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Abstract

The present study, using the Cox proportional hazard model, suggests a firm faces a significantly higher risk of takeover if its cost performance lags behind its industry benchmark. The effects o variables capturing cost inefficiency on the risk of takeover appear to be remarkably stable over the nearly two decades spanned by the sample, while the effect of the variables measuring the risk-size relationship indicate temporal changes. Once cost inefficiency is accounted for, the paper fails to find consistent evidence for the effects of other conventionally used performance measures, such as profitability and q, on the risk of takeover.

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Corporate Inefficiency and the Risk of Takeove

"Corporate raiding" has been a permanent feature of the American corporate landscape since the mid-1800s (Pound (1992)). In recent decades, mergers and acquisitions have played an increasingly important role in allocating resources in the US economy. It took only the first five years of the 1990s to complete the same number (about 23,000) of mergers and acquisitions as were done in the entire previous decade (Mergers and Acquisitions, September-October, 1995) and the value of takeovers in the peak years of each decade equaled about one-fourth of GNP (Fortune, March 2, 1998.) Such a prominent role of takeovers in reallocating control over capital in the US economy has given rise to a vigorous debate over whether takeovers actuall improve the allocation of resources. This debate has focused on two issues: the pre-takeover performance of targets and buyers and the post-takeover changes in performance. The purpose of this paper is to reexamine empirical evidence on the pre-takeover performance of targets.

Earlier studies of determinants of the risk of takeover have not yielded consistent conclusions concerning the efficiency of targets relative to non-target firms. Ravenscraft and Scherer (1987) argued that, prior to the 1980's, targets were often more profitable than non-target firms, Billett (1996) suggested that they were equally profitable during 1977-1986, and Cheh, Weinberg and Yook (1999) presented evidence that targets in 1985-1993 were less profitable than non-target firms. Using a measure of market valuation (market-to-book, Tobin's q, etc.) as a proxy for performance, some studies report that the performance of targets was not significantly different from the non-targets prior to the 1980's (Mueller (1980), Palepu (1986)) and during the 1980's (Powell (1997), Ambrose and Megginson (1992), Cudd and Duggall (2000)), while others report a relatively lower valuation for target firms in the 1980's (Hasbrouck (1985), Mörck et. al. (1989), Davis and Stout (1992), Cheh, Weinberg and Yook (1999)). [1]

The present study, based on the 1980-1997 sample of nearly 900 Fortune 500 companies, advances the findings reported in the literature in several ways. First, our results suggest that a Fortune 500 corporation faces a significantly higher risk of takeover if its cost performance lags behind its industry benchmark. Second, the effects of variables capturing cost inefficiency, relative to industry benchmarks, on the risk of takeover appear to be remarkably stable over the nearly two decades spanned by the sample. Third, once cost inefficiency is accounted for, the paper fails to find consistent evidence for the effects of other conventionally used performance measures, such as profitability and q, on the risk of takeover. These results suggest that a variable capturing cost inefficiency, such as the industry-adjusted cost per unit of revenue used in this paper, may be an important determinant of the risk of takeover in its own right, rather than just as a measure of inefficiency standing in for profitability. Thus the paper proposes that the industry-adjusted cost variable should be included in models of takeover risk.

We interpret our results following the distinction between revenue and cost restructuring advanced in the context of privatization in transition economies by Grosfeld and Roland (1997), Frydman, *et al* (1999) and Frydman, Hessel, and Rapaczynski (2000). Once the model includes a proxy for cost efficiency, other performance measures capture inefficiencies mostly related to the revenue side of a firm's operations. Thus, we conjecture that the strength of the cost variables as determinants of the risk of takeover stems from a relatively greater predictability of post-takeover gains from cost restructuring of a potential target, as compared with predictability of gains from revenue restructuring. Moreover, the temporal instability of the effects o performance measures, such as profitability or q, on the risk of takeover may be related to the ephemeral and firm-specific nature of revenue restructuring opportunities, such as developing new technologies, or restructuring products.

In addition to examining the effects of various performance measures, the paper also investigates the effect of firm size on the risk of takeover. Prior analyses of takeovers have suggested and often found that size has a negative effect on the risk of takeover. (See, for example, Singh (1975) and Hasbrouck (1985).) This negative effect of size on risk has been attributed to the difficulties in financing larger takeover transactions. However, size may also have a positive effect on risk, and the specification of our model has been designed to test for such a possibility. Since the cost variable includes overhead costs and the post-takeover cost restructuring is likely to entail economies of scale, the marginal increase in size tends to enhance the potential for post-takeover savings in the cost per unit of revenue. Thus, the effect of size on the risk of takeover can be positive or negative and it is expected to *vary over time* depending on the relative strengths of these two opposing effects. Evidence presented in this paper appears to be consistent with this interpretation: while the effect o firm-size on the risk of takeover i always significant, *the magnitude and the sign* of this effect is significantly different across the time periods of this study.[2]

Finally, this paper employs statistical methodology, the Cox regression model, which is particularly appropriate for the study of a time-varying risk profile. The literature on takeovers has predominately used logistic and probit regressions to analyze takeover data.[3] These techniques estimate the probability of takeover over a fixed period of time as a function of a firm's characteristics in the beginning of the period. As such these techniques are not suitable for the investigation of the temporal profile of risk. In contrast, the Cox model is a dynamic technique, which incorporates time-dependent covariates and estimates the hazard rate o takeover at any time of the study period as a function of these covariates. Moreover, the formulation of the model allows for the possibility of changing effects of these characteristics

over time, as well as for the dependence of the effects on the levels of these characteristics.

The other notable feature of the Cox regression model, as compared with the logit and probit models, is that it accommodates right censored and left-truncated takeover times. Since the firm that has not experienced a takeover during the period of the study may be taken over within a year of the end of the study, inconsistent conclusions from the estimation of logit or probit models are likely to result merely from differences in the end points of the studies.

The paper is organized as follows: we begin with a description of the sample, definiti of performance measures and analysis of descriptive statistics in Section I. Section II introduces the Cox regression model in the context of a takeover analysis and discusses its advantages over other methods used in the earlier takeover studies. The results of estimation of alternative specifications of models of the risk of takeover are presented and discussed in Section III. Section IV contains concluding remarks.

I. THE DATA

A. The Sample

The present study is based on a sample of firms that were included in a Fortune 500 ranking of US corporations in at least one year between 1980 and 1997. There were 1,092 firms in the *Compustat* files ranked in the Fortune 500 in at least one year during that period. Cooperatives, subsidiaries and other non-publicly traded companies are excluded as they do not have figures for market value and are not strictly subject to a takeover as will be defined here. Financial firms are excluded because their accounting statements are not comparable to operating companies. Regulated firms (railroads and public utilities) are excluded because of restrictions on pricing and rates of returns. After excluding the types of firms listed above, there were 938 firms ranked in the Fortune 500 in at least one year between 1980 and 1997.

Takeovers are tracked for each year from 1981 through 1997. A takeover is a transaction in which one firm is subsumed into another, i.e., where a complete change of ownership occurs. The study examined every firm in the sample to determine if that firm was involved in a takeover rather than relying on one listing of takeovers. The first source was the deletions list provided in Fortune's annual issue. This information was supplemented with Mergers & Acquisitions Almanac, CCH Capital Changes Reporter, Moody's Industrial and Transportation Manuals (corporate history), Hoover's Corporate Profiles and the footnotes and deletion codes to *Compustat*. There were 318 firms identified as targets.

All performance data from 1980 through 1996 and the SIC industry codes are taken fro the *Compustat* files. Data for the year prior to takeover for 57 targets came from Moody's Industrial Manuals and SEC reports, when it was not available in *Compustat*. The year prior to

that being supplemented was checked to be sure that the reporting conventions are the same as those used in *Compustat* before any observations were added to the dataset.

Industry adjustments are based on the median performance for each year of active firms in the *Compustat* Industrial[4] files with the same 2-digit SIC code. [5] We required a minimum o 10 observations for each industry-year for the industry adjustments. Lack of industry medians reduced the sample to 896 firms and 276 takeovers. (A count of firms and targets for each year in our sample is presented in Table AI in the Appendix).

Some target firms will continue to report financial data to *Compustat* after a takeover if they have debt securities that remain publicly traded. Observations on known targets that post-date a takeover were excluded from our data set unless and until the firm's common stock was re-issued to the public. Most of the firms in the study with initial public offerings after 1980 released one or two years worth of data to *Compustat* for years prior to the public offering date. Because those firms are not "at risk" before their initial public offering, those observations were also excluded from the analysis. Our data set contains 10,784 observations.

