WORKING
PAPERS

MERGERS, EVENT STUDIES AND SYSTEMATIC RISK

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WORKING PAPER NO. 145

October 1986

BUREAU OF ECONOMICS
FEDERAL TRADE COMMISSION
WASHINGTON, DC 20580

MERGERS, EVENT STUDIES AND SYSTEMATIC RISK

BY

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October 1986

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ACKNOWLEDGEMENTS

We would especially like to thank Gerry Butters and Pauline Ippolito for the many helpful comments and suggestions at all stages of the preparation of the report. Useful comments were provided by Richard Higgins and Mike Salinger. We would also like to thank Catherine Daniels for her help with the data preparation.

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August 18 1986

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MERGERS, EVENT STUDIES AND SYSTEMATIC RISK

ABSTRACT

The combination of industrial organizational theory and financial data have been used to evaluate the economic effects of mergers. Recent studies attempt to identify the economic sources of merger-created gains by examining the stock market reaction of rival firms. The use of rival firms is useful because the monopoly power and efficiency hypotheses can have different predictions concerning the effects of a merger on the returns of the rival firms. Eckbo (1983), and Eckbo and Weir (1985) reject the monopoly power hypothesis because events which reduce the likelihood of a merger (*e.g.* FTC complaint) do not cause rival firms to realize negative abnormal stock market performance. Stillman (1983) rejects the monopoly power hypothesis for the same reason and also observes that the rival firms do not realize abnormal gains on the dates when the likelihood of a merger increases (*e.g.* merger announcement).

Statistical tests of the hypotheses concerning the impacts of merger events on the abnormal stock market performance of rival firms are based on the "event test" methodology. In most studies abnormal performance is defined as the deviation of a firm's realized return from the expected risk-adjusted return. The expected risk-adjusted return is based on the pre-event estimated systematic or beta risk of the firm.

A problem with the "event test" methodology is that if the announcement of a merger (or any merger-related "event") changes the systematic risk of the rival firms, and abnormal performance is calculated over a post-event time window, using a pre-event systematic risk confounds abnormal performance with changes in risk. In the appendix to this report, we combine the theory of the firm with a financial model of asset returns to derive an equilibrium expression for systematic risk. A direct implication of this expression is that merger-related events will cause systematic risk to shift.

Using the Stillman data of contested horizontal mergers we find strong empirical evidence that beta is endogenous to merger-related events. In particular, the systematic risk of rival firms increase (decrease) after events which decrease (increase) the likelihood of merger. This systematic change in beta risk causes abnormal return measures to be biased.

Using post-event data to estimate systematic risk corrects for this bias (actually it over-corrects). The empirical results suggest that abnormal performance measures are sensitive to the particular systematic risk that is used to adjust the realized return. Even after correcting for the bias in abnormal

returns, though the rival firms did have a significant abnormally positive return after events which increase the likelihood of a merger, they did not have a significant abnormal loss after events which decrease the likelihood of a merger. Therefore, the empirical evidence is still not entirely consistent with the monopoly power hypothesis.

The finding that there is no significant abnormal change in value for the rival firms around "negative" events raises interesting questions since these same firms experience a large and significant change in systematic risk. These conflicting pieces of evidence are discussed in the final section of the report.

SECTION 1

INTRODUCTION

The use of capital market return data to investigate issues in industrial organization is relatively new and gaining in popularity among academic economists and those who formulate public policy.[1] The combination of industrial organization theory and financial data is used most often to evaluate the impact of mergers on stockholder wealth.[2] Capital market data is useful in measuring the economic effects of mergers because such data presumably reflects all available information regarding the expected future cash flows of the combining firms. Because of the efficiency of the capital market, prices react quickly to changes in information.[3] As a result, following the unexpected announcement of a merger, returns for merging firms can provide a summary of the expected effects of the merger on the future cash flows of the firms.[4]

There are a large number of studies that investigate the wealth impacts of mergers. These studies show that, as a result of a merger proposal, the shareholders of target firms receive large abnormal positive returns while the shareholders of the acquiring firms tend to earn a normal rate of return.[5] From the perspective of a regulator, most merger impact studies are deficient because they do not identify the economic cause of the increase in the target firm's value. As a result, they do not assist the regulator in distinguishing between mergers that will result in increased monopoly power and higher output prices from mergers that will result in efficiency or synergy

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[1] For an overview of this literature see Schwert (1981).

[2] For a review of this literature see the survey article by Jensen and Ruback (1983).

