banks will be more willing to make unprofitable loans to customers during difficult financial times when they trust losses will be recouped over the course of a long relationship. Firms also gain when a good payment record guarantees future improvements in the conditions of their loan contracts, or as they acquire a valuable reputation as trustworthy borrowers.¹ These aspects of bank-firm relationships are particularly important in the bank-centered financial systems commonly found in continental Europe (including Scandinavia). At the same time, however, the bank's acquisition of private information over the course of a relationship could effectively "lock-in" customers and permit their banks to extract monopoly rents.²

The duration of bank-borrower relationships should reflect the net impact of these offsetting factors. If the value of a relationship tends to increase through time, or if firms become locked into specific banks, then the likelihood of terminating a relationship should decline through time. On the other hand, if relationships generally become less valuable over time and if switching costs are not prohibitively large, we should observe that terminations increase with time. Moreover, it seems likely that a relationship's value will depend on a firm's specific characteristics. Firms facing large information asymmetries with outside investors stand to benefit most from long-term bank relationships but are also particularly susceptible to holdup problems and high switching costs.

Event studies clearly indicate that bank relationships have value. In contrast to other kinds of external financing, bank loan announcements generate positive abnormal returns to the borrower's stock.³ Slovin, Sushka and Polonchek (1993) establish the value of bank-borrower relationships in another context, by showing that borrowers earned negative (positive) abnormal returns as Continental Illinois Bank's probability of failure rose (fell). Hoshi, Kashyap and Scharfstein (1991) provide indirect evidence about a bank relationship's value. They find that the investment patterns of bank-affiliated firms are less correlated with their cash flows, presumably because intra-*keiretsu* lending is more flexible than the arm's-length financing available to unaffiliated firms.

While these studies show that bank relationships can increase borrower value, they provide little insight into the sources of value for different types of firms. Petersen and Rajan (1994) and Berger and Udell (1995) demonstrate explicitly that firms in longer relationships receive more bank credit and pay lower interest rates on loan commitments. However, their data source (the 1988-89 National Survey of Small Business Finance) provides only limited information about the duration of relationships, and no information about when firms terminate relationships, and under what circumstances.

We utilize a unique data source to study the value of long-term bank relationships, emphasizing the willingness and ability of firms to terminate relationships. Listing regulations require firms on the Oslo Stock Exchange (OSE) to report annually the banks that they deal with on a regular basis. We track these relationships from 1979 to 1995, recording when firms start and end relationships, and when they switch from one bank to another. Norway provides a natural setting for studying the value of relationships because banks supply 90% of all commercial debt.⁴ We combine each relationship history with financial information about the firm and its banks, then use hazard function estimators to infer the determinants of relationship

duration. The analysis is complicated by the fact that the data source does not include the complete history of every relationship. Relationships started prior to 1979 or before a firm lists on the OSE are left censored, while relationships that continue beyond 1995 or after a firm delists are right censored. We analyze the sensitivity of our results to corrections for left and right censoring. Because of these corrections, our paper also provides an example of the value of censored-robust estimators.

We find that the probability of ending a bank relationship increases in duration, suggesting that the value of relationships decline over time. Moreover, small, young, and highly-leveraged firms maintain the shortest relationships. In other words, those borrowers commonly thought to be most dependent on bank financing terminate their relationships quickly. These firms do not appear to be forced out by their banks, nor do they leave because of lending capacity constraints, mergers, or bank distress. Taken together, our results suggest that firms do not become locked into bank relationships. Moreover, we show that bank competition has two opposing effects on relationship duration. Multiple-bank firms terminate relationships earlier than single-bank firms. But the multiple-bank firms tend to turn over newer relationships and keep one long-term relationship. Therefore, long-term relationships appear valuable to firms that are unlikely to face credible holdup threats from one monopolistic bank.⁵

Despite the data's richness, we do not have direct information on why relationships begin or end, nor can we observe information specific to each relationship, such as the credit conditions of the loan contract or the non-lending services provided by the bank. Instead, we must base our inferences on what is revealed through the observed terminations. This limits our overall conclusions. For instance, we cannot measure the gains or losses to customer welfare over the course of the relationships. Nevertheless, we believe that our data set,

combined with our methodology, provides interesting and informative results about the nature of bank relationships.

We organize the rest of the paper as follows. Section 2 describes the bank relationship data and details the construction of the firm-specific variables. Section 3 introduces the econometric methodology used in our analysis. Section 4 contains the empirical results, including tests of robustness. Section 5 contains a short discussion, and concludes the paper.

2. Data

This section describes the relationship data, presents the distribution of the observed duration of bank relationships, and describes the firm-specific variables used in the cross-sectional regressions. We obtain annual data on bank relationships of firms listed on the Oslo Stock Exchange (OSE) for the years 1979 to 1995 from *Kierulf's Handbook*, an annual publication of the OSE. The handbook contains financial and accounting information on all listed firms, as well as other firm-specific information provided to the stock exchange, including firm age and ownership structure. To comply with listing requirements, each firm must report its primary bank relationships, up to a maximum of four. During an average year, 74% of the firms maintain only one bank relationship, while another 17% maintain two relationships, 7% maintain three relationships, and only 2% maintain four or more relationships. We identify a firm as ending a bank relationship when it drops a bank from its list of primary banks or replaces the bank with a new one. We define the duration of a relationship to be the number of consecutive years a firm lists in *Kierulf's Handbook* before it is dropped.

Kierulf's Handbook provides no information about primary bank relationships beyond the identity of each bank. To better understand the nature of these relationships, we collected additional information through phone interviews with 16 randomly chosen firms. Through

these interviews, we confirmed the accuracy of the information in the handbook, inquired about the services provided by primary banks, and sought information about other bank relationships held by firms but not listed as primary bank relationships. All firms interviewed use their primary banks for both short-term and long-term borrowing. All of the firms, except for one, also obtain deposit, cash management, and foreign exchange services from their primary bank, and seven of these firms reported purchasing additional derivatives services from their primary bank. We discovered that 11 firms maintain at least one relationship with a bank that is omitted from the list of primary relationships. These firms claim to purchase fewer services from such secondary banks. For ten of the firms, secondary banks provide services related to foreign exchange. In addition, the secondary banks provide lending services to six firms and cash management services to one firm.

Table 1 presents an annual overview of the number of firms and turnover in bank relationships in our sample. We exclude banks from the firm sample because they do not report relationships with other banks. The sample consists of an average of 111 firms per year, representing 95% of all non-bank firms listed on the Oslo Stock Exchange. On average, six firms terminate a relationship every year, while 10 firms start a new one. Relationship turnover activity increases during the years 1986 to 1988, a period marked both by substantial financial deregulation and the beginning of a banking crisis in Norway. Deregulation of the banking sector began in 1984 with the removal of interest rate ceilings and government-mandated lending controls. Subsequently, both bank loan activity and loan losses increased substantially. Kaen and Michalsen (1997) report that the kroner volume of loans increased by 37.5% in 1985 and 23.4% in 1986, while commercial loan losses, as a percentage of commercial bank loans, quadrupled between 1984 and 1987. Concurrent with the increase in the turnover in bank relationships is an increase in the number of firms delisting from the OSE. Many of the delistings during the crisis period are banks, which either merge with

another bank or become privately held institutions after being purchased by the Norwegian government.