Each firm is assigned to one of six sectors based on its industry: basic resources, cyclical consumer products, non-cyclical consumer products, energy, industrial and technology. The sectors follow the definitions used in the Dow Jones Stoxx Index and are used to control for sector-specific effects on firm performance and the risk of takeover. The difference between the 2-digit SIC code industries and the sectors is worth noting. SIC industry codes, even at the 2-digit level, are specific enough that different codes are assigned, for example, to clothing wholesalers and clothing manufacturers. Sectors, on the other hand, would gather all firms in the clothing industry together (cyclical consumer products). The industry adjustment is meant to make firm performance comparable across industries. Wholesalers and manufacturers face

different cost structures, so that an adjustment based on the SIC code is appropriate for measures of performance. Descriptions of the sectors and the sectoral distribution of sample firms are summarized in Table I below and Table AII in the Appendix.

B. Performance Measures and Descriptive Statistics

The simple annual hazard rate, defined as the number of targets as a percent of the number of firms under study each year, is displayed in Figure 1. A striking feature of Figure 1 is that the hazard rate precipitously falls after 1988, after increasing, albeit at a decreasing rate, in the earlier part of the 1980's. Indeed the average hazard rate of 3.4% per annum for the subperiod 1980-1988 is over twice as large as the average annual rate of 1.6% for 1989-1996. In view of this apparent structural break in 1988, we will present the descriptive statistics for the performance measures used in this paper for the subperiods prior to and post 1988.

Insert Figure 1 approximately here

In what follows, we investigate the effects of the following five measures of corporate performance on the risk of takeover: net profit rate, operating profit rate, cost per unit of revenue, labor productivity and a proxy for Tobin's q. Table II below contains definitions of these variables. In order to gauge the performance of a firm in our sample relative to similar firms, our study actually uses the industry-adjusted measures of performance: for each measure, the industry median (computed as described above) is subtracted from the observation on a firm's performance measure.[6] Moreover, inferior performance of a firm relative to industry standard signals the potential for gain in a takeover.

Insert Table II approximately here

We use two measures of profitability in our hazard models: net profit and operating profit. Net profit (net return on assets) is simply net income divided by total assets. While net profit accounts for income and expenses from activities other than the production of goods and services, operating profit deducts only costs and depreciation from total revenue. In essence, the

difference between operating profit and net profit measures firm-specific cash managemen activities (use of leverage, interest income and expenses, etc.). To measure the profitability per unit of capital employed, both measures of profit are scaled by assets. [7]

Although a shortfall in the industry-adjusted profitability signals inefficient use of resources, such shortfall is likely to be an uncertain *measure* of a potential gain from a takeover. Beyond the well-known accounting problems [8] it is generally difficult to ascertain the extent and type of, as well as the payoffs from, restructuring activities required to raise the profitability of the target. This is especially the case for restructuring revenue generation (through activities such as discovery, development and introduction of new product groups), which is inherently oriented toward anticipating future decisions of other agents (customers and competitors) and, thus, it is not only risky, but also subject to risks that are hard or impossible to compute on the basis of past history. In contrast, cost-cutting restructuring measures are often a matter of discipline and relatively standard procedures, with outcomes that involve relatively predictable risks [9]

Earlier literature interpreted measures such as cost per unit of revenue as proxies for cash flow or profitability.[10] The foregoing argument suggests, however, that cost efficiency relative to the industry standard may provide a relatively reliable measure of the prospective gain from post-takeover cost restructuring of a target. Therefore, the industry-adjusted cost per unit of revenue may be an important determinant of the risk of takeover and it should not be necessaril considered as just a proxy for profitability. [11]

Labor productivity is an alternative measure of efficiency in that it measures output per unit of labor. Productivity is measured as sales (in 1980 dollars) per employee. Where costs measure the efficient use of all inputs, productivity measures the efficient use of labor. [12]

While the measures described above are based solely on accounting data, our fifth performance measure is based on market valuation. The ratio of (market value of common stock *plus* book value of preferred stock and debt) to total assets is often used as a proxy for Tobin's q and it is intended to capture any intangible value the firm may have, beyond the value of its physical assets.

In addition to the five performance measures, we will use revenue (net sales) in constan 1980 dollars as a measure of the size of firms in this study.[13] Beyond controlling for firm size, the deflated revenue variable also provides information, complementary to the cost per unit of revenue, on the potential gains from a takeover of a relatively inefficient target [14] In earlier studies, the significance of the size variable was often related to financing constraints of the takeover transactions.[15] Both of these interpretations motivate our use of the unadjusted, rather than industry-adjusted size variable in our hazard models [16]

Table III below presents descriptive statistics for the measures of performance and size used in this study. Since the hazard models are estimated using annual data over seventeen years and tables of annual measures would not be particularly informative, we present descriptive statistics for the two subperiods suggested by our discussion of Figure 1: 1980-88 and 1989-1996.[17] Furthermore, performance information for each firm is summarized by the average of the observations for a given performance measure during each of the subperiods. [18]

Insert Table III approximately here

Table III presents the median industry-adjusted performance measures for targets and non-targets in the two observati subperiods: 1980-88 and 1989-96. The top half of Table III presents the performance measures for non-targets in each of the two subperiods. Although the profit measures do not point to unambiguous conclusions concerning temporal gains in efficiency by the non-targets (while operating profit suggests significant gains, the change in ne

profit is not significant across subperiods, p-values equal 0.04 and 0.25, respectively), both cost per unit of revenue and labor productivity measures indicate very large and significant (p-values <0.01) improvements in the use of resources by non-targets during 1989-96 as compared to 1980-88.[19] Thus, as suggested above, the profitability measures appear to be the noisier indicators of the short-run efficiency gains than more direct measures of resource utilization such as cost per unit of revenue or labor productivity

The bottom half of Table III displays the performance measures for targets in each of the two subperiods. These medians are further divided by the subperiod in which the firms were taken over. For all performance measures except labor productivity, the relative performance of targets in 1981-89 is significantly worse than that of non-targets. "Later" targets, those firms that were taken over during the second subperiod 1990-97, also underperform the non-targets during 1980-88. This suggests that a firm's performance may lag for some time before it becomes a takeover target.

Similarly to non-targets, targets also improve over time. While the gap between the cost performance of targets and non-targets widens substantially over time, it remains unchanged or diminishes for all other performance measures. Despite the narrowing of the gap between targets and non-targets for the profitability measures, net and operating profit for targets remain significantly inferior to that of non-targets during the second subperiod, 1989-96.[20] However, the q measure is significantly worse for targets only in the first subperiod. The performance gap substantially widens and remains highly significant for cost per unit of revenue.

In addition to performance measures discussed above, Table III presents the statistics for the size of firms. As we shall discuss in more detail in Section III, it is important to note that the relative size of targets and non-targets changes across the two subperiods: while target and non-

target size are not significantly different from each other during 1980-88, targets are significantly smaller than non-targets during the 1989-1996 subperiod.

In summary, a striking feature of the descriptive statistics displayed in Table III is tha *relative* performance of targets and non-targets varies over time. The relative performance gap between targets and non-targets may appear to diminish or not, depending on the performance measure used in the analysis. This suggests that a successful modeling of the risk of takeover may require not only the use of performance measures best capturing the performance gap between targets and non-targets, but also, even more importantly, the use of statistical models and specifications allowing for changing effects over time of performance measures and other covariates on the risk of takeover.

II. THE COX REGRESSION MODEL

The statistical model used in this study is the Cox hazards regression model proposed b Cox (1972). This model, because of its many features discussed below, has gained enormous popularity in the analysis of survival data in biostatistics. Since takeover data in our study can be interpreted as survival data, the Cox regression model offers a powerful tool for modeling the dependence of the risk of takeover on firms' characteristics, and of the evolution of that risk over time. An exhaustive discussion of the Cox regression model may be found, for example, in Kalbfleisch and Prentice (1980), Fleming and Harrington (1991) and Andersen et al.(1992). The first reference provides the most accessible discussion, whereas the other two are more mathematically demanding.

The literature on takeovers has predominately used logistic and probit regressions t analyze takeover data. These techniques estimate the probability of takeover over a fixed period of time as a function of a firm's characteristics in the beginning of the period. As such these

techniques are not suitable for the investigation of the temporal profile of risk. The Cox model estimates the hazard rate of takeover at any time of the study period as a function of the history of time-dependent characteristics of a firm. It allows for the possibility of changing effects o these characteristics over time, as well as for the dependence of the effects on the levels of these characteristics.