[3] For an excellent discussion of the theory of efficient capital markets and the empirical evidence concerning the theory see Fama (1970).

[4] Efficient capital markets and the assumption of rational expectations implies that across a large sample of mergers the market is unbiased in the way it revalues the assets of a firm. For an alternative interpretation of financial data see Shiller (1981) or Summers (1986).

[5] Some of these papers include Dodd (1980), Asquith (1983), Mandelker (1974), Dodd and Ruback (1977). For a survey of results see Jensen and Ruback (1983).

gains. Studies that investigate the wealth impacts on the shareholders of the merging firms can not distinguish between these two possibilities because the expected future cash flows of a firm would increase in either case.

Recent studies attempt to identify the economic sources of merger-created gains by examining the stock market reactions of all firms that are potentially affected by the merger. Eckbo (1983) and Stillman (1983) incorporate conventional industrial organization hypotheses into "event-test-based" statistical tests. In very similar papers these authors hypothesize that if a merger is expected to cause higher output prices because of an expected gain in monopoly power in the industry, then the merging firms' rivals should experience an increase in value after the announcement of the merger because they are expected to partake in the gain from increased monopoly power.[6] The increase in industry concentration reduces the costs of tacit or overt collusion, and all participating firms share in the gain from higher industry prices. Conversely, information that reduces the likelihood of a merger taking place should lower the value of the rival firms in the case of a merger for monopoly.

The predictions of the industry-wide efficiency hypothesis concerning the change in value of rival firms after merger-related events are identical to those of the monopoly power hypothesis. Industry-wide efficiency gains arise from the informational impact of a merger announcement. The announcement of an efficiency enhancing merger may disclose new technology to rivals who can achieve similar efficiency through similar mergers. The industry-wide efficiency gains hypothesis implies that a takeover between two firms in an industry may raise the probability of a takeover of other firms in the industry. Since target firms on average experience large positive returns, an increase in the probability of takeover may cause the capital market to capitalize these potential gains for the target's rivals and increase the value of all firms in the industry.[7] Conversely, events which decrease the likelihood

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[6] This rules out the possibility that the gain in monopoly power to the merging firms increases the probability that they will deliberately raise the cost of firms. It is generally believed that price predation is not a serious consideration and therefore that an abnormal loss to the rival firms after the announcement of a merger is inconsistent with the monopoly power hypothesis.

[7] It is possible that an increase in efficiency for all firms could reduce wealth (*e.g.* in agriculture) but that under appropriate conditions (elastic demand) the above scenario seems plausible.

that the merger will occur in the industry should lower the value of the rival firms.[8]

If a merger results in an efficiency gain only to the merging firms, rival firms will be at a disadvantage and the expected future cash flows of the rival firm will decrease if the merging firms are expected to use the efficiency gain to lower price and expand their combined market share. The loss of market share will result in a loss of value to the rival firms. Therefore, if the announcement of a merger causes the rival firms to experience abnormally low returns, the merger is expected to yield efficiency gains only for the merging firms.[9] Conversely, events which make the merger less likely should increase the value of rival firms if the merger was going to result in an efficiency gain only to the merging firms.

The above discussion implies that the change in the value of the rival firms cannot be used to distinguish between mergers that will result in monopoly power and mergers that will yield industry-wide efficiency gains since the expected changes in the value of the rival firms after merger-related events are the same under both hypotheses. The change in value of the rival firms is useful in testing whether the changes are consistent with either of these hypotheses. The change in the value of the rival firms can be used to distinguish mergers that will result in efficiencies to only the merging firms and the other hypotheses since the predictions of the rival firm efficiency hypothesis are the opposite of the others.

Statistical tests of the hypothesis concerning the impacts of merger events on the abnormal stock market performance of target firms, acquiring firms and rival firms, are based upon the "event test" methodology. An "event test" statistic relies on the abnormal return performance of firms caused by an event. To determine whether a firm has experienced *abnormal*

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[8] Eckbo claims that even under the industry-wide efficiency hypothesis, rival firms may not lose after a complaint announcement. He claims that the announcement of the merger releases information relevant to efficiencies. A complaint announcement does not dissolve this information. This presumes that the rivals can use the information without engaging in a merger that will also result in a complaint by the antitrust enforcement agencies.