In the analysis to follow, we define a sample observation as one relationship between a firm and a bank, or a firm-bank relationship. The number of firm-bank observations equals the total number of independent firms in the sample times the number of relationships maintained by each firm over the sample period. Our data set contains 419 such observations. Table 2 categorizes the firm-bank observations by their observed duration, and gives a sense for the impact of censoring. Column (1) lists the distribution of all bank relationships sorted by the number of years each relationship remains in our sample. Column (2) presents the distribution including only those relationships that begin before 1979. Column (3) excludes the pre-1979 relationships. From column (1), it appears as if only a small proportion of relationships (6.2%) continue beyond the 16-year cutoff of the sample. The median duration of an observed relationship is four years, 40% of the observed relationships do not extend beyond two years, and fully 86% of the firms appear to end their bank relationship by the tenth year. Thus, a first-pass look at the duration data suggests that bank relationships are short-lived and that the end-of-sample cutoff affects only a small proportion of the observations. However, relationships begun before 1979 appear to last relatively longer. Out of these firms, 17.8% continue their bank relationship beyond 1995 and the median relationship lasts six years. Similarly, column (3) indicates that excluding the pre-1979 relationships shifts the weight of the observed durations back to the left. We return to the impact of censoring later.

The firms in our sample maintain relationships with 55 different banks. Of these banks, 14 are international banks, 24 are Norwegian commercial banks, and the remaining 17 are Norwegian savings banks. However, the relationships are concentrated across only a handful of these banks. In an average year, 75% of the firms maintain a relationship with at

least one of Norway's two largest commercial banks, Kreditkassen or Den norske Bank. Prior to 1990, there were three major banks, but Bergen Bank and Den norske Credit merged to form Den norske Bank in 1990. Nearly 40% (21) of the banks merged with another bank between 1979 and 1995. Unless otherwise indicated in *Kierulf's Handbook*, we assume customers of merged banks continue with the combined entity, so that no break in the relationship occurs. We explore the sensitivity of our results to market concentration and bank mergers in Section 4.4.

2.1 Firm-specific variables

We identify seven firm-specific characteristics that serve as indicators for a firm's dependence on a bank relationship. Fama (1985), Diamond (1984, 1991), and Rajan (1992) maintain that small and young firms are more likely to suffer from information problems and, therefore, find bank financing useful. $\ln Sales$, defined to be the natural logarithm of year-end sales deflated by the Norwegian consumer price index (CPI), serves as a proxy for firm size and Age , defined to be the number of years since a firm's founding date, measures firm age. Titman and Wessels (1988) show that highly profitable firms are less dependent on external debt financing, including bank financing. We construct $Profitability$ using the ratio of operating income (sales minus cost of goods sold) to the book value of assets. Holding the level of internal financing constant, firms with more growth opportunities should have greater external financing needs, and therefore be more dependent on bank financing. $Tobin's Q$ is defined as the year-end market value of equity plus book value of debt, divided by the book value of assets. Because much of the value of high-growth firms comes in the form of unrealized investment opportunities, $Tobin's Q$ also serves as a proxy for the level of information asymmetry. Because banks supply such a high proportion of commercial credit in Norway, highly leveraged firms should be more dependent on banks than firms with lower debt levels.

Leverage is the book value of debt, divided by the sum of the year-end market value of equity and book value of debt. Firms with multiple bank relationships have more than one potential source of inside bank financing and should therefore face lower switching costs and be less susceptible to holdup threats by any one bank.⁶ The dummy variable *Multiple relationships* equals one when a firm maintains more than one bank relationship, and zero otherwise. Finally, implicit in the moral hazard models of Boot and Thakor (1994), Rajan (1992), and von Thadden (1995) is the idea that a bank's ability to reduce agency-related problems may be unnecessary if the firm already maintains an effective monitoring mechanism. *Ownership concentration*, defined to be the proportion of equity owned by a firm's ten largest shareholders, proxies for an alternative monitoring source.

With the exception of *Age*, we measure each variable using the values taken from the year prior to either the end of the relationship or the date of right censoring, whichever comes earlier. For the purpose of correctly specifying our regression model, we also define a variable, *Age at start*, to be the time elapsed between the firm's founding date and either the start of the relationship, or the date of left censoring, whichever comes last. This definition avoids the spurious correlation that firms become older as duration lengthens. Matching the firm-level and bank relationship data reduces the number of observations from 419 to either 383 or 270, depending on whether we include ownership concentration in the analysis. The initial loss of 7.8 % of the observations results primarily from missing accounting data. *Ownership concentration* further reduces the sample because, for a large part of our sample period, disclosure of ownership information was voluntary and not consistently available.

Table 3 contains summary statistics on the firm-characteristic variables. The average firm in our sample generates sales of 741 million Norwegian Kroner (NOK), or roughly \$100 million, making it larger than the family-owned firms studied by Petersen and Rajan (1994)

and Berger and Udell (1995), but smaller than the typical publicly-traded U.S. company.⁷ Moreover, the firm is 53 years old, earns operating income equal to 1.7% of its assets, and has a market-to-book ratio of 1.4. The average firm also finances 55% of its assets with debt. Although not shown in the table, this is split almost evenly between short-term and long-term liabilities.⁸ Firms maintaining multiple bank relationships generate 44% of the firm-bank observations. There are two reasons for the high incidence of multiple-bank relationships. First, because we count each firm-bank relationship as one observation, a firm with multiple relationships enters as two or more observations. Second, firms with multiple-bank relationships are more likely to end a bank relationship, generating greater turnover in observations. The ten largest shareholders own 69% of the equity of the companies reporting ownership information.

3. Econometric Specification

This section develops the econometric methodology employed in analyzing the duration of bank relationships in our sample. We begin by introducing terminology common to duration analysis and then describe the hazard function estimators. Let T represent the duration of time that passes before the occurrence of a certain random event. In the econometrics literature, the passage of time is often referred to as a spell, while the event itself is called a switch. A simple way to describe the behavior of a spell is through its survivor function, $S(t) = \Pr(T \geq t)$, which yields the probability that the spell T lasts at least to time t . The survivor function equals one minus the cumulative distribution function of T . The behavior of a spell can also be described through the use of the hazard function. The hazard function determines the probability that a switch will occur, conditional on the spell surviving through time t , and is defined by

$$\lambda(t) = \lim_{\Delta t \rightarrow 0} \frac{P(t \leq T < t + \Delta t | T \geq t)}{\Delta t} = \frac{-d \log S(t)}{dt} = \frac{f(t)}{S(t)}, \quad (1)$$

where $f(t)$ is the density function associated with the distribution of spells. Neither the survivor function nor the hazard function provides additional information that could not be derived directly from $f(t)$. Instead these functions present economically interesting ways of examining the distribution of spells. The hazard function does provide a suitable method for summarizing the relationship between spell length and the likelihood of switching. When $\lambda(t)$ is increasing in t , the hazard function is said to exhibit positive duration dependence, because the probability of ending the spell increases as the spell lengthens. Similarly, negative duration dependence occurs when $\lambda(t)$ is decreasing in t , and constant duration dependence indicates the lack of a relation between $\lambda(t)$ and t .

When estimating hazard functions, it is econometrically convenient to assume a proportional hazard specification, such that

$$\lambda(t, X(t), \beta) = \lim_{\Delta t \rightarrow 0} \frac{P(t \leq T < t + \Delta t | T \geq t, X(t), \beta)}{\Delta t} = \lambda_0(t) \exp(\beta' X_t), \quad (2)$$

where X_t is a set of observable, possibly time-varying explanatory variables, β is a vector of unknown parameters associated with the explanatory variables, $\lambda_0(t)$ is the baseline hazard function and $\exp(\beta' X_t)$ is chosen because it is non-negative and yields an appealing interpretation for the coefficients, β . The logarithm of $\lambda_0(t, X(t), \beta)$ is linear in X_t . Therefore, β reflects the partial impact of each variable in X on the log of the estimated hazard rate.