The other notable feature of the Cox regression model, as compared with the logit and probit models, is that it accommodates right censored and left-truncated takeover times. The logit and probit models dichotomize the sample by a takeover outcome within the study period. However, the firm that has not experienced a takeover during the period of the study may be taken over within a year of the end of study. Thus inconsistent conclusions are likely to result merely from differences in the end points of the studies [21] In contrast, the Cox model considers such a firm as not having yet experienced a takeover, that is as having a right-censored takeover time. The Cox model also accommodates delayed entry (left-truncated takeover times), that is, it does not require that all firms in the sample are followed from the beginning of the study. The requirement that all firms are to be followed from the beginning of the study would have excluded over 200 firms from our sample. [22] The described features of the Cox model make it particularly suitable for studying the variation of takeover risk over time.

A. Description of The Model

Our, relatively brief, exposition of the Cox model will be in the context of the takeover data. Assume that all firms in our sample are at risk for takeover and le T_i, $1 \le i \le n$, be the time to takeover (survival time) of the *i*'th firm in the sample. For this study we identify time 0 as year 1980, and thus the time to takeover is measured relative to year 1980. The time to takeover of the *i*'th firm is assumed to depend on a vector $\{X_i^*(t), 0<t<T_i\}$ of its time-dependent characteristics or covariates. In the Cox model the relation between the time to takeover and the covariates is modeled by specifying the form of the conditional hazard function of a takeover time. The conditional hazard function of a takeover time T_i, $\lambda(t|X_i(t))$, for given covariates, is defined by

$$\lambda(t|X_i(t)) = \lim_{\Delta t \to 0} P(T_i < t + \Delta t \mid T_i \ge t, X_i(t)) / \Delta t . \qquad (1)$$

It is seen from (1) that for small Δt

$$\lambda(t|X_i(t))\Delta t \approx P(T_i < t + \Delta t \mid T_i \ge t, X_i(t)),$$

and thus $\lambda(t|X_i(t))$ is approximately the probability that a firm experiences a takeover just after time t given survival till time t and given the covariates $X_i(t)$. Here $X_i(t)$ may be any suitable function of the history of covariates up till time t, $\{X_i^*(t), 0 < t < T_i\}$, but in most applications o the hazard models it is assumed that the hazard of failure at time t depends on the current values of the covariates, i. e., that $X_i(t) = X_i^*(t)$. Our specification o $X_i(t)$ involves lagged values of the covariates and is discussed below. The Cox hazard regression model specifies the following form for the conditional hazard functi

$$\lambda(t \mid X_i(t)) = \lambda_0(t) \exp(\beta' X_i(t)),$$

where $\beta' = (\beta_1, \ldots, \beta_k)$ is a vector of unknown regression coefficients, $\lambda_0(t)$ is an unknown and unspecified baseline hazard function, and $\beta' X_i(t)$ is an inner product.

An important aspect of the Cox model is that, at any point in time, the ratio of the hazard rates of takeover for two different firms does not involve the baseline hazard function. Consequently, in the case of time independent covariates the ratio of hazard rates stays constan over time. For this reason the Cox regression model is often referred to as the proportional hazards model. The parameter $\exp(\beta_p)$ represents a relative change in the hazard rate resulting from a one unit increase in the value of the *p*'th covariate, holding all other covariates constant, namely

$$\exp(\beta_p) \qquad \frac{\exp[\beta_p (X^p + 1)]}{\exp[\beta_p (X^p)]}$$

The baseline hazard function, $\lambda_0(t)$, gives the hazard rate for a firm with covariates equal to 0. Since we use the cyclical consumer products sector as a baseline and we do not adjust the size variable $\lambda_0(t) \exp(\beta_{size} Size)$ represents the hazard rate of a takeover faced by a firm in the cyclical consumer products sector of a given size, performing at its industry medians for all other performance measures.

The parameters of the Cox regression model are $\lambda_0(t)$ and the regression coefficient β. Cox (1972) proposed the partial likelihood method for the estimation of β. The essential feature of the method is that it does not involve the baseline hazard function $\lambda_0(t)$, that is, parameter β can be estimated in the absence of knowledge o $\lambda_0(t)$. The baseline hazard function is estimated subsequently in a nonparametric fashion. Since our interest in this study is in the estimation o the relative risk of takeover faced by the firms we discuss below partial likelihood estimation o regression coefficient β. For a discussion of the estimation methods o $\lambda_0(t)$ we refer the reader to the aforementioned references.

B. Takeover Data and Estimation

For takeover data, as is typical for survival data in general, we do not observe the takeover times (i. e., survival times) for all firms and, furthermore, some firms may not be observed from the beginning of the study. Thus, for the *i*'th firm the observed data consist of the entry time $V_i \geq 0$, exit time, min (T_i, T), which is either a takeover time T_i, or the end of stud time, T, whichever is smaller, and the covariate history $\{X_i^*(t), V_i \leq t < \min(T_i, T)\}$. Let $T_{(1)} < T_{(2)} < ... < T_{(L)}$ denote ordered observed takeover times. Let k) be the label for a firm experiencing a takeover a $T_{(k)}$, so the covariate history associated with label (k) is $\{X_{(k)}^*(t), V_{(k)} \leq t < \min(T_{(k)}, T)\}$. Given these data and assuming that takeover times are all distinct, the regression coefficients, β, are estimated by the value $\hat{\beta}$ which maximizes the partial likelihood

$$L(\beta) = \prod_{k=1}^{L} \frac{\exp[\beta' X_{(k)}(T_{(k)})]}{\sum_{j \in R_k} \exp[\beta' X_j(T_{(k)})]} , \qquad (2)$$

Here R_k is the set of firms at risk of a takeover just before time $T_{(k)}$, that is, $R_k = \{j : V_j < T_{(k)} \leq T_j\}$. We see that the partial likelihood is formed by taking the product over all takeover times. The k'th factor in this product:

$$\frac{\exp[\beta' X_{(k)}(T_{(k)})]}{\sum_{j \in R_k} \exp[\beta' X_j(T_{(k)})]},$$

is the conditional probability that the firm with covariates $X_{(k)}(T_{(k)})$ is taken over at $T_{(k)}$ given that the firms in R_k are at risk and that exactly one takeover occurs at $T_{(k)}$. We note that a firm that has not experienced a takeover during the time of the study contributes to the partial likelihood by its presence in some or all of the risk sets. Even though the partial likelihood $L(\beta)$ is not a likelihood function in the usual sense, it can be treated as an ordinary likelihood function for purposes of inference about β. Thus, under mild conditions $\hat{\beta}$ is asymptotically normally

distributed with a covariance matrix which can be consistently estimated using either the usua matrix of second derivatives of $L(\beta)$ or, as is the case in this study, using the robust estimator o Lin and Wei (1989). Similarly, the inferences about inclusion/exclusion of the covariates can be based on likelihood ratio methods.

The derivation of the partial likelihood in (2) is based on the assumption that takeover times are continuous random variables and thus that no ties occur among takeover times. However, in many studies, including ours, time is measured discretely, which results in the presence of ties.[23] When ties are present the following approximate partial likelihood has been proposed. As before, let $T_{(1)} < T_{(2)} < ... < T_{(L)}$ be the ordered takeover times. Let d_k be the number of takeovers at $T_{(k)}$, and let D_k be the set of firms that are taken over at $T_{(k)}$. The approximate partial likelihood is given by

$$\tilde{L(\beta)} \quad \prod_{k=1}^{L} \frac{\exp(\beta' S_k)}{\{ \sum_{j \in R_k} \exp[\beta' X_j(T_{(k)})] \}^{d_k}} , \qquad (3)$$

where $S_k = \sum_{j \in D_k} X_j(T_{(k)})$ and, as before, R_k is the risk set at $T_{(k)}$. If there are ties, the regression coefficients, β, are estimated by the value $\hat{\beta}$ which maximizes (3). The approximate partial likelihood is accurate if, for all k, the number of ties, d_k, is small relative to the size of the risk se R_k. It can be seen from Figure 1 and Table A-I that this condition is satisfied for our data; the ratio of the number of takeovers to the number of firms at risk is always less than 0.05, and a most takeover times it is not greater than 0.03.

In computing (3), we assume that $X_j(T_{(k)}) = X_j^*(T_{(k)} - 1)$, that is, we assume, that the hazard of failure a $T_{(k)}$ depends on the values of covariates at time $T_{(k)} - 1$. This is a natura assumption for our data: since performance measures are not available for the year in which a

firm experiences a takeover, we use instead the last available values of performance measures from the year preceding the year of takeover.

In our application the Cox regression model is implemented using STATA (StataCorp. (1997)).