[9] This scenario assumes that it is possible that for horizontal mergers, a production efficiency gained through the merger is not always available to industry rivals. This could occur if the purpose of the merger was to share complimentary products, get rid of inefficient management, etc.

performance it is necessary to know the expected (normal) rate of return to the firm. Financial models of asset returns show that "riskier" assets have higher expected returns since investors must be compensated for bearing risk. However, investors are only compensated for risk that they cannot avoid by diversification of their wealth into other securities.[10] This type of risk is called systematic or undiversifiable risk. Therefore, in "event" studies, the abnormal stock market performance is defined as the deviation of a firm's realized return from the risk (systematic) adjusted return. In most studies, the risk-adjusted return is obtained from the pre-event estimated systematic or beta risk of the firm.

A problem with the "event test" methodology is that if the announcement of a merger changes the systematic risk of the consolidating and rival firms, and abnormal performance is calculated over a post-event time window, using a pre-merger systematic risk confounds abnormal performance with changes in systematic risk. Most studies ignore this potential problem of endogenous systematic risk and use estimates of systematic risk based on pre-event data as an instrument for the systematic risk during the post-event time window. If merger-induced changes in risk are related to the hypotheses that are used to discriminate between monopoly and efficiency mergers then conclusions regarding these hypotheses based on the usual abnormal performance measures can be wrong.

Much of the reason the problem of endogenous systematic risk has been ignored is the lack of theory to predict and explain changes in systematic risk after merger-related events.[11] In the appendix to this report, we combine the theory of the firm with a financial model of asset returns to derive an equilibrium expression for systematic risk which

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[10] The reason for this is demonstrated in the following example. Suppose that both security A and security B are risky in the sense that the rate of return has a large variation. Suppose that when security A has a high return security B has a low return. If both of these securities have high expected returns (to compensate for the risk), an investor can buy both securities (diversification) and have low risk and high return. Thus it is clear that a better measure of risk is undiversifiable risk. Formal models of asset returns show that only this type of risk is reflected in expected returns.

[11] Even without a theoretical explanation it is still important to attempt to take account of changes in systematic risk, but a theoretical model explaining why and how systematic risk should change after the announcement of a merger would be of value in interpreting results from merger studies.

results from profit maximization by the firm and is consistent with the market clearing conditions of the asset market.[12] A direct implication of this expression for systematic risk is that unexpected merger-related information causes systematic risk to shift. This result suggests that the assumption of beta stationarity in merger event analysis is not valid and that careful attention should be paid to the effect of shifts in systematic risk on the abnormal return measures typically used in event studies.[13]

Eckbo (1983) and Eckbo and Wier (1985) reject the monopoly power hypothesis because events which reduce the likelihood of a merger taking place (*e.g.* complaint filed by the Federal Trade Commission) do not cause rival firms to realize negative abnormal performance. Stillman (1983) rejects the monopoly power hypothesis for the same reason and also observes that rival firms do not realize unexpected gains after the announcement of events which increase the likelihood of the merger taking place. If, as argued above, events which increase or decrease the likelihood of a merger taking place cause systematic risk to change, then ignoring changes in systematic risk may bias abnormal return measures.

In Section 2, the Stillman data of challenged horizontal mergers is used to test the hypothesis that there are merger-induced changes in beta for the rival firms. Merger-induced changes in systematic risk though a necessary condition do not automatically imply that cumulative average abnormal return measures based on pre-event systematic risk are biased. Section 3 derives conditions under which abnormal return measures based on pre-event systematic risk are biased and verifies that these conditions exist in the data. To adjust for the bias, abnormal return measures for rival firms are computed based on pre- and post-event systematic risk (the use of post-event systematic risk actually over-corrects for the bias) and the conclusions of Eckbo and Stillman are re-evaluated.

Section 4 concludes the report with a review of the findings of this study.

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[12] This model is based on the work of Kupiec (1986).

[13] An understanding of the model of systematic risk presented in the appendix of this report is not necessary for an understanding of the report. The important point of the appendix is that there is a theoretical basis to expect changes in systematic risk to rival firms around merger-related events. In fact is it because of the model of systematic risk that we chose to investigate the empirical validity of endogenous systematic risk of rival firms.

SECTION 2

EMPIRICAL EVIDENCE OF CHANGES IN SYSTEMATIC RISK FOR RIVAL FIRMS

Introduction

In the appendix of this report we develop a model of systematic risk which predicts that the systematic risk of a firm is endogenous in merger event studies. In particular, the release of unexpected merger related information may cause the systematic risk of firms that are rivals to the merging firms to change. Changes in systematic risk in turn may affect abnormal performance measures of rival firms and bias test statistics regarding the hypotheses concerning the economic source of the merger-induced gain. Therefore, it is important to examine whether the hypothesis of endogenous systematic risk has empirical validity.