The baseline hazard $\lambda_0(t)$ determines the shape of the hazard function with respect to time. Eq. (2) can be estimated without specifying a functional form for the baseline hazard. The Cox (1972) partial likelihood model bases estimation of β on the ordering of the duration

spells. Because it specifies no shape for $\lambda_0(t)$, we refer to the Cox (1972) partial likelihood model as “semi-parametric”. Two commonly used parametric specifications for the baseline hazard are the Weibull and the exponential distributions. The Weibull specification assumes $\lambda_0(t) = \lambda\alpha t^{\alpha-1}$, and allows for duration dependence. When $\alpha > 1$ ($\alpha < 1$), the distribution exhibits positive (negative) duration dependence. The exponential distribution, which exhibits constant duration dependence, is nested within the Weibull as the case $\alpha = 1$. Using maximum likelihood methods, we estimate hazard functions using the Cox (1972) partial likelihood model, Weibull specification, and exponential specification.

We assume that the explanatory variables in our model can vary through time. To obtain interpretable estimates from the proportional hazard models, we require that our variables be either “defined” or “ancillary” with respect to the duration of a spell (see Kalbfleisch and Prentice, 1980). A defined variable follows a deterministic path. Age is an example of a defined variable because its path is set in advance of the bank relationship, and varies deterministically with relationship duration. An ancillary variable has a stochastic path, but the path cannot be influenced by the duration of the spell. For the reported results, we also assume that the conditional likelihood of ending a spell depend only on the value of an ancillary variable at time t , and not on past or future realizations of the variable. We later discuss the sensitivity of our results to these assumptions.

3.1 Censoring

Censoring affects a total of 76% of the original 419 observations. Not knowing when a relationship starts, or when it ends, or both, means we are unable to observe the true duration of the relationship for these observations. With no adjustment to account for censoring, maximum likelihood estimation of the proportional hazard models produces biased and inconsistent estimates of model parameters.

Accounting for right-censored observations can be accomplished by expressing the log-likelihood function as a weighted average of the sample density of completed duration spells and the survivor function of uncompleted spells (see Kiefer, 1988). Controlling for left censoring is less straightforward and often ignored in economic duration analysis. However, Heckman and Singer (1984) argue that the biases induced by left censoring can be as severe as those created by right censoring. To analyze the sensitivity of our results to left censoring, we incorporate an estimation strategy shown by Heckman and Singer (1984) to yield consistent, albeit inefficient, estimates of duration under left censoring.

4. Empirical Results and Robustness Tests

Before turning to cross-sectional estimates of the hazard function, we first examine some simple plots of the distribution of relationship spells. Figure 1 shows estimates of the survivor function, $S(t) = \Pr(T \geq t)$. The plots illustrate the impact of right censoring on estimates of relationship duration. The lighter solid line in Figure 1 traces the survivor function without adjusting for right censoring. The darker solid line includes the adjustment. To construct the survivor function, we use the Kaplan and Meier (1958) estimator, $\hat{S}(k) = \prod_{i=0}^k (1 - \hat{\lambda}(i))$, where $\hat{S}(k)$ is the estimated probability that a relationship survives beyond year k . Without a correction for right censoring, $\hat{\lambda}(i)$ is the number of firms leaving the data set during year i , divided by the total number of firms remaining in the data set at the beginning of year i . With a correction for censoring, $\hat{\lambda}(i)$ is the number of firms observed to terminate a relationship in year i , divided by the number of surviving firms.

The survivor function decreases quickly when the censoring adjustment is omitted. The estimated likelihood of a relationship surviving beyond the beginning of its fifth is only 48% (see Table 2), while the estimated chance of surviving past the beginning of the 16th year

is 6.2%. In contrast, when the adjustment for right censoring is added to the estimation equation, the likelihood of surviving past the beginning of year five years increases to 83%, and the likelihood of surviving beyond the 16th year increases to 54%. Without an adjustment for right censoring, relationships appear to end relatively quickly, biasing inferences on the durability of relationships.

Figure 1 also depicts a test for duration dependence. The dashed line with asterisks plots the survivor function adjusted to account for right censoring, assuming constant duration dependence. The two lighter dashed lines define a confidence interval that incorporates approximately 95% of the expected values surrounding the estimate restricted to constant duration dependence. Because the thick solid line lies within the 95% confidence interval bands, the non-parametric estimates cannot reject the hypothesis of constant duration dependence. In other words, the plots suggest that the likelihood of ending a relationship is no greater for long-term relationships than for short-term relationships.

4.1 Estimates using the partial likelihood model

Starting in Table 4, we estimate the impact of the firm-specific characteristics on the conditional probability of ending a bank relationship using the proportional hazard specification in Eq. (2) and the semi-parametric Cox (1972) partial likelihood model. There are two ways to interpret the signs on the slope estimates represented by β in Eq. (2). First, each estimate represents the partial impact of a firm-specific characteristic on the probability of ending a relationship, holding duration constant. Second, because duration is inversely related to the hazard rate, a positive (negative) coefficient estimate implies a shorter (longer) duration.

We present four different models in Table 4. The first model uses all of the firm-specific variables, but does not correct for right censoring. It shows that firms maintain

shorter relationships when they are smaller, younger, have more growth opportunities, and are highly leveraged. Model 2 includes the adjustment for right-censored observations. After applying the adjustment, the coefficients on *Ln Sales* and *Leverage* nearly double in value, the estimate associated with *Multiple relationships* jumps ten-fold and becomes significant at the 5% level, and *Age at start* and *Tobin's Q* are no longer statistically significant. Moreover, the difference in the log-likelihood values between Model 1 and Model 2 rejects the hypothesis that right censoring has no impact on the coefficient estimates at the 1% level. Models 3 and 4 adjust for right censoring but drop *Ownership concentration*, allowing us to increase the sample size by 42%. Excluding *Ownership concentration* and including the additional observations does not alter the magnitude of the relations implied by Model 2. However, *Profitability* becomes statistically significant at a 5% level in Model 4. The positive estimate implies that profitable firms end bank relationships earlier, consistent with the argument that profitable firms are less dependent on bank financing and therefore less susceptible to holdup costs. Moreover, because credit denials and forced terminations by banks are likely reserved for unprofitable firms, the significantly positive estimate produced in Model 4 suggests that banks do not initiate the terminations that we observe.

The corrected estimates suggest that the conditional likelihood of ending a bank relationship decreases in firm size, and increases in firm leverage, profitability, and when firms maintain multiple-bank relationships. In other words, small, highly-leveraged, and profitable firms, and firms with more than one bank relationship tend to maintain shorter relationships. This basic pattern, with some alterations, will persist throughout the rest of this analysis.

4.2 Results using restricted baseline hazard models

To check the sensitivity of the regression results to restrictions on the baseline hazard rate, Table 5 reports the results from the exponential and Weibull specifications of the baseline hazard function presented in Eq. (2). For each specification, we report the results of three regressions. The first regression includes *Ownership concentration*, the second regression drops *Ownership concentration* but uses the same 270 observations as in the first regression, and the third regression drops *Ownership concentration* and increases the sample size to 383. All of the regressions in Table 5 include an adjustment for right censoring.

The magnitude and significance of the coefficient estimates are similar to those in Table 4, indicating that they are not sensitive to the specification of the baseline hazard function. *Profitability* continues to be positive and statistically significant over all specifications. In addition, the negative coefficient estimate on *Age at start* is significant at the 10% level in Model 6.