III. DETERMINANTS OF THE RISK OF TAKEOVER

A. Performance Measures and Size

Descriptive statistics discussed in Section I suggest that targets are inefficient relative to non-targets. Although the relative inefficiency of targets appears to be particularly pronounced when efficiency is measured by the cost per unit of revenue, the assessment of the relative importance of various measures for the risk of takeover requires a multivariate hazard model. Table IV presents the estimation results for the model involving all of our performance measures. In addition to performance and size, our specification also includes the dumm variables indicating the sector a firm is in. Beyond controlling for sectoral effects, these variables can also be interpreted as capturing the role of the takeover mechanism in reallocating resources across sectors. To check for structural change in 1988, we allow the coefficients to differ in each of the subperiods: 1980-88, and 1989-1996.

Insert Table IV approximately here

A remarkable aspect of the estimation results presented in Table IV is that, in addition to size, cost per unit of revenue is the only performance measure which has a coefficient with the same sign *and* that is (highly) significant in *both* subperiods: 1980-88 and 1989-96. Thus the results in Table IV suggest that during the entire observation period, 1980-96, greater *cost inefficiency* relative to the industry standard (median) exposes a firm to a greater risk of takeover. Moreover, Table IV shows that when cost per unit of revenue is included in the hazard model, no other performance measure has an effect on the risk of takeover that is significant in both

subperiods. Both net and operating profit are significant in the second subperiod, but their effects have opposite signs. However, net and operating profit appear to have no significant effect (and the estimated coefficients for both have positive signs) during 1980-88. As suggested by the descriptive statistics, q is indeed only significant in one of the subperiods: 1980-88. Finally, the productivity measure is insignificant in both subperiods.

In summary, industry-adjusted cost per unit of revenue appears to be the only strong and temporally consistent determinant of takeover risk and the effects of other measures seem to be unstable over time. We interpret these results using the distinction between cost and profitability as measures of potential gain from post-takeover cost and revenue restructuring, introduced in Section I.B.

Industry-adjusted cost per unit of revenue is a direct measure of cost inefficiency and, as we have argued, cost inefficiency can be more reliably observed by the outside parties assessing the costs and benefits of a takeover and gains from cost-cutting measures are likely to be easier to predict than outcomes of revenue restructuring of a potential target. *Once cost per unit of revenue is included* in the hazard model, profitability and firm q proxy for other inefficiencies generally stemming from the revenue side of the firm's operations which are not directly captured by the cost inefficiency measure. Since the assessment of prospective gains from revenue restructuring activities of a potential target is likely to involve subjective assessments o a potential target as well as the economic environment (business cycle, new technologies, foreign trade development, *etc),* the effect of performance measures other than cost efficiency is likely to be unstable over time.

Finally, only one sectoral effect, for the technology sector, is significant, but of the opposite sign, in the two subperiods.[24] Since sectoral effects capture a complex process of the

reallocation of resources through takeovers across sectors, we would also not expect them to remain stable over time. Changes in the economic environment, such as shifts in global trade or consumer demand as well as technical progress, are likely to affect the sector-related risk o takeover. Since these changes are inherently dynamic and, in general, unstable over time, we would expect sectoral dummies to be temporally unstable.

B. Cost Inefficiency and Size

Given the apparent importance of cost and size, this section presents the results of an analysis of their effects on the risk of takeover. Extensive statistical analysis of the model specification in Trimbath (2000) suggests that the effects of size and cost on the risk of takeover depend on the magnitudes of these variables. Thus, the specification of our hazard model uses two size variables: one for larger firms with size above the sample median, and one for smaller firms with size below the sample median. In addition to the continuous cost variable, we include a dumm variable for firms with costs above their industry median. This variable indicates a potential for gain in taking over a firm whose efficiency has fallen behind its industry benchmark. We also allow for a change in the parameters of the model in 1988.

Table V presents the results of estimation of three hazard models. The model in the firs column includes only the size variables. The models in the second and third columns include the cost variables, not split and split in 1988, respectively.

Insert Table V approximately here

The results presented in Table V confirm our earlier observations based on the descriptive statistics and the model including all of our performance measures presented in Table IV. The effect of cost on the risk of takeover is positive and highly significant irrespective o whether the cost variables are (column 3) or are not split across subperiods (column 2). In addition to the marginal positive effect of cost on risk, firms with cost per unit of revenue above

the industry median face a significantly greater risk of takeover. For example, an estimate of the cost dummy, reported in the second column of Table V, implies that, *ceteris paribus*, a hypothetical firm with cost above the industry median faces over 2.5 times greater risk o takeover than a firm with cost at the industry median.

The effects of the cost variables are not significantly different in the two subperiods: separate tests for equality of coefficients of the continuous and dummy cost variables failed to reject equality of coefficients with p-values equal to 0.26 and 0.61, respectively. We also note that the estimated coefficients of the other variables, size and sectoral dummies, remain virtuall unchanged, when the cost variables are split across the subperiods.

The results on the effect of size on risk, presented in Table V, show that the magnitude and sign of the effect of size on risk are different in the two subperiods under study. For both smaller and larger firms, the effect of size on risk has become significantly more negative in the 1989-96 subperiod as compared with 1980-88 (p-values for tests of equality in the two subperiods for smaller and larger firms are 0.035 and 0.016, respectively). For smaller firms, the effect of size turns from positive and significant during 1980-88 to negative (though no significant) during 1989-96. For larger firms, the magnitude of the significantly negative coefficient of the size variable during 1980-88 more than quadruples and becomes very highl significant during the 1989-96 subperiod. Finally, it is remarkable that estimates of size coefficients appear to be "robust" with respect to a major change of the specification of the model: they remain virtually unchanged when cost variables are added (in models in columns 2 and 3 of Table V) to the model (in column 1 of Table V) containing only size variables and sectoral dummies. As we shall show in the next Section, the size coefficients also remain unchanged when the other performance measures are added to the model.

Prior analyses of takeovers have suggested and often found that size has a negative effec on the risk of takeover. This negative effect of size on risk has been attributed to the difficulties in financing larger takeover transactions (for example, see Singh (1975) and Hasbrouck (1985)). However, the cost variable includes overhead costs, and thus the marginal increase in size enhances the potential for post-takeover gains in the cost per unit of revenue. This implies tha the effect of size on the risk of takeover might be negative or positive and, in general, should be expected to vary over time depending on the relative strengths of these two opposing effects. In particular, during the periods in which financing of takeover transactions is relatively easy the effect of size on risk is expected to be less negative (and perhaps even positive), as compared with the periods in which financing of takeovers is substantially more difficult. As we shall discuss next, the 1980's was a period characterized by easier access to financing of takeovers. Thus, we would expect the sign and magnitude of the size coefficient to change over time. The results in Table V appear to be consistent with the interpretation given here.

Although an extensive analysis of a significantly more negative effect of size on the risk of takeovers during 1989-96, as compared with 1980-88 is outside the scope of this paper, an explanation based on the changing costs and availability of financing of takeovers appears to have at least some plausibility. The early part of the 1980-88 period included the introduction and rapid growth of the "junk bond era" of takeover financing [25] The early part of the 1980's was also characterized by an antitrust environment favorable to large takeovers. This began to change with the introduction of restrictions on takeover financing. As early as 1983, Congress considered eliminating the tax deduction for interest paid on all debt used in takeovers. In 1986, changes in Federal Reserve margin rules limited the use of high yield securities in takeovers. The turnaround was completed by 1989 when new tax legislation raised the cost of financing for

large takeovers.[26] None of the high yield securities issued in 1990 was reported by issuers as intended for takeover financing (source: Securities Data Corporation).

To gauge the numerical impact of the changing effect of size on risk, we consider two hypothetical firms with the same industry adjusted cost per unit of revenue and in the same sector. Suppose that one of the firms, called A, had a size equal to the median of the sample in both subperiods: $968.43 million and $1,151.64 million, respectively, and the other firm, called B, had a size equal to the third quartile of the sample in each of the subperiods: $2,565.69 million and $3,849.95 million, respectively. Using the estimates reported in the second column of Table V, the larger firm B faced a 6% lower risk of takeover during 1980-88 than the median firm A. This relative risk had fallen precipitously after 1989. During 1989-96, firm B faced a 34% lower risk of takeover than the median firm A.

Table VI presents another example of the impact of changes in the size effect estimated in Table V, on hypothetical changes in risk across the two subperiods for four actual targets taken over before 1989. To focus on the changing deterrent effect of the size of large firms between the two subperiods, we suppose that the targets would have remained equally cost-inefficient in 1989-96 as they were at the time of takeover. Since all firms in the sample grew between the two subperiods, we assume that the four selected firms would have grown between the two subperiods at the same rate as the median firm [27] The examples of actual targets presented in Table VI, illustrate that, due to the changing size effect, the risk of takeover faced by large cost-inefficient firms declined precipitously in the 1990's as compared with the 1980's.