The first part of this section reviews the appropriate methodology needed to test the hypothesis that the systematic risk of rival firms change as a result of the release of unexpected merger related information. Descriptions of the data that are used and the empirical results of the tests follow. In the final part of this section the implications of the changes in systematic risk for rival firms' abnormal performance measures are discussed.

The Market Model

To test for changes in systematic risk, it is necessary to introduce a formal statistical model of security returns. Following other researchers, we adopt the "market model", a model based on the single assumption that in each unit of time security returns have a multivariate normal distribution.

Define R_m as a random variable that is the return on a diversified portfolio of risky securities. R_m is a proxy for the return to the market portfolio, the portfolio of all risky assets. The assumption of multivariate normally distributed security returns implies that for individual securities,

(1) $R_{it} = a_{it} + b_{it}R_{mt} + \tilde{e}_{it}$

where $E(R_{mt}\tilde{e}_{it}) = 0$

$E(\tilde{e}_{it}) = 0$

$E(e_{it}^2) = \sigma_i^2$

and the disturbances, e_{it}, are independent normal variates. The conventional applications of the market model require that the process generating security returns be stationary, implying that,

$$a_{it} = a_i \quad \text{for all } t$$

(2) $$b_{it} = b_i \quad \text{for all } t,$$

and also that e_{it} is identically, independently distributed with mean 0 and a variance which for each firm i is constant over time, or

(2a) $$e_{it} \text{ iid } N(0,\sigma_i^2), \text{ for all } t.$$

Therefore the market model can be written as

(3) $R_{it} = a_i + b_iR_{mt} + \tilde{e}_{it}.$

Estimating this regression equation yields an estimate of b_i which is the estimate of the systematic risk of firm i, since this coefficient is the covariance of the return to security i with the return to the market portfolio divided by the variance of the return to the market portfolio. The systematic risk measures the component of fluctuations of the return to a specific security i that are correlated with the fluctuations in the return to the portfolio of all risky assets, and therefore can not be avoided through portfolio diversification.

Testing for Structural Change in Risk: The Dummy Variables Technique

The most common procedure used to test for event-induced changes in systematic risk is the categorical or "dummy variable" approach. The test procedure is as follows. Measure returns in event relative time, that is,

$t < 0$ if the calender date is prior to the event,

$t = 0$ if the calender date is the event date, and

$t > 0$ if the calender date is after the event.

Estimate the regression equation

$$(4) \quad R_{it} = a_i + a_i' D_i + b_i R_{mt} + b_i' D_i R_{mt} + e_{it}$$

where $D_i = 0$ if $t < 0$

$D_i = 1$ if $t > 0$

R_{it} = the return to rival firm i at time t

R_{mt} = the return to the portfolio of all risky assets at time t.

The t-test on the post-event slope coefficient, b_i' is a test for beta stationarity. That is, if b_i' is significantly greater than zero then systematic risk has shifted significantly upwards and if b_i' is significantly less than zero systematic risk has significantly shifted downward.

One problem with the "dummy variable" test is that the specification requires that the error term be homoskedastic across time, that is the variance of e_{it} is unchanged throughout the entire period. If the merger event alters the variance of the error term the t-statistics on the coefficients are biased because the standard error of each coefficient in a regression depends on the estimated variance of the error term.

Testing for Changes in Beta Under Event-Induced Heteroskedasticity

If the merger event changes the variance of the market model residual as well as the security's systematic risk, the test for beta stationarity is based on separate market model estimates. The appropriate test statistic is

$$(5)\quad Z_i = \frac{b_i^{pre} - b_i^{post}}{\sqrt{SE_{pre}^2 + SE_{post}^2}}$$

where b_i^{pre} = market model OLS estimate of the slope coefficient based on pre-event ($t<0$) data,

b_i^{post} = market model OLS estimate of the slope coefficient based on post-event ($t>0$) data,

SE_{pre}^2 = the standard error of b_i^{pre} and,

SE_{post}^2 = the standard error of b_i^{post}.

In large samples, Z_i has the standard normal distribution. Therefore changes in systematic risk can be tested against the null hypothesis of constant risk by examining whether Z_i as computed from equation (5) is significantly different from zero based on the standard normal distribution.