The Weibull model estimates α to be significantly greater than one, implying that bank relationships exhibit positive duration dependence. This result contrasts with our unconditional estimates in Figure 1 that found no duration dependence. Heckman and Singer (1984) provide an explanation for these conflicting results. They argue that heterogeneity across observations biases non-parametric estimates in favor of negative duration dependence. By controlling for heterogeneity through the firm-specific characteristics we mitigate this bias and uncover positive duration dependence.⁹

The parametric models allow us to assign economic meaning to the censored-adjusted estimates in Table 5. For instance, estimates of the median duration of a bank relationship range between 15.8 years and 22.1 years in Table 5, compared with a median of four years based on the unadjusted observations in column (1) of Table 2.¹⁰ We can back out estimated

hazard rates to illustrate the magnitude of positive duration dependence. Model 6 implies that the likelihood of ending a relationship over the subsequent year after surviving one year is 1.7%, after two years 2.6%, after five years 3.9%, after ten years 5.0%, and after 20 years 6.5%.

We can also quantify the estimated impact of the explanatory variables on the expected duration of the relationship. Model 6 implies that the relationship of a single-bank firm lasts 7.7 years longer than a similar firm with multiple bank relationships. A 50% decrease in firm size from its median (to NOK 83 million) reduces the median fitted duration by 1.9 years, a 50% increase above the median value of *Leverage* (to 83%) reduces the duration by 6.6 years, and an increase in *Profitability* from its mean of 1.7% to its median of 4.7% reduces duration by 0.81 years. Taking these changes jointly, a sample firm characterized as small, highly leveraged, and profitable maintains a relationship for only 8.6 years, compared with 15.8 years for the average firm in the sample. By contrast a firm that is 50% larger than the median (NOK 249 million), carries 50% less debt than average (28%), and has a return on assets of 1.0% maintains a relationship for a median of 30.9 years.

4.3 Robustness Tests

Table 6 checks the robustness of the results in Tables 4 and 5. We analyze previously unexamined reasons for observing bank terminations, apply corrections for left censoring, and evaluate the assumed process governing the path of the explanatory variables. For all of the results, we report only the Weibull specification without *Ownership concentration*.

4.3.1 Other Explanations for Terminations

Norwegian bank regulations prohibit a bank from lending more than 5% of its equity capital to any one firm. In Model 1 of Table 6, we add the variable *Bank size* as a measure of a firm's

debt level relative to the loan capacity of its banks. Our aim is to determine whether firms terminate relationships because they outgrow the lending capacity of their banks. To construct *Bank size*, we first obtain the book value of equity for Norway's 15 largest banks. For all other banks, we assume the book value of equity is zero. This assumption biases downward the true lending capacity of the banks. We then define *Bank Size* to be $\ln[1+(\text{book value of firm debt})] - \ln[1+(\text{book value of equity of the firm's banks})]$, where if the firm maintains more than one relationship, the second term includes the sum of the book value of equity across the banks. The estimate for this variable (appearing in the column labeled *Added variable*) is statistically insignificant, indicating that bank lending limits are not binding at the time a firm terminates a relationship.

For the second model presented in Table 6, we identify all relationships before 1990 involving Bergen Bank, Den norske Credit, or Kreditkassen, and after 1990 involving either Den norske Bank or Kreditkassen, with the dummy variable *Large bank*. The *Large bank* estimate in the *Added variable* column is statistically significant. Holding the other variables constant at their mean values, the estimate implies that relationships with Den norske Bank and Kreditkassen last a median of 18 years, while relationships with other banks last a median of 12 years. Despite the significance of *Large bank*, all of the original regression results remain intact. The impact of *Large bank* could suggest that firms with relatively large or complex financial demands have little choice but to rely on one of Norway's two largest banks. That is, large firms become locked into large banks because no other large bank alternatives exist. Consistent with this conjecture, we find in results not reported here that firms tend to switch from smaller banks to larger banks. But this explanation runs counter to the fact that many of our firms also maintain relationships with large international banks like Barclays, Citibank, Chase Manhattan, Chemical Bank, and Credit Lyonnaise. Alternatively, the largest banks in Norway could be the best quality banks and the *Large bank* result could

imply that firms value long relationships with high quality banks.¹¹ According to a survey reported in Ongena and Smith (1998), Norwegian treasury managers perceive Den norske Bank and Kreditkassen to be the highest quality banks in Norway.

A merger between two banks can interrupt the benefits flowing from a bank relationship, culminating in the termination of a relationship. Sapienza (1998) finds the likelihood of terminating a lending relationship is greater after a bank merger, particularly when the borrower is a small customer of the bank targeted in the acquisition. Her study does not, however, control for relationship duration. To study the impact of bank mergers on our hazard rate estimates, we add a dummy variable *Merger*, defined to be one when a bank merger occurs in either the year of, or the year prior to, a termination. Model 3 of Table 6 indicates that *Merger* has no impact on the likelihood of terminating a relationship, or on the other coefficient estimates in the regression. Though not reported here, we also ran a regression specification similar to Sapienza's (1998) specification, controlling for the influence of duration. In accordance with her variable definition, we assign a value of one to the merger variable whenever a bank merger occurs at any point during the course of the relationship. In contrast to the results in Sapienza (1998), we find that firms are *less* likely to end a relationship when a merger has occurred at some point in the past. Throughout all regressions, the relation between the hazard rate and our firm-specific characteristics remains unchanged.

Financial distress at banks could interrupt the flow of relationship benefits and induce firms (or banks) to terminate relationships early. Model 4 in Table 6 adds a dummy variable *Distress* that equals one if a firm's bank announces insolvency in the year of, or prior to, termination. The bank distress data come from Ongena, Smith, and Michalsen (1999). The results in the *Added variable* column indicate that the event of bank distress does not influence relationship termination rates.

Because the decision to switch banks may be different from the decision to simply drop a bank, we include a dummy variable *Replace* in Model 5 that takes the value of one when a firm, in the termination year of an incumbent relationship, reports a new relationship. By using this ex-post information, we assume that a firm knew of a viable replacement bank before the termination decision was made. The coefficient on *Replace* is positive, statistically different from zero, and economically significant. The estimate implies that firms with viable replacement banks end relationships after roughly five years, while otherwise identical firms without a replacement bank end their relationships after 24 years. Therefore, a firm that finds it easy to replace its incumbent relationship with a competitor reduces considerably the time it spends in a given relationship. Holding all else constant, this result suggests that firms without viable alternatives could be locked in to one relationship. However, the result could also imply that firms satisfied with a long-term relationship do not seek out other sources of financing. In any case, the signs and magnitude of the original firm-specific estimates remain robust to the addition of *Replace*.

In Model 6 we seek to determine whether multiple-bank firms terminate older relationships in favor of new ones, or terminate a series of short bank relationships while maintaining one long relationship. We do this by restricting the regression sample to include only multiple-bank firms, and adding the dummy variable *Relative* to the regression specification. *Relative* takes the value of one when the relationship being terminated is longer than the average length of the firm's other relationships.¹² The estimate associated with *Relative* is negative and statistically significant, suggesting that multiple-bank firms tend to drop and replace their newer relationships in favor of keeping one long relationship. According to the estimate, multiple-bank firms turn over a new relationship after four years, compared with 15 years for their long-term relationships. This result helps to explain why we see relatively long pre-1979 relationships in Table 2. Many of the terminations observed

during the sample period are new relationships maintained by multiple-bank firms. When we interact *Relative* with *Ln Sales* (not reported), we find that small firms are even more likely to turnover new relationships and keep a long-term relationship. The finding on *Relative* is important because it suggests that firms with viable alternatives to single-bank financing find value in a long-term relationship. In other words, freed from holdup problems, firms - particularly small ones - prefer long-term bank relationships.