Insert Table VI approximately here

C. Size, Cost and Other Performance Measures

The results presented in Table V show that cost inefficiency appears to be an important determinant of the risk of takeover. Moreover, the results presented in Table IV suggest that *once*

the cost variables are included in the model, other performance variables are at most significan in only one of the subperiods and some appear to have a "wrong" sign. Since the performance measures used in this study are significantly correlated with each other, Table VII reports estimation results for the models including cost and one other performance measure as well as for the models with performance measures other than the cost variables.

Insert Table VII approximately here

The models presented in columns 1, 3 and 5 of Table VII include one other performance measure in the model of Table V. Since we also want to compare the models including the cost variable with the specification in which another performance measure is used *instead* of the cos variable, columns 2, 4, and 6 of Table VII present the results of the models for each performance measure that do not include the cost variables. We do not display results for models involving productivity since productivity effects turned out to be insignificant irrespective of whether the cost variable was or was not included in the model.[28] Since the coefficients for net profit are no significantly different in each of the subperiods in the model without costs (p-value equal 0.38) and are not significant in both subperiods in the model with costs, we do not split the net profit variable across time.

The results presented in columns 1, 3 and 5 of Table VII show that the effect of firm q is significant in only one subperiod (1980-88) and no other performance measure is significant in either of the subperiods. It is also worth noting that the estimates of the coefficients of the cost and size variables, as well as sectoral dummies, remain virtually unchanged when the other performance measures are added to the model. Thus, the model from Table V appears to be remarkably robust.

These results are consistent with our earlier argument. The post-takeover gains fro restructuring activities related to the non-cost side of firm operations are relatively more difficult to predict. Consequently, the effects of performance measures (such as profitability or q), tha proxy for these activities in models including costs, are likely to be unstable over time and thus the coefficients of these variables might be significant in some subperiods, and not significant in others.

In the models excluding the cost variables (columns 2, 4 and 6), the models involving profitability measures show significant effects in both subperiods, but the effect on the risk o takeover of operating profit changes over time (the p-value for equality of coefficients in the two subperiods is equal to 0.02). The coefficient of q is only significant in the first subperiod. Thus, as emphasized throughout this paper, a well-specified model of the risk of takeover should, in general, allow for structural changes over time. As we noted in the introduction, earlier studies of determinants of takeovers were based on samples from different time periods and used statistica methodology that inherently precluded the modeling of temporal instability. Our results in Table VII and the rest of the paper may help explain some of the inconsistencies among those earlier studies.

Although profitability measures are significant in both subperiods in models *excluding* the cost variables, these models have significantly lower explanatory power. This can be readil seen by comparing the value of the log-likelihood functions in models with and without costs. For all models displayed in Table VII, the log-likelihood of the model drops precipitously when the cost variables are eliminated from the model specification.[29] These results combined with the lack of significance of the profitability measures in the hazard models *including* the cost variables, suggest that profitability is a proxy for the cost variables. This conclusion should be

contrasted with the usual interpretation of cost as a proxy for profitability

IV. CONCLUDING REMARKS

The evidence presented in this paper suggests that a Fortune 500 corporation faces a higher risk of takeover if its cost performance lags behind its industry benchmark and thus variables capturing the cost inefficiency, relative to industry benchmarks, should be included in the specification of the models of the risk of takeover. The paper fails to find consistent evidence for the effects of other conventionally used performance measures, such as profitability and q, on the risk of takeover. Although this paper suggests that the primary function of takeovers appears to lie in targeting the relative cost inefficiency, further research is needed to examine the role o takeovers in correcting dynamic inefficiency related to the revenue side of corporate operations.

REFERENCES

Ambrose, Brent W. and William L. Megginson, 1992, The role of asset structure, ownership structure, and takeover defenses in determining acquisition likelihood, *Journal of Financial and Quantitative Analysis*, 27(4), 575-589.

Andersen, Per Kragh, O. Borgan, R. D. Gill, and N. Keiding, 1993, *Statistical Models Based on Counting Processes* (Springer-Verlag, New York, N.Y.).

Billett, Matthew T., 1996, Targeting capital structure: the relationship between risky debt and the firm's likelihood of being acquired, *Journal of Business* 69(2), 173-192.

Cheh, John J., Randy S. Weinberg and Ken C. Yook, 1999, An application of an artificial neural network investment system to predict takeover targets, *Journal of Applied Business Research*, 15, 33-45.

Cox, D.R., 1972, Regression models and life-tables, *Journal of the Royal Statistical Society Series B* 34, 187-220.

Cudd, Mike, and Rakesh Duggal, 2000, Industry distributional characteristics of financial ratios: an acquisition theory application, *The Financial Revie* 41, 105-120.

Davis, Gerald F. and Suzanne K. Stout, 1992, Organization theory and the market for corporate control: a dynamic analysis of the characteristics of large takeover targets, 1980-1990, *Administrative Science Quarterly* 17, 605-633.

Dickerson, Andrew P., Heather D. Gibson, and Euclid Tsakalotos, 1998, Takeover risk and dividend strategy: a study of UK firms, *Journal of Industrial Economics* 46(3), 281-300.

Fleming, T. R., and D. P. Harrington, 1991, *Counting Processes and Survival Analysis* (Wiley, New York, NY).

Frydman, Roman, Cheryl Gray, Marek Hessel, and Andrzej Rapaczynski, 1999, When does privatization work? The impact of private ownership on corporate performance in the transition economies, *Quarterly Journal of Economics* 114(4), 1153-1191.

Frydman, Roman, Marek Hessel, and Andrzej Rapaczynski, 2000, Why ownership matters Politicization and entrepreneurship in the restructuring of enterprises in Central Europe, mimeo.

Grosfeld, Irena and Gerard Roland, 1997, Defensive and strategic restructuring in Centra European enterprises, *Journal of Transforming Economies and Societies* 3, 21-46.

Hasbrouck, Joel, 1985, The characteristics of takeover targets: q and other measures, *Journal of Banking and Finance* 9, 351-362.

Herman and Lowenstein, 1988, The efficiency effects of hostile takeovers, in Coffee, John C. Jr., Louis Lowenstein, and Susan Rose-Ackerman, eds.: 1988, *Knights, Raiders and Targets: The Impact of Hostile Takeovers* (Oxford University Press, New York).

Kalbfleisch, J. D., and R. L. Prentice, 1980, *The Statistical Analysis of Failure Time Data* (Wiley, New York, NY).

Lichtenberg, Frank R., 1992, *Corporate Takeovers and Productivity* (MIT Press, Cambridge, MA.).

Lin, DY and LJ Wei, 1989, The robust inference for the Cox proportional hazards model, *Journal of the American Statistical Association*, 84(408), 1074-1078.

Matsusaka, John G., 1993, Takeover motives during the conglomerate merger wave, *Rand Journal of Economics* 24(3), 357-379.

Mørck, Randall, Andrei Shleifer, and Robert W Vishny, 1988, Characteristics of targets o hostile and friendly takeovers, in Auerbach, Alan J., 1988, *Corporate Takeovers: Causes and Consequences* (University of Chicago Press, Chicago, Ill.).

Mørck, Randall, Andrei Shleifer, and Robert W Vishny, 1989, Alternative mechanisms for corporate control *American Economic Review* 79(4), 842-852.

Mueller, Dennis C. (ed.), 1980, *The determinants and effects of mergers: an international comparison* (Königstein/Ts, Oelgeschlager, Gunn & Hain, Verlag A. Hain, Cambridge, Mass.).

Neumark, David and Steven A. Sharpe, 1996, Rents and quasi rents in the wage structure: evidence from hostile takeovers, *Industrial Relations* 35(2), 145-79.

Palepu, Krishna G., 1986, Predicting takeover targets: a methodological and empirical analysis, *Journal of Accounting and Economics* 8, 3-35

Pound, John, 1992, Raiders, targets, and politics: The history and future of American corporat control, *Journal of Applied Corporate Finance* 5, 6 - 18.

Powell, Ronan G., 1997, Modelling takeover likelihood, *Journal of Business Finance and Accounting* 24(7/8), 1009-1030.

Ravenscraft, David J., Scherer, F.M., 1987, *Mergers, Sell-Offs, and Economic Efficiency* (Brookings Institution, Washington, D.C.).

Singh, Ajit, 1975, Take-overs, economic natural selection, and the theory of the firm: Evidence from the postwar United Kingdom experience, *The Economic Journal* 85, 497-515.

StataCorp., 1997, *Stata Statistical Software: Release 5.0* (Stata Corporation, College Station, TX).