The Data

The statistical tests described above require security return data on rival firms to mergers around dates when unexpected merger-related information is released. The mergers, rivals and event dates used in this analysis are taken directly from the Stillman (1983) study of abnormal return to rival firms. In that study Stillman lists the acquiring and acquired firms, the rival firms to these mergers and the dates upon which unexpected information regarding the mergers was reflected in security prices. As in the Stillman study, this study uses the Center For Research on Security Prices (CRSP) data tape to obtain the security return data around the event

dates for the rival firms given in Stillman.[14]

The important elements of the process Stillman uses to collect the set of mergers, rival firms and event dates are outlined below. For a more detailed description of the data construction, see Stillman.

Sample Selection

The Stillman sample consists of horizontal mergers that were challenged by either the Department of Justice or the Federal Trade Commission in the years 1962 through 1972 and in addition met the following criterion.

1) The merging firms had rival firms that were traded on either the New York Stock Exchange of the American Stock Exchange.

2) It was possible to isolate events which unambiguously had an effect on the perceived likelihood of the merger.[15]

Mergers challenged by the government under Section 7 of the Clayton Act were obtained from the Merger Case Digest and the Trade Regulation Reporter. The set of 11 mergers Stillman used in his study was the result of excluding mergers because of the restrictions in the above paragraph and others discussed below.

Since the CRSP tape begins on July 1, 1962 any merger that was announced earlier than this date was excluded. This left a total of 163 mergers. Mergers in heavily regulated industries were left out because of the potential weak link between horizontal mergers and anticompetitive behavior in a regulated market. Mergers which were not primarily horizontal or cases where there were multiple merger complaints were excluded. Mergers in which neither the acquiring or acquired firms were on the CRSP tape were excluded because the target and/or acquiring firm is used to identify relevant event dates. Finally mergers in which the rival firms could not be identified

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[14] There was a small discrepancy in the return listed on one of the merger event dates. In particular Stillman reports that Lehn and Fink had a return of 11.04 percent on 3/28/66. The CRSP data used in this study showed that this 11.04 percent return occurred on 3/25/66.

[15] This will be formally defined later in this section.

via published opinions and fact memoranda by the enforcement agencies were excluded. These eliminations reduced the universe of mergers to 18.

The final step in the construction of the data set was to identify, for the 18 mergers, dates of events which were likely to have affected the perceived probability that the mergers would actually take place. Stillman hypothesized that the following types of events would affect the perceived probability of merger: merger rumors and announcements, decisions by the courts on temporary restraining orders and preliminary injunctions, decisions by district courts and administrative law judges, and decisions by appellate courts. These dates were obtained from the Wall Street Journal and docket sheets of the Federal Trade Commission and the Department of Justice.

To include only event dates likely to have affected the perceived probability that the mergers would actually take place Stillman uses the above dates only if the target firm and/or the acquiring firm had a significant abnormal return on the particular day. This reasoning is based on the well established empirical finding that the return to target firms reacts strongly to changes in the probability that the merger will take place. Though this procedure omits many mergers, concentrating on those mergers where there is a significant abnormal return to one of the merging firms increases the potential signal to noise ratio in abnormal return measures. Out of the 18 mergers only 11 mergers had event dates on which the target firm or acquiring firm had an abnormal return. These 11 mergers are the mergers used in the Stillman study and are therefore the 11 mergers used in this study.

Table I gives the resulting mergers and is taken directly from Stillman. Table II lists the event dates which affected the perceived probability of the merger taking place (the date on which the target firm and/or acquiring firm had an abnormal return). It is these event dates that are used to test for the merger-induced changes in systematic risk of the rival firms.

Stillman collected the rival firms by examining published opinions in cases that were litigated. These opinions often contain a description of the industry and identify industry members. The other source was fact memoranda prepared by the Federal Trade Commission or Department of Justice in preparation for the formal filing procedure.