4.3.2 *Left censoring*

Up to now, we have only corrected for right censoring and ignored the impact of left censoring. In Models 7 and 8, we conduct two experiments to examine the sensitivity of our results to the presence of left censoring. In model 7, we assume the first observed year in the sample is 1985 rather than 1979. If our regression results are sensitive to left-censoring, then changing the start date should induce instabilities in the parameter estimates. The estimates are robust to the 1985 starting date. They are also robust to a variety of other start dates not reported in the table. In Model 8, we eliminate all left-censored observations. Heckman and Singer (1984) show that this strategy yields consistent though inefficient estimates of duration in the presence of left censoring. The median estimate of duration for Model 8 is 6.7 years. This estimate is larger than the unadjusted median estimate of 4 years in Table 2, but significantly smaller than the estimates that reflect adjustments only for right censoring. It is likely that correcting for right censoring without also correcting for left censoring overestimates the median duration of a relationship. With only 86 observations, none of the coefficient estimates in Model 8 is statistically significant. However, with the exception of *Profitability*, all of the parameter estimates maintain the same sign as in the earlier results.

4.3.3 *Process governing explanatory variables*

Lastly, we return to the restrictions imposed in Section 3.3 on the stochastic process assumed to govern the firm-specific explanatory variables. In particular, we check the sensitivity of the results to the assumption that the hazard rate at date t is independent of the path followed by the firm characteristic variables prior to date t . We first change the dating of the variables and re-estimate the model. Model 9 of Table 6, labeled “All-lagged,” lags all of the explanatory variables so that they are measured two years prior to termination or censoring (with the exception of *Age at start*, which continues to be measured at the beginning of the relationship). This modification results in little change to the original results. Next, we examine a model that explicitly allows for some path dependence in the firm characteristic variables. We do this by allowing each variable to vary through the duration of the relationship between a high and low cohort, while holding the other variables constant with respect to time. Though we do not report the results, this specification does not alter our earlier results.

5. Discussion and Conclusion

This paper presents new evidence on the value of long-term bank relationships by examining the duration of relationships. We document the presence of positive duration dependence in bank relationships. In other words, firms become more likely to end a bank relationship as a relationship matures. Taken alone, this result suggests that the value of relationships decline through time, and that firms are able to end relationships early, possibly to avoid lock-in. This inference is strengthened by the fact that small, young, and highly-leveraged firms maintain the shortest relationships. Although theory suggests that such bank-dependent firms are the most susceptible to lock-in, our findings imply that switching costs are low enough to permit these firms to change banks often.

Holding other firm characteristics constant, we show that competing bank relationships reduce the market power of any one bank, making long-term relationships more valuable. Although firms with multiple bank relationships terminate relationships frequently, they do so by terminating newer relationships and keeping long-term ones. Intuitively, the existence of alternative sources of bank credit reduces the ability for any one bank to threaten holdup. With lower holdup costs, a long-term relationship becomes more valuable to the multiple-bank firms.

We also find some indication that firms terminate relationships as they outgrow their banks. Firms tend to switch from small banks to larger banks, and maintain the longest relationships with Norway's two largest banks. However, we find no evidence that this preference for larger banks arises as a result of limited capacity at other banks. Instead, growing firms could prefer the higher quality services offered by the large Norwegian banks.

The evidence presented here should be useful to future theorists interested in modeling the value of bank relationships. However, one should take caution in drawing far-reaching conclusions from our study. Our data reveals very little about the actual nature of the relationships. We are unable to observe how the price and quantity of lending change over the course of the relationship and do not know the other types of banking services offered to customers in a bank relationship. Indeed, an ideal extension of this study would be to obtain a time-series of relationship-specific information about banks and their customers and examine the duration of the relationship as a function of relationship-specific variables.

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Table 1

Annual overview of sample.

This table lists, by year, the total number of firms contained in *Kierulf's Handbook*, the number of Oslo Stock Exchange (OSE) listed banks, the number of firms reporting bank relationships, the number of new bank relationships, the total number of relationships ending, the return on the value-weighted index of all OSE-listed companies, and the number of OSE listings and delistings. A bank relationship in this table is a primary bank relationship, as defined by the firm and reported in *Kierulf's Handbook*. We identify a firm as ending a relationship when it drops a bank from the list or replaces one bank with another. All numbers are from *Kierulf's Handbook*, except the return on the OSE index and the number of listings and delistings, which are from *Oslo Børs Informasjon AS* (OBI). The column containing 'Firms reporting bank relationships' is the sample of firms used in our analysis.

Year	OSE firms, including banks	OSE-listed banks	Firms reporting bank relationships	New relationships	Relationship terminations	Return on OSE Index	New OSE Lists	OSE Delists
1979	113	13	96	-	-	86.2%	-	-
1980	109	13	93	5	5	-13.0	6	10
1981	112	14	96	2	1	4.0	5	2
1982	117	14	100	3	4	-16.9	6	1
1983	136	15	115	5	5	92.8	21	2
1984	158	16	140	7	5	27.3	22	0
1985	159	17	138	6	1	27.5	7	6
1986	154	18	133	17	16	-8.8	8	12
1987	143	14	125	14	10	-6.3	5	15
1988	129	13	113	18	12	33.9	3	17
1989	130	15	111	11	6	52.4	11	11
1990	114	11	100	14	7	-14.2	7	24
1991	117	8	106	14	9	-10.0	15	11
1992	121	9	101	16	5	-10.0	11	7
1993	125	9	106	10	4	64.8	15	12
1994	131	7	113	14	5	7.1	17	11
1995	133	6	98	10	6	14.2	20	18
Mean	129.5	12.5	110.8	10.4	6.3	15.3	11.2	9.9

Table 2

Distribution of observed duration of bank relationships.

This table lists marginal and cumulative distributions for the observed duration of bank relationships, in years. A bank relationship in this table is a 'primary' bank relationship, as defined by the firm and reported in *Kierulff's Handbook*. We identify a firm as ending a relationship when it drops a bank from the list or replaces one bank with another. The observed duration of a relationship is the number of consecutive years a bank appears in *Kierulff's Handbook* as a primary bank relationship before being dropped. *N* is the number of firm-bank observations, defined to be the number of firms listing bank relationships multiplied by the number of banks per firm.

Observed duration, in years	Proportion of:					
	All bank relationships (N=419)		Relationships formed before 1979 (N=146)		Relationships formed between 1979 and 1995 (N=273)	
	Marginal	Cumulative	Marginal	Cumulative	Marginal	Cumulative
< 1	15.8%	15.8%	17.8%	17.8%	14.7%	14.7%
1	12.6	28.4	2.1	19.9	18.3	33.0
2	11.4	39.8	2.7	22.6	16.1	49.1
3	6.4	46.2	2.7	25.3	8.4	57.5
4	6.2	52.4	2.7	28.0	8.0	65.5
5	7.2	59.6	7.6	35.6	7.0	72.5
6	7.4	67.0	13.0	48.6	4.4	76.9
7	6.4	73.4	9.6	58.2	4.8	81.7
8	5.5	78.9	8.2	66.4	4.0	85.7
9	4.1	83.0	3.4	69.8	4.4	90.1
10	2.9	85.9	4.1	73.9	2.2	92.3
11	3.3	89.2	4.8	78.7	2.6	94.9
12	1.4	90.6	1.4	80.1	1.5	96.4
13	1.7	92.3	0.7	80.8	2.2	98.6
14	0.5	92.8	0.0	80.8	0.7	99.3
15	1	93.8	1.4	82.2	0.7	100.0
≥16	6.2	100.0	17.8	100.0	0.0	100.0
Mean duration (years)	5.1		7.3		3.9	
Median duration (years)	4.0		6.0		2.0	

Table 3

Descriptive statistics for firm-specific characteristics.