Trimbath, Susanne, 2000, The evolution of the determinants and effects of corporate takeovers in the US, 1980-1997, Dissertation, New York University, Department of Economics, (UMI, forthcoming).

TABLE I
Sectors

The sectors are described in this table by the industries that are assigned to each. Every firm in the study is assigned to one of six sectors based on its industry. The sectors follow the definitions used in the Dow Jones Stoxx Index.

	Description
Sector 1: Basic Resources	Forest products, Mining diversified, Non-ferrous metals, Paper products, Precious metals, Steel, Chemicals
Sector 2: Cyclical Consumer Products	Auto parts & equipment, Auto manufacturers, Airlines, Entertainment & leisure, Home furnishings & appliances, Home construction, Lodging, Textiles & apparel, Media, Broadline retailers, Specialty retailers
Sector 3: Non-cyclical Consumer Products	Cosmetics & personal care, Food retailers & wholesalers, Consumer & household products & services, Medical supplies, Tobacco, Health care providers, Beverages, Pharmaceuticals
Sector 4: Ener	Coal, Oilfield equipment & services, Oil companies, Pipelines
Sector 5: Industrial	Building materials, Heavy construction, Air freight & couriers, Containers & packaging, Electric components & equipment, Factory equipment, Diversified industrials, Heavy machinery, Marine transportation, Industrial & commercial services, Trucking, Transportation equipmen
Sector 6: Technology	Aerospace & defense, Communication technology, Computers, Diversified technology, Industrial technology, Medical & biological technology, Office equipment, Software

TABLE II
Measures of Performance and Size

The variables used to measure performance and size in this study are defined in this table. The terms used in the definitions (e.g., "Net Sales) are as defined in *Compustat*.

Variable	Definition
Net Profit (Rate)	(Net Income) / (Total assets)
Operating Profit (Rate)	(Operating Income after depreciation)/ (Total assets)
Cost per unit of revenue	(Cost of goods sold + Selling, general and administrative expenses) / (Net sales)
(Labor) Productivity	(Net Sales, in 1980 dollars)/(Number of employees)
(Proxy for Tobin's) q	((Common shares outstanding *times* Annual closing price) + preferred stock + long term debt + debt due in one year) / (Total assets)
Size	Net Sales, in 1980 dollars

TABLE III
Performance of Targets and Non-Targets

For this table, each firm's performance was averaged during a given subperiod: 1980-88 and 1989-1996. All variables, except size, are industry adjusted. Industry adjusted observations calculated as firm *minus* the industry median, where industry median is matched on 2-digit SIC code and year of observation. The table entries are then the medians of those industry-adjusted averages of observations for firms. The target medians are bold where they are significantly different from non-targets in the same observation subperiod (1980-88 or 1989-1996). Size is measured as revenue (net sales, $millions, 1980). Cost is the (cost of goods sold *plus* selling, general and administrative expenses) per unit of revenue (%). Net profit is net income *divided* by assets (%). Operating profit is operating income *divided* by assets (%). Productivity is revenue ($millions, 1980) per thousand of employees. Firm q is the ratio of (market value of common stock *plus* book value of preferred stock and debt) to total assets. Number of 1990-97 targets (63) that we have the observations for in th subperiod 1989-96 is smaller than the actual number of 1990-97 targets (78), due to delayed entry of 15 firms.

Observation subperiod:	**1980-88**	**1989-96**
	NON-TARGETS	
	Median of Averages of Firm-Observations in Each Subperiod	
Size	953	1604
Cost	-9.6	-19.4
Net profit	0.8	1.1
Operating profit	1.7	2.6
Productivity	7.81	17.32
Firm q	-0.03	-0.09
Number of firms	550	624
	TARGETS	
Target in:	***1981-89***	***1990-97***	***1990-97***
Size	791	792	**1105*** **
Cost	**0.3*** **	**-1.0*** **	**-0.03*** **
Net profit	**-0.9*** **	**-0.2***	**-0.5*** **
Operating profit	**-0.4*** **	0.3	**1.3***
Productivity	5.20	2.00	16.58
Firm q	**-0.13*** **	-0.04	-0.12
Number of firms	198	63	78

***, ** and * indicate Wilcoxon rank sum statistics significant at 1, 5 and 10 percent, respectively.

TABLE IV
Size and All Performance Measures and the Risk of Takeover

We estimate the risk of takeover using the Cox proportional hazard model with robust standard errors (Lin and Wei, 1989). Coefficients are the change in the logs-odds per unit. Standard errors are in parentheses, significant coefficients are bold-faced. Standard errors are adjusted for clustering on the firm identifier. Size is measured as revenue (net sales, $millions, 1980). Cost is the (cost of goods sold *plus* selling, general and administrative expenses) per unit of revenue (%). Net profit is net income *divided* by assets (%). Operating profit is operating income *divided* by assets (%). Productivity is revenue ($millions, 1980) per thousand of employees. Firm q is the ratio of (market value of common stock *plus* book value of preferred stock and debt) to total assets. All measures (except size) adjusted for median performance in the same 2-digit SIC code industry and year. Dummy variables fo the economic sectors in each subperiod were included in the regression, but only significant coefficients are reported. Sector dummy variables are equal to one if the firm is in that sector and the observation is in that subperiod, zero otherwise.

Size, 1980-1988	**-0.00006****
	(0.00002)
Size, 1989-1996	**-0.00017*****
	(0.00005)
Cost, 1980-1988	**0.038*****
	(0.006)
Cost, 1989-1996	**0.024*****
	(0.005)
Net profit, 1980-1988	0.005
	(0.008)
Net profit, 1989-1996	**-0.014*****
	(0.004)
Operating, 1980-1988	0.018
	(0.012)
Operating profit, 1989-1996	**0.017***
	(0.009)
Productivity, 1980-1988	-0.0006
	(0.0005)
Productivity, 1989-1996	-0.0017
	(0.0011)
Firm q, 1980-1988	**-0.57*****
	(0.16)
Firm q, 1989-1996	-0.028
	(0.13)
Sectors	
Technology, 1980-88	**-0.57***
	(0.30)
Technology, 1989-96	**0.71***
	(0.40)
Test Statistics for the Model	
Number of firms	896
Number of takeovers	276
Number of observations	10,784
Degrees of freedom	22
Chi-squared	156.1***

***, ** and * indicate test statistics significant at 1, 5 and 10 percent, respectively.

TABLE V
Size and Cost Inefficiency and the Risk of Takeover

We estimate the risk of takeover based on size and costs using the Cox proportional hazard model with robust standard errors (Lin and Wei, 1989). Coefficients are the change in the logs-odds per unit. Standard errors are in parentheses, significant coefficients are bold-faced. Standard errors are adjusted for clustering on the firm identifier. Size is measured as revenue (net sales, $millions, 1980). Size is split according to the medians of the sample in respective subperiods. Cost is the (cost of goods sold *plus* selling, general and administrative expenses) per unit of revenue (%). Costs are adjusted for median performance in the same 2-digit SIC code industry and year. Cost above industry is a dummy variable equal one if the firm's cost is greater than the industry median, zero otherwise. Dummy variables for the economic sectors in each subperiod were included in the regression, but only significant coefficients are reported. Sector dummy variables are equal to one if the firm is in that sector and the observation i in that subperiod, zero otherwise. All models estimated using 896 firms, 276 takeovers and 10,784 observations.

Firms smaller than the sample median			
Size, 1980-1988	**0.00046***	**0.00054****	**0.00057****
	(0.00024)	(0.00023)	(0.00023)
Size, 1989-1996	-0.00040	-0.00009	-0.00013
	(0.00033)	(0.0030)	(0.0031)
Firms larger than the sample median			
Size, 1980-1988	**-0.00004***	**-0.00005****	**-0.00004****
	(0.00002)	(0.00002)	(0.00002)
Size, 1989-1996	**-0.00019*****	**-0.00018*****	**- 0.00018*****
	(0.00006)	(0.00005)	(0.00006)
Cost, 1980-1996		**0.018*****	
		(0.004)	
Cost above industry, 1980-1996		**0.99*****	
		(0.15)	
Cost, 1980-1988			**0.024*****
			(0.005)
Cost, 1989-1996			**0.016*****
			(0.004)
Cost above industry, 1980-1988			**0.91*****
			(0.18)
Cost above industry, 1989-1996			**1.09*****
			(0.31)
Sectors			
Non-Cyclical Consumer Products, 1980-1988		**0.35***	**0.36***
		(0.19)	(0.19)
Technology, 1980-1988	**-0.62****		
	(0.30)		
Technology, 1989-1996		**0.83****	**0.79****
		(0.40)	(0.39)
Test Statistics for the Model			
Degrees of freedom	14	16	18
Chi-squared	41.1 ***	174.4***	209.1***

***, ** and * indicate test statistics significant at 1, 5 and 10 percent, respectively.

Table VI
Relative Risk for Large Targets in the Two Subperiods

The relative risk of takeover is estimated using the coefficients in the second column of Table V with the appropriate size coefficient corresponding to the observation year. The hypothetical size of each target firm in 1989-96 is computed under the assumption that each of the firms would have grown at the same rate as the median firm. Estimates are relative to the firm with median size.