Table I

Challenged Horizontal Mergers in the Sample

Acquiring (Acquired)	Merger Year	Industry	Complaint Year
Chrysler (Mack)	1964	Heavy trucks	1964
Schenley (Buckingham)	1964	Liquor Distilling	1966
Russell Stover (Fanny Farmer)	1965	Candy	1965
General Dynamic (UEC)	1966	Coal	1967
Sterling Drug (Lehn and Fink)	1966	Health and Beauty Aids	1969
Bendix (Fram)	1967	Filters	1967
Cooper (Waukesha)	1967	Natural Gas Engines	1967
Atlantic (Sinclair)	1968	Oil Refining	1969
Gould National (Clevite)	1969	Batteries	1969
Warner Lambert (Parke Davis)	1970	Ethical	1971
Jim Walter (Panacon)	1972	Roofing Materials	1974

TABLE II

DESCRIPTION OF MERGER EVENTS IN THE SAMPLE OF 11 MERGERS IN THE PERIOD 5/64 - 4/72

Merger	Event	Date of Return	Stock	Sign of Excess Return
Chrysler Mack	Merger Announced after Close of Trading 5/4/64	5/1/64 5/4/64	Mack	+
	Complaint Filed 7/30/64	7/31/64	Mack	-
	Preliminary Injunction 8/17/64	8/17/64	Mack	-
Schenley Buckingham	Merger Agreement Announced 8/27/64	8/26/64	Schenley	+
Russell Stover Fanny Farmer	Merger agreement Announced 2/9/65	8/26/64	Fanny Farmer	+
General Dynamics UEC	Major stock Purchase by General Dynamics 9/29/66	9/30/66	UEC	+
Sterling Drug Lehn and Fink	L and F Announced Receiving Bid From Sterling 1/3/66	2/1/66	Lehn and Fink	+
	L and F Approved Bid 3/28/66	3/25/66	Lehn and Fink	+

TABLE II

DESCRIPTION OF MERGER EVENTS IN THE SAMPLE OF 11 MERGERS IN THE PERIOD 5/64 - 4/72

Merger	Event	Date of Return	Stock	Sign of Excess Return
Sterling Drug Lehn and Fink	FTC Judge Dismissed Complaint 5/12/71	5/12/71 5/13/71	Sterling	+
Bendix Fram	Fram Agreed To Merge 1/3/67	12/28/66 1/3/67	Fram	+
Cooper Waukesha	Cooper Plans To Acquire Remainder of Shares 7/25/67	7/25/67	Cooper	+
Atlantic Sinclair	Complaint Filed 1/15/69	1/16/69	Sinclair	-
	Temporary Restraining Order 1/17/69	1/16/69	Sinclair	-
Gould National Clevite	Merger Agreement Announced 3/10/69	3/10/69	Clevite	+
Warner Lambert Parke Davis	Parke Davis Agreed To Merger 7/31/70	7/31/70	Parke Davis	+
Jim Walter Panacon	Jim Walter Agreed To Buy 89% Stock Interest 4/4/72	4/4/72	Jim Walter	+

Empirical Specification of Time Periods

To test for changes in systematic risk requires the specification of a pre-event and a post-event time period. One possibility is to use the actual event dates listed in Table II to divide the pre-event and post-event periods. Previous work suggests that there is leakage of information when a large merger-related event takes place. As a result the capital market share prices tend to reflect the information before the official public release of the information. In light of this, the post-event period is taken to begin 5 days before the public release event date listed in Table II. The pre-event periods and post-event periods that are used to test for shifts in systematic risk are reported in the table where the empirical results are reported. Tests concerning the sensitivity of our empirical results to changes in these pre- and post-event periods have been performed and are reported in the section that presents the empirical results.

In cases where there is more that one event per firm and the event periods overlap, changes in systematic risk around the later event date are considered so that one event does not mask the effect of the previous event on changes in risk.

Empirical Results

The first set of empirical results concerns the choice of specification with which to examine the changes in systematic risk of the rival firms. After the choice of the specification, the empirical results concerning the changes in systematic risk of the rival firms based on this specification are presented.

Heteroskedasticity Test

As previously discussed, there are at least two alternative techniques to test for shifts in systematic risk: the dummy variable model of equation (4) and the use of two separate regressions for pre- and post-event data. The dummy variable approach is justified only if the variance of the residual is the same in the pre- and post-event period. However, we found that in over 50% of the rival firms in our sample there are significant changes in the estimate of the variance of the

residual.[16]

Shifts in Systematic Risk

Table III presents the estimates of the shifts in systematic risk for the rival firms. The column labeled "type of event" indicates whether the event under consideration increased (+) or decreased (-) the likelihood of the merger taking place.

The results reported in Table III suggest that the assumption that systematic risk is constant during merger events is not valid. For 14 out of 35 rival firms there was a significant shift (at the 10% level) in systematic risk.[17] How do these results compare with other research that has examined shifts in systematic risk?