For this table, we measure each characteristic in the year prior to the end of the bank relationship (or date of right censoring, if censored first). All firm characteristics are from *Kierulf's Handbook* or company annual reports. *Sales* is year-end sales in millions of Norwegian Kroner, deflated by the Norwegian consumer price index (with 1979=100). One US dollar is roughly equivalent to 7 Norwegian Kroner. *Ln Sales* is the natural logarithm of *Sales*. *Age* is the time elapsed between the firm's founding date and the year of measurement. *Age at start* is the time elapsed between the firm's founding date and either the start of the relationship, or the date of left censoring, whichever comes last. *Profitability* is the ratio of operating income to book value of assets. *Tobin's Q* is the ratio of year-end market value of equity plus book value of debt divided by the book value of assets. *Leverage* is the book value of debt divided by the sum of year-end market value of equity and book value of debt. *Multiple relationships* equals one when a firm maintains more than one bank relationship and zero otherwise. *Ownership concentration* measures the proportion of equity owned by a firm's ten largest shareholders. Companies report ownership structure information on a voluntary basis; therefore, the number of observations for ownership is lower. A bivariate t-test determines the statistical significance of the correlation coefficients. *N* is the number of firm-bank observations.

Variable	N	Mean	Median	St. Dev	Minimum	Maximum
Sales	383	741.1	165.8	2,009.9	0.0	30,698.0
Ln Sales	383	7.1	7.4	2.4	0.0	12.6
Age	383	53.0	49.0	43.3	0.0	245.0
Age at start	383	47.5	44.0	42.1	0.0	243.0
Profitability	383	1.7%	4.7	15.3	-126.2	37.7
Tobin's Q	383	1.4	1.2	0.8	0.3	9.2
Leverage	383	55.4%	58.7	24.9	0.0	98.2
Multiple relationships	383	44.3%	0.0	49.7	0.0	100.0
Ownership concentration	270	68.4%	69.5	17.5	4.8	100.0

Correlation Matrix	Age	Age at start	Profitability	Tobin's Q	Leverage	Multiple relationships	Ownership concentration
Ln Sales	0.085	0.068	0.303***	-0.209***	0.383***	0.123***	-0.048
Age		0.994	0.121***	0.011	-0.018	0.102***	-0.018
Age at start			0.119***	0.016	-0.011	0.097**	-0.013
Profitability				-0.075*	-0.071*	0.004	-0.082*
Tobin's Q					-0.543***	-0.102**	-0.009
Leverage						0.173***	0.010
Multiple relationships							-0.164***

*** Significant at 1%, ** significant at 5%,* significant at 10%.

Table 4

Partial likelihood estimates of proportional hazard model.

The estimates in this table are based on ML estimation of the proportional hazard model using the Cox (1972) partial likelihood function. The coefficients measure the partial impact of each variable on the likelihood a relationship terminates, conditional on duration. *Ln Sales* is the natural logarithm of year-end sales measured in 1979 Norwegian Kroner. *Age at start* is the time elapsed between the firm's founding date and either the start of the relationship, or the date of left censoring, whichever comes last. *Profitability* is the ratio of operating income to book value of assets. *Tobin's Q* is the ratio of year-end market value of equity plus book value of debt divided by the book value of assets. *Leverage* is the book value of debt divided by the sum of year-end market value of equity and book value of debt. *Multiple relationships* equals one when a firm maintains more than one bank relationship and zero otherwise. *Ownership concentration* measures the proportion of a firm's equity owned by its ten largest shareholders. With the exception of *Age at start*, we measure all variables in the year prior to termination or right censoring, whichever comes later. The estimates in model 1 are not adjusted for right censoring. The estimates in models 2-4 are adjusted for right censoring. Coefficients are listed on the first row in each cell, with standard errors reported below in parentheses. The last column lists the value of the optimized log likelihood function $L(\theta)$. N is the number of firm-bank observations.

Model	N	Ln Sales	Age at start	Profitability	Tobin's Q	Leverage	Multiple relationships	Ownership concentration
1	270	-0.096*** (0.032)	-0.00541*** (0.00160)	0.392 (0.541)	0.184** (0.092)	1.066*** (0.380)	0.058 (0.131)	0.300 (0.360)
2	270	-0.215*** (0.058)	-0.00238 (0.00280)	1.588 (1.161)	0.244 (0.174)	2.143*** (0.708)	0.608** (0.254)	0.666 (0.681)
3	270	-0.213*** (0.058)	-0.00227 (0.00278)	1.567 (1.181)	0.249 (0.166)	2.161*** (0.704)	0.559** (0.248)	-
4	383	-0.195*** (0.042)	-0.00350 (0.00241)	1.741** (0.882)	0.237 (0.146)	2.088*** (0.515)	0.520*** (0.191)	-

*** Significant at 1%, ** significant at 5%, * significant at 10%.

Table 5

Parametric estimation of proportional hazard model.

The estimates in this table are based on ML estimation of the proportional hazard model using the exponential and the Weibull distributions as baseline hazard rates. The parameter α measures the degree of duration dependence. The exponential model assumes $\alpha = 1$. *Ln Sales* is the natural logarithm of year-end sales measured in 1979 Norwegian Kroner. *Age at start* is the time elapsed between the firm's founding date and either the start of the relationship, or the date of left censoring, whichever comes last. *Profitability* is the ratio of operating income to book value of assets. *Tobin's Q* is the ratio of year-end market value of equity plus book value of debt divided by the book value of assets. *Leverage* is the book value of debt divided by the sum of year-end market value of equity and book value of debt. *Multiple relationships* equals one when a firm maintains more than one bank relationship and zero otherwise. *Ownership concentration* measures the proportion of a firm's equity owned by its ten largest shareholders. With the exception of *Age at start*, we measure all variables in the year prior to termination or right censoring, whichever comes later. All estimates are adjusted for right censoring. Coefficients are listed on the first row in each cell, with standard errors reported below in parentheses. *N* is the number of firm-bank observations.