			Estimated relative risk	
Target (date of takeover)	**Size**	**Costs**	**Actual**	**Hypothetical in 1989-96**
Cities Service Co. (1982)	7,763	0.090	2.26	0.45
General Foods Corp. (1985)	8,053	0.011	1.93	0.36
RCA Corp. (1986)	7,908	0.023	1.98	0.38
Safeway Inc. (1986)	17,319	0.004	1.20	0.02

Table VII
Model with Costs Versus Models with Other Performance Measures

We estimate the risk of takeover based on additional performance measures using the Cox proportional hazard model with robust standard errors (Lin and Wei, 1989). Coefficients are the change in the logs-odds per unit. Standard errors are in parentheses, significant coefficients are bold-faced. Standard errors are adjusted for clustering on the firm identifier. Size is measured as revenue (net sales, $millions, 1980). Size is split according to the medians of the sample in respective subperiods. Cost is the (cost of goods sold *plus* selling, general and administrative expenses) per unit of revenue (%) .Net profit is net income *divided* by assets (%). Operating profit is operating income *divided* by assets (%). Productivity is revenue ($millions, 1980) per thousand of employees. Firm q is th ratio of (market value of common stock *plus* book value of preferred stock and debt) to total assets. All measures (except size) adjusted for median performance in the same 2-digit SIC code industry and year. Performance above (below) industry are dummy variables equal one if the firm's performance is greater than (less than) the industry median, zero otherwise. Dummy variables for the economic sectors in each period were included in the regression, but only significant coefficients are reported. Sector dummy variables are equal to one if the firm is in that sector and the observation is in that period, zero otherwise. All models estimated using 896 firms, 276 takeovers and 10,784 observations

Firms smaller than the sample median							
Size, 1980-1988	**0.00054****	**0.00045***	**0.00052****	**0.00050****	**0.00052****	**0.00045***	**0.00045***
	(0.00023)	(0.00024)	(0.00023)	(0.00024)	(0.00023)	(0.00024)	(0.00024)
Size, 1989-1996	-0.00008	-0.0003	-0.00008	-0.00033	-0.00009	-0.00039	-0.00039
	(0.00030)	(0.0003)	(0.00030)	(0.00032)	(0.00030)	(0.00032)	(0.00032)
Firms larger than the sample median							
Size, 1980-1988	**-0.00005****	**-0.00003***	**- 0.00005****	**-0.00003***	**-0.00005****	**-0.00004****	**-0.00004****
	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)
Size, 1989-1996	**-0.00018*****	**-0.00018*****	**- 0.00018*****	**-0.00018*****	**-0.00018*****	**-0.00019*****	**-0.00019*****
	(0.00005)	(0.00006)	(0.00006)	(0.00006)	(0.00005)	(0.00006)	(0.00006)
Cost, 1980-1996	**0.018*****		**0.020*****		**0.019*****		
	(0.004)		(0.005)		(0.004)		
Cost above industry, 1980-1996	**0.99*****		**1.02*****		**0.93*****		
	(0.15)		(0.16)		(0.16)		
Net profit rate, 1980-1996	-0.001	**-0.011*****					
	(0.004)	(0.001)					
Operating profit rate, 1980-1988			0.008	**-0.033*****			
			(0.008)	(0.007)			
Operating profit rate, 1989-1996			0.0026	**-0.017*****			
			(0.017)	(0.002)			
Firm q, 1980-1988					**-0.28****	**-0.60*****	**-0.6027*****
					(0.14)	(0.15)	(0.1505)
Firm q, 1989-1996					0.013	-0.07	-0.0747
					(0.12)	(0.13)	(0.1285)

***, ** and * indicate test statistics significant at 1, 5 and 10 percent, respectively.

(Table VII continued on next page)

Table VII Model with Costs Versus Models with Other Performance Measures (continued)

Sectors						
Non-cyclical consumer products, 1980-1988	**0.33***		**0.32***		**0.35***	
	(0.19)		(0.19)		(0.19)	
Technology Sector, 1980-1988		**-0.62****		**-0.61****		**-0.62****
		(0.30)		(0.31)		(0.30)
Technology Sector, 1989-1996	**0.84****		**0.86****		**0.82****	
	(0.40)		(0.41)		(0.40)	
Test Statistics for the Model						
Log Likelihood	-1,700.2	-1,755.5	-1,699.9	-1,751.0	-1,698.4	-1,752.9
Degrees of freedom	17	15	18	16	18	16
Chi-squared	176.1***	156.7***	180.9***	167.99**	182.5***	62.6***

***, **, and * indicate test statistics significant at 1, 5 and 10 percent, respectively.

APPENDIX

TABLE A-I
Number of Firms and Targets by Yea

This table gives the number of firms in the study for each year, The date is year of observation. Data on targets ends in the year before the takeover was completed. Hence, the 13 targets listed for Date 1980 were taken over in 1981, etc. The column total denotes the total number of firms in the sample. The number of firms each year differs from the total since some firms do not survive for the entire sample period and some firms enter with delay.

Date	Firms	Targets
1980	679	13
1981	668	14
1982	665	9
1983	661	20
1984	668	24
1985	657	32
1986	635	26
1987	642	33
1988	619	27
1989	607	13
1990	607	6
1991	607	2
1992	618	7
1993	621	8
1994	623	17
1995	624	7
1996	583	18
Total	896	276

TABLE A-II
Sectoral Distribution of Sample Firms

The average number of firms in each sector is presented in this table. Every firm in the study is assigned to one of six sectors based on its industry. The sectors follow the definitions used in the Dow Jones Stoxx Index.

	Average Number of Firms Per Annum
Sector 1: Basic Resources	115
Sector 2: Cyclical Consumer Products	157
Sector 3: Non-cyclical Consumer Products	118
Sector 4: Energy	
Sector 5: Industrial	377
Sector 6: Technolog	811
All Sectors	634

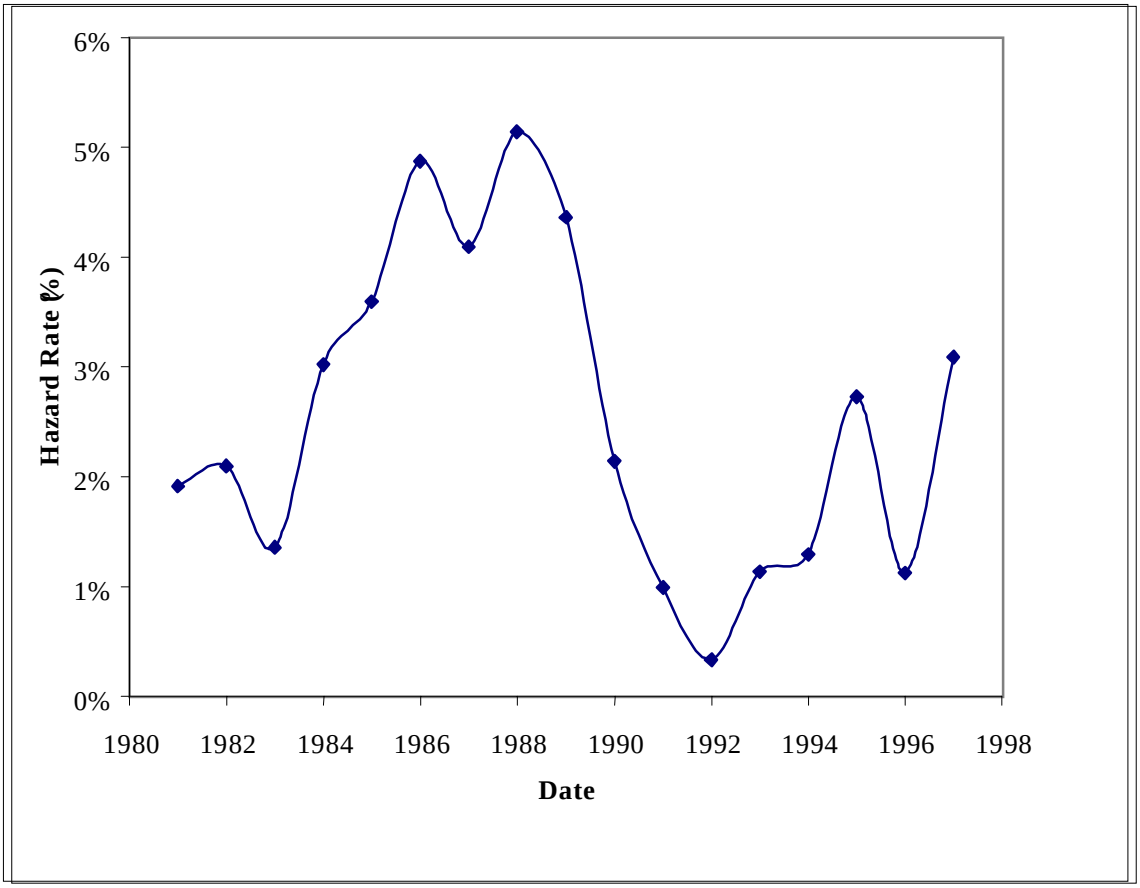

Figure 1. Annual hazard rate. The simple annual hazard rate shown in the figure is calculated as [number of targets] / [total number of firms at risk] per year. The date is the year of the takeovers used in the hazard rate