No other research that we are aware of has examined changes in systematic risk to rival firms, though changes in the systematic risk of the merging firms has been examined. In their investigation of tender offers Dodd and Ruback (1977) find that only 26 out of 112 bidders experienced a significant change in systematic risk. Dodd and Ruback test for shifts in systematic risk using a single regression equation. As previously noted, this specification assumes the variance of the residual to be constant, an assumption which in our sample is violated.[18]

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[16] An F test is used to test for changes in the variance of the residual. The procedure is as follows. Estimate the "market model" using only data from the pre-event period and again with data only from the post-event data. The ratio of the mean square errors of these two regressions is distributed $F(n_1-k_1,n_2-k_2)$ where n_1 and n_2 are the number of observations in the respective samples and k_1 and k_2 are the number of exogenous variables in the respective equations.

[17] 12 out of 35 were significant at the 5% level.

[18] To examine whether the differences in the methodology reduces the number of significant results the single equation approach was also used. Our results remain intact.

TABLE III

ESTIMATES OF THE SHIFTS IN BETA FOR RIVAL FIRMS WHEN A MERGER-RELATED EVENT TAKES PLACE

Merger	Pre-Event Period	Post-Event Period	Event Date	Rival	Change In Beta	Type of Event
Chyrsler	09/17/63 to 08/11/64	08/12/64 to 01/12/65	08/17/64	General Motors	.06 (.25)	-
				International Harvestor	1.27*** (3.81)	-
Schenley	09/27/63 to 08/20/64	08/21/64 to 01/21/64	08/26/64	American Distiller	.21 (.75)	+
				Brown Foreman	.04 (.11)	+
				Heublin	.75 (1.29)	+
				National Distiller	.75** (2.47)	+
Russell Stover	03/09/64 to 01/30/65	01/31/65 to 06/31/65	02/04/65	Barton	+.06 (.09)	+
General Dynamics	10/29/65 to 09/24/66	09/25/66 to 02/25/67	09/30/66	Conoco	-.09 (.42)	+
				Standard Oil,Ohio	-.40** (1.99)	+
Sterling Drug	02/26/65 to 01/25/66	01/26/66 to 06/26/66	02/01/66	American Cyanimide	-.37* (1.77)	+
				Pfizer	-.40* (1.70)	+
				Warner Lambert	-.94*** (3.16)	+

TABLE III

ESTIMATES OF THE SHIFTS IN BETA FOR RIVAL FIRMS WHEN A MERGER RELATED EVENT TAKES PLACE

Merger	Pre-Event Period	Post-Event Period	Event Date	Rival	Change In Beta	Type of Event
Sterling Drug	06/06/70 to 05/05/71	05/06/71 to 10/06/71	05/12/71	American Cyanimide	-.07 (.31)	+
				Pfizer	.25 (1.11)	+
				Warner Lambert	-.38** (2.19)	+
Bendix	01/15/66 to 12/22/66	12/23/66 to 05/23/67	12/28/66	General Motors	.52** (2.36)	+
Cooper	08/25/66 to 07/19/67	07/20/67 to 12/20/67	07/25/67	Caterpillar	-.10 (.23)	+
				Dresser Industries	-1.04** (2.33)	+
				Ingersoll Rand	.99*** (3.08)	+
				Worthington	-.10 (.19)	+
Atlantic	02/16/68 to 01/10/69	01/11/69 to 06/11/69	01/15/69	Conoco	.83*** (3.46)	-
				Exxon	.42** (2.20)	-
				Shell	.08 (.32)	-
				Standard Oil Of Indiana	.34 (1.27)	-
				Texaco	.09 (.19)	-

TABLE III

ESTIMATES OF THE SHIFTS IN BETA FOR RIVAL FIRMS WHEN A MERGER RELATED EVENT TAKES PLACE

Merger	Pre-Event Period	Post-Event Period	Event Date	Rival	Change In Beta	Type of Event
Gould National	04/10/68 to 03/04/69	03/05/69 to 08/05/69	07/25/67	ESB	.23 (.62)	+
				PR Mallory	-.34 (1.30)	+
				Union Carbide	-.42** (1.97)	+
Warner Lambert	08/31/69 to 07/25/70	07/26/70 to 12/26/70	07/31/70	American Home Products	-.12 (.68)	+
				Smithkline	-.20 (.80)	+
				Upjohn	.21 (.86)	+
				American Cyanamide	-.64** (3.46)	+
Jim Walter	04/05/71 to 03/29/72	03/30/72 to 08/30/72	04/04/72	Certain Teed	-.10 (.26)	+
				Flintkote	-.16 (.52)	+
				John Manville	-.01 (.01)	+