Model	N	$\hat{\alpha}$	$\hat{\beta}$								Median
			Intercept	Ln Sales	Age at start	Profitability	Tobin's Q	Leverage	Multiple relationships	Ownership concentration	Duration
Exponential (1)	270	1 -	-4.275*** (0.878)	-0.241*** (0.070)	-0.00396 (0.00302)	1.911* (1.155)	0.354 (0.240)	2.553*** (0.843)	0.757** (0.283)	0.748 (0.838)	22.1 (3.1)
Exponential (2)	270	1 -	-3.771** (0.280)	-0.239*** (0.069)	-0.00382 (0.00298)	1.918* (1.138)	0.357* (0.212)	2.577*** (0.823)	0.702** (0.280)	-	21.9 (3.0)
Exponential (3)	383	1 -	-3.601*** (0.561)	-0.218*** (0.053)	-0.00352 (0.00259)	2.124** (0.997)	0.268 (0.195)	2.281*** (0.628)	0.659*** (0.231)	-	19.8 (2.3)
Weibull (4)	270	1.260 ⁺ (0.162)	-3.906*** (0.730)	-0.202*** (0.055)	-0.00404 (0.00236)	1.634* (0.901)	0.314 (0.194)	2.223*** (0.661)	0.611*** (0.229)	0.627 (0.664)	18.3 (3.0)
Weibull (5)	270	1.257 ⁺ (0.162)	-3.488*** (0.504)	-0.201*** (0.054)	-0.00391 (0.00233)	1.647* (0.892)	0.318* (0.172)	2.249*** (0.646)	0.566** (0.224)	-	18.2 (2.9)
Weibull (6)	383	1.351 ⁺⁺⁺ (0.135)	-3.260*** (0.408)	-0.178*** (0.038)	-0.00344* (0.00183)	1.752** (0.717)	0.238* (0.141)	1.933*** (0.444)	0.491*** (0.168)	-	15.8 (1.9)

+++ , ++ , + $\alpha=1$ can be rejected at 1%, 5%, and 10% respectively. *** Significant at 1%, ** significant at 5%, * significant at 10%.

Table 6

Estimation of Weibull proportional hazard hazard model: robustness tests.

The estimates in this table are based on ML estimation of the proportional hazard model using the Weibull distribution as the baseline hazard rate. *Profitability* is the ratio of operating income to book value of assets. *Bank Size* is $\ln(1 + \text{book value of firm debt}) - \ln(1 + \text{book value of equity of the firm's bank(s)})$. If the firm maintains more than one relationship, the denominator is the sum of the book value of equity across the banks. *Large bank* is a dummy variable taking the value of one when a relationship is with one of Norway's two largest banks, Den norske Bank or Kreditkassen. *Merger* is a dummy variable set equal to one when a relationship bank was involved in a merger in the year prior to, or concurrent with, the termination of a relationship. *Replace* is a dummy variable that equals one if a bank is replaced by another bank upon termination. *Distress* is a dummy variable that equals one if a firm's bank becomes distressed in the year prior to, or concurrent with, the termination of a relationship. *Relative* takes the value of one if the duration of the terminated relationship is greater than the average duration of the other relationships maintained at the point of termination (single-bank relationships are excluded). *Tobin's Q* is the ratio of year-end market value of equity plus book value of debt divided by the book value of assets. *Leverage* is the book value of debt divided by the sum of year-end market value of equity and book value of debt. *Age at start* is the time elapsed between the firm's founding date and either the start of the relationship, or the date of left censoring, whichever comes last. *Multiple relationships* equals one when a firm maintains more than one bank relationship and zero otherwise. *Ln Sales* is the natural logarithm of year-end sales measured in 1979 Norwegian Kroner. With the exception of *Age at start*, we measure all firm-specific variables in the year prior to termination or right censoring, whichever comes later. In the *Start 1985* model, the starting date of the sample is assumed to be 1985. The *No left censoring* model excludes left-censored observations from estimation. The *All Lagged* model measures all of the explanatory variables (with the exception of *Age at start*, which continues to be measured at the beginning of the relationship) two years prior to a relationship end, or upon right censoring. Coefficients are listed on the first row in each cell with standard errors reported below in parentheses. *N* is the number of firm-bank observations.

Model	N	$\hat{\alpha}$	$\hat{\beta}$								Median Duration
			Intercept	Ln Sales	Age at start	Profitability	Tobin's Q	Leverage	Multiple relationships	Added Variable	
Bank Size (1)	383	1.350 ⁺⁺⁺ (0.136)	-3.265 ^{***} (0.481)	-0.175 ^{***} (0.039)	-0.00346* (0.00184)	1.752 ^{**} (0.720)	0.230 (0.142)	1.929 ^{***} (0.445)	0.481 ^{***} (0.173)	0.00464 (0.01510)	15.9 (1.9)
Large bank (2)	383	1.364 ⁺⁺⁺ (0.136)	-2.936 ^{***} (0.391)	-0.159 ^{***} (0.038)	-0.00289 (0.00179)	1.584 ^{**} (0.700)	0.213 (0.134)	1.784 ^{***} (0.437)	0.354 ^{**} (0.170)	-0.403 ^{**} (0.165)	15.6 (1.9)
Merger (3)	383	1.351 ⁺⁺⁺ (0.135)	-3.257 ^{***} (0.410)	-0.178 ^{***} (0.038)	-0.00346* (0.00183)	1.773 ^{**} (0.725)	0.234 (0.143)	1.932 ^{***} (0.447)	0.496 ^{***} (0.169)	0.058 (0.289)	15.8 (1.9)
Distress (4)	383	1.351 ⁺⁺⁺ (0.136)	-3.298 ^{***} (0.425)	-0.175 ^{***} (0.038)	-0.00346* (0.00185)	1.842 ^{**} (0.737)	0.220 (0.148)	1.911 ^{***} (0.451)	0.541 ^{***} (0.177)	0.405 (0.306)	16.0 (2.0)
Replace (5)	383	1.452 ⁺⁺⁺ (0.136)	-3.756 ^{***} (0.455)	-0.142 ^{***} (0.038)	-0.00416 ^{**} (0.00119)	1.499 ^{**} (0.652)	0.307 ^{**} (0.145)	1.511 ^{***} (0.481)	0.560 ^{***} (0.189)	1.509 ^{***} (0.204)	19.0 (3.0)

Relative (6)	170	2.054 ⁺⁺⁺ (0.233)	-2.468 ^{***} (0.432)	-0.121 ^{***} (0.028)	-0.00165 (0.00145)	1.315* (0.672)	0.340 ^{**} (0.155)	2.274 ^{***} (0.418)	-	-1.252 ^{***} (0.136)	9.8 (0.7)
Start 1985 (7)	355	1.214 ⁺ (0.163)	-3.013 ^{***} (0.413)	-0.232 ^{***} (0.049)	-0.00310 (0.00234)	2.304 ^{**} (0.937)	0.349 ^{***} (0.116)	2.302 ^{***} (0.532)	0.571 ^{***} (0.194)	-	12.0 (1.9)
No left (8)	86	1.485 ⁺ (0.308)	-1.970 ^{**} (0.838)	-0.105 (0.064)	-0.00474 (0.00330)	-0.226 (1.385)	0.028 (0.360)	0.946 (0.798)	0.430 (0.334)	-	6.7 (1.2)
All Lagged (9)	345	1.625 ⁺⁺⁺ (0.158)	-3.032 ^{***} (0.386)	-0.113 ^{***} (0.026)	-0.00132 (0.00197)	-0.808 (0.701)	-0.049 (0.155)	1.300 ^{***} (0.332)	0.376 ^{**} (0.155)	-	16.4 (1.7)

+++ , ++ , + $\alpha=1$ can be rejected at 1% , 5% , and 10% respectively. *** Significant at 1% , ** significant at 5% , * significant at 10% .