FOOTNOTES

[1] Separating takeover targets into subsets defined by the reaction of the target's management to an initial bid have also failed to produce consistent results. The targets of hostile takeovers are reported to be relatively poo performers (Mörck, Shleifer and Vishny (1988)), relatively better performers (Herman and Lowenstein (1988)) and not different from other firms (Davis and Stout (1992)).

[2] For earlier evidence of changes in the risk-size relationship across time and/or across levels of size, see Herman and Lowenstein (1988), Powell (1997), Singh (1975), and Neumarke and Sharpe (1996).

[3] See Mörck, Shleifer and Vishny (1988) for an example of the use of probit models and Palepu (1986) for an example of the use of logit models in the context of takeovers. The only prior use of hazard models in the study of takeovers was Davis and Stout (1992) and Dickerson et. al. (1998). Davis and Stout focused on the implications of takeovers for organizational theories of the firm. They did not examine changes in risk across time or levels of performance measures. Dickerson's study was based on UK takeovers from 1948-1970 and focused on dividend policy as the determinant of risk. They examined changes in marginal risk for dividends and investment only.

[4] All observations in the Compustat research file were excluded, including firms that were deleted for non-takeove reasons. This might have eliminated a few very poor performers who were deleted b *Compustat* (moved to the Research files) due to bankruptcy or other failures.

[5] Observations with footnotes in *Compustat* denoting an acquisition that increased net sales by at least 50% were excluded from the computation of the industry medians. However, only the observation in the year the takeover closed was excluded to avoid unusual figures that are due to the transaction and not strictly performance.

[6] Since the performance of a firm and an industry median are likely to covary in response to macroeconomic (business cycle) shocks, regulatory and other changes in the environment, industry adjustment also makes the performance measures comparable across time.

[7] While various scaling measures have been used for profits, assets are the preferred measure, though it is not without problems. For example, the book value of assets can be affected by the choice of depreciation accounting method. Still, return on assets is a conventional measure of profitability in financial studies.

[8] The reported profit rates depend on various accounting conventions making them a less reliable measure of th short-run efficiency. Net income is affected by management's financing choices and other activity commonly known as "earnings management".

[9] We do not claim here that cost-cutting measures involve no risks, but that these risks tend to be better known and to involve less radical uncertainty than those inherent in revenue-restructuring activities. This interpretation of the distinction between revenue and cost restructuring is advanced and further discussed in Frydman, *et al* (1999) and Frydman, Hessel, and Rapaczynski (2000). For an early discussion, see Grosfeld and Roland (1997).

[10] For example Ravenscraft and Scherer (1987) used the equivalent of 1 *minus* (cost per unit of revenue) as a prox for profitability.

[11] For an earlier use of cost per unit of revenue as a measure of static efficiency gains, see Frydman, *et al* (1999).

[12] Lichtenberg (1992) used Total Factor Productivity in his study of the effect of changes in control fo manufacturing plants. (In this paper we investigate, changes in control on the firm rather than plant level.)

[13] Previous studies used the book value of assets (Ravenscraft and Scherer (1987) and Cudd and Duggal (2000)) or market value of equity (Hasbrouck (1985) and Morck, Schleifer and Vishny (1989)) in constant dollars to measure size. The book value of assets may fall with depreciation even though the underlying assets remain in use at the firm. Market values are subject to intra-firm variation that may be more closely associated with changes in performance than firm size. Though sales seem a better measure of firm size and are superior as a direct cost-related indicator of potential short-run efficiency gains, in our sample of firms the three measures of size are highl correlated: the correlation coefficients for sales with assets and market value are 0.87 and 0.68, respectively. The correlation coefficient for assets with market value is 0.67. Moreover, the results concerning the effect of size on the risk of takeover reported in this paper remain virtually unchanged when assets or market value are used a measures of size instead of sales in the estimated hazard models.

[14] As we discuss further in Section III.B. below, we would expect the potential gains from takeovers of large inefficient firms to be significantly greater than gains from takeovers of smaller firms.

[15] See Section III.B. and reference therein for a discussion of the role of size for the risk of takeover.

[16] Adjusting the size variable might also obscure its meaning. For example, the adjusted size of a large firm, which is smaller than the median firm in its industry, could be smaller than the adjusted size of a relatively small firm, which is *larger* than its industry median. However, these cases are rare in our sample and adjusted and unadjusted size variables are highly correlated (the correlation coefficient is 0.999). Furthermore, estimation results for hazard models using an adjusted size variable are very similar to the results reported here. For a detailed analysis of such models, see Trimbath (2000).

[17] This anticipates our presentation of the estimation results in Section III, where we will further discuss the rationale for structural change of the risk model in approximately 1988.

[18] Thus for targets during 1981-89, observations used to compute averages of performance per subperiod are available only for part of the subperiod, that is until the year preceding the takeover. The same is true for averages over 1990-97 for targets during 1990-97. Note, however, that for targets during 1989-96, averages of observations are computed over the *entire* subperiod 1980-88.

[19] Detailed analysis of this phenomenon is outside the scope of this paper. It seems plausible, however, that the heightened threat of takeovers during the 1980's was an important factor behind the apparent drive by the managers of non-target firms to implement efficiency-enhancing restructuring of their firms.

[20] For a contrary suggestion that targets are often better performers see Herman and Lowenstein (1988) and Ravenscraft and Scherer (1987). But see Matsusaka (1993) for a further analysis of the Ravenscraft and Scherer findings, showing that their results were influenced by the inclusion of many small, privately held firms.

[21] For example, if a logit or probit model were estimated for our sample for the period 1980-1985, the 26 firms that were taken over in 1986 would have been considered as non-targets in 1985.

[22] As can be seen from Table A-I in the Appendix, 217 firms had their initial public offering, and thus publicly available data, after 1980. Despite the unavailability of data for these firms for some time after the beginning of the study, these firms can be part of our sample.

[23] In our study, time is measured in years relative to 1980, so that possible values of takeover times are 1, 2, ..., 17, representing years 1981 to 1997

[24] However, as we shall show in the following sections, sectoral dummies are much more stable when the model involves cost variables and one other performance measure only.

[25] Several factors make it virtually impossible to collect reliable statistics on the use of high yield financing fo takeovers. For competitive reasons, buyer firms may not reveal their intention to use the proceeds of new debt fo takeovers. Conversely, firms that reveal their intention may not be successful in completing a takeover.

[26] The market for high yield securities virtually collapsed at about the same time, thereby removing this source of financing altogether. The two events are not necessarily unrelated. See, for example, Lichtenberg (1992) for a discussion of the impact of consideration of this tax code change on the capital markets.

[27] Even under the assumption that these targets would have remained the same size, which would have made them much smaller relative to the median firm, the risk would have declined between the two subperiods due to the shifts of the size coefficients in Table V. We also ignore the sectoral effects that, in any case, would have made th hypothetical decline of risk for the two firms in the non-cyclical consumer sector, General Foods and Safeway, even greater.

[28] To conserve space, we also do not display models with dummy variables for performance below industry median, for measures other than cost. These dummy variables are not significant in any of the models including costs (including a model without the marginal effects for net profit) and significant only in some isolated subperiods in models without costs. Furthermore, neither the inclusion of these variables nor specifications using unadjusted performance measures affects any of the conclusions reached in this or other sections of the paper.

[29] The p-values of each of the likelihood ratio tests comparing models with and without costs--columns 1 and 2, 3 and 4, 5 and 6-- are substantially smaller than 0.001.