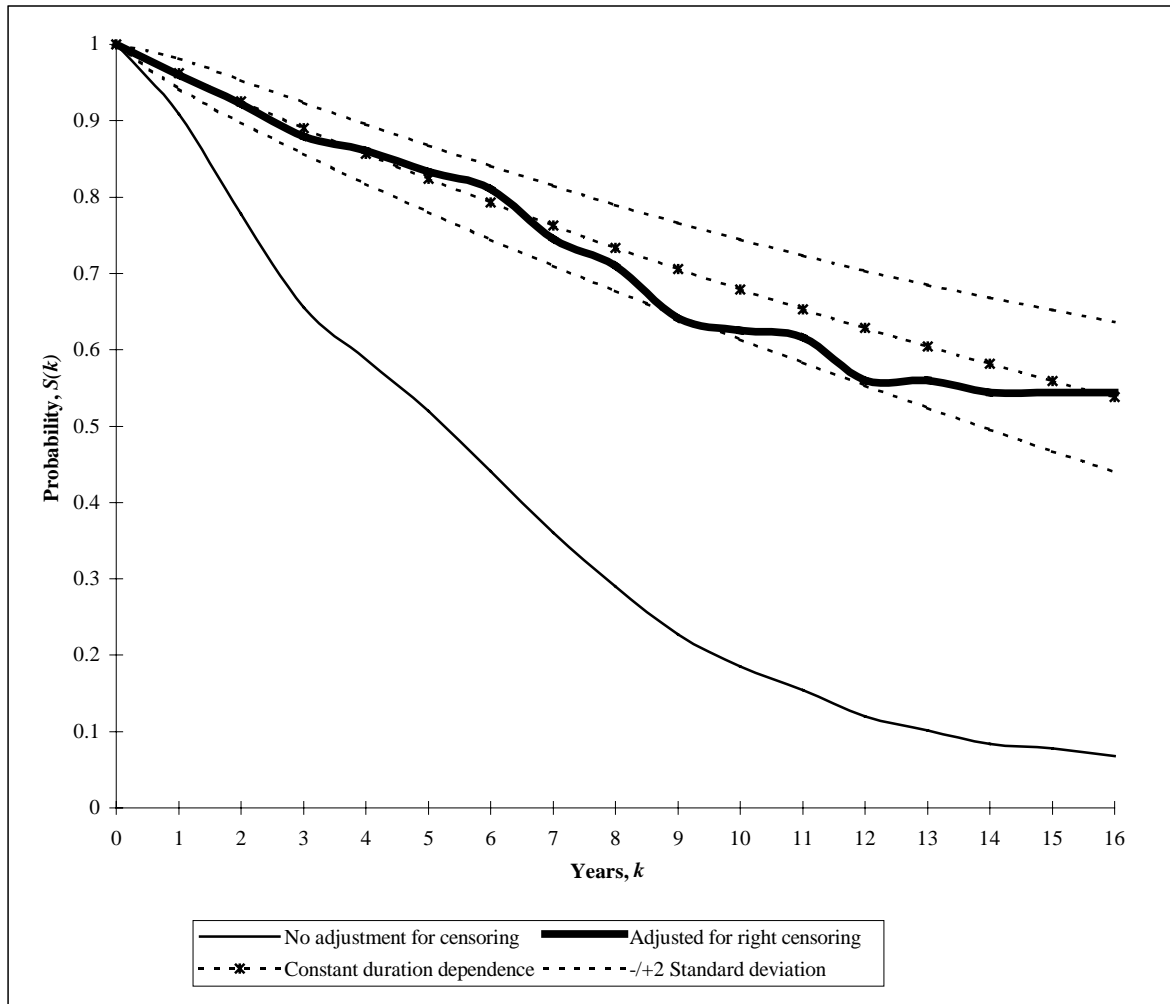


Fig. 1. Non-parametrically estimated survivor functions with and without adjustment for right censoring.

The figure is based on estimates of the survivor function $\hat{S}(k) = \prod_{i=0}^k (1 - \hat{\lambda}(i))$, where $\hat{\lambda}(i)$ is the sample estimator for the probability a firm ends a bank relationship, conditional on the relationship lasting i periods. The heavy-dashed line plots the implied censored-robust estimate for a survivor function calculated under the restriction of constant duration dependence. The two lighter-dashed lines plot approximate 95 percent confidence intervals around the restricted estimate. Number of firm-bank observations: 383.

Notes

- ¹ Diamond (1991), Rajan (1992), Berglöf and von Thadden (1994), Boot and Thakor (1994), Chemmanur and Fulghieri (1994), and von Thadden (1995) formally model the benefits of bilateral and long-term relationships.
- ² Greenbaum, Kanatas and Venezia (1989), Sharpe (1990), Rajan (1992), Petersen and Rajan (1995), and von Thadden (1998) analyze the value of bank relationships in the presence of such holdup costs.
- ³ For example, see Mikkelsen and Partch (1986), James (1987), Lummer and McConnell (1989), James and Wier (1990), Best and Zhang (1993), Preece and Mullineaux (1994), Billett, Flannery and Garfinkel (1995), and Shockley and Thakor (1998).
- ⁴ Commercial debt consists of loans to all non-financial firms by financial institutions. Source: *Statistical Yearbook of Norway, 1996*. Although bank-dominated on the debt side, regulations in Norway forbid a bank from taking significant equity positions in non-financial companies. As of year-end 1994, Norwegian banks owned less than 1% of the equity in the non-financial sector (Nilsen (1995)).
- ⁵ In a recent paper, Farinha and Santos (2000) also use duration analysis to study bank switching behavior, but emphasize a firm's choice in moving from a single bank relationship to multiple relationships. Consistent with our results, they find that the likelihood of moving to a multiple bank relationship is increasing in relationship duration, firm leverage, and firm growth potential.
- ⁶ Houston and James (1996) find that investment by multiple-bank firms is less sensitive to fluctuations in internal cash flow than single-bank firms. Detragiache, Garella and Guiso (2000), Ongena and Smith (2000), and Farinha and Santos (2000) study the choice of number of bank relationships.
- ⁷ A few large firms dominate the OSE, skewing the average size. For example, the average OSE firm had a market value of \$150 million in 1995, placing it in the second smallest size decile of NYSE firms according to Ibbotson (1996). However, the average size of Norway's five largest publicly-listed firms, which account for roughly two-thirds of the total OSE market capitalization, places them into the second largest NYSE size decile.
- ⁸ On average, trade credit (accounts payable plus unearned revenue) represents 9.6% of total liabilities. We cannot observe the amount of bank debt in each firm's capital structure. However, if we assume that our sample firms issue all traded non-bank corporate debt in Norway (commercial paper and corporate bonds), then bank debt represents approximately 80% of the average OSE firm's liabilities. In 1994, total non-financial commercial paper issuances represented 1.6%, and corporate bond issuances 7.1%, of sample firm debt. Source: *Statistical Yearbook of Norway, 1996*.
- ⁹ Although we do not report the results, we also estimate the conditional hazard function assuming the baseline hazard follows a log-logistic distribution. The log-logistic allows for non-monotonic duration dependence. The estimates suggest that the likelihood of ending a bank relationship increases over time in the earlier part of a relationship (positive duration dependence), but decreases later in the relationship (negative duration dependence). Plots of the estimated survivor function using partial likelihood estimates produce a similar shape. The coefficient estimates on the explanatory variables from the log-logistic regressions are nonetheless very close to those reported in Tables 4 and 5. The log-logistic distribution does not nest constant duration dependence as a special case, making comparison with the Weibull and exponential models difficult.

- ¹⁰ The estimated median duration is $t = \frac{-\ln(0.5)^{1/\hat{\alpha}}}{\exp(\beta\bar{X})}$. Because it assumes constant duration dependence, the exponential estimates the median duration of a relationship to be longer than the Weibull specification with positive duration dependence.
- ¹¹ Billett et al. (1995) argue that the value of a bank relationship is positively related to the quality of the bank.
- ¹² For example, suppose a firm maintains a relationship with both Bank A and Bank B, and we observe a termination with Bank A. Then, *Relative* equals one if the relationship between the firm and Bank A is longer than the relationship with Bank B.