Absolute value of t values appear in parentheses
* indicates significance at the 10% level
** indicates significance at the 5% level
*** indicates significance at the 1% level

Haugen and Langetieg (1975) found that 13 out of 59 firms had significant shifts in beta (10% significance level). Dodd (1980) uses daily return data and states that different estimation periods were used to compute beta and that cumulative average residuals were not sensitive to these estimation periods. Mandelker (1974) has done the most thorough analysis of shifts in systematic risk. Mandelker (1974) examined how beta changes during the entire time window of an event study and did find shifts in beta. He reports that beta increases steadily in the pre-merger period and then decreases in the post event period. To adjust for shifts in risk Mandelker uses pre- and post-event data. Mandelker reports that the methods used to calculate beta produced large differences in the size of cumulative residuals.

The results reported in Table III appear to reveal larger shifts in systematic risk than has previous research. This is especially true since we examine shifts in systematic risk for rival firms while others have focused on the firms directly involved with the merger.[19] Previous research has focused on mergers in general and not only on challenged horizontal mergers as does this study. Therefore, the larger shifts for the rival firms than what other researchers have found for the firms involved with the merger may reflect the type of sample of mergers examined.

The results given in Table III support the notion that systematic risk changes during merger-related events. Since abnormal performance measures often use pre-event systematic risk to adjust the realized return in the post-event period, changes in systematic risk have implications for abnormal performance measures used in merger event analysis.

In the next section of this report we derive the bias in abnormal performance measures that results from shifts in systematic risk. We also examine the implications of the bias on the monopoly power hypothesis and examine whether the changes in beta listed in Table III would change Eckbo's and Stillman's conclusion that the results from the "event tests" do not support the monopoly power hypothesis.

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[19] We have also examined the shifts in systematic risk for the acquiring firms using the same pre- and post-event periods used for the rivals. We find that 50% of the acquiring firms experience significant shifts in systematic risk (at the 10% level of significance). We do not analyze the target firms since many of the target firms become delisted or the resulting post-announcement beta largely reflects the systematic risk of the acquiring firm.

SECTION 3

CHANGES IN SYSTEMATIC RISK AND THE BIAS IN ABNORMAL RETURN MEASURES: IMPLICATIONS FOR THE EFFICIENCY AND MONOPOLY POWER HYPOTHESES

Introduction

The work presented in the previous section provided empirical evidence that systematic risk is endogenous to merger events. In the studies which examine the abnormal performance of rival firms to distinguish monopoly power versus efficient mergers, the abnormal performance is defined as the deviation of a firm's realized return from an expected risk-adjusted return, where the risk adjustment is often based on the pre-event estimated systematic risk of the firm. A problem with this methodology is that the announcement of a merger was shown to cause a change in systematic risk and therefore if abnormal performance is calculated over a post-event period, using a pre-event systematic risk results in abnormal performance measures that confound "true" abnormal performance with changes in systematic risk.

Since Eckbo, Eckbo and Weir, and Stillman all reject the monopoly power hypothesis based on insignificant abnormal returns to rival firms after complaint announcements, small changes in these abnormal return measures may affect the conclusions of these studies. Therefore it is important to be sure that the cumulative average abnormal returns of rival firms over the sample of mergers are not systematically biased for or against any of the hypotheses.

This section outlines the conditions under which cumulative average abnormal returns for rival firms are biased and examines whether the changes in systematic risk identified in Table III satisfy these conditions. After verifying that the abnormal performance measures of rival firms are likely to be biased, the implications of this bias on the monopoly power and efficiency hypotheses are examined.

Finally, this section examines whether the conclusions of previous empirical work based on abnormal stock market performance of rivals will change as a result of the bias in the performance measures. In particular, the Stillman data is used to retest the rival firm hypotheses using an adjustment to abnormal returns which overcompensates for the bias, and

therefore bounds the true abnormal return.

The Bias in Abnormal Performance Measures

The standard abnormal performance measure of an event test is the predicted market model residual in post-event periods where the predicted return is based on pre-event market model estimates. The cumulative abnormal performance measure as used in event studies is defined as,

$$(6)\quad \sum_{t=1}^{p} e_{it} = \sum_{t=1}^{p} \left(R_{it} - a_i - b_i R_{mt}\right)$$

where a_i = the estimate of the intercept term of the market model based on pre-event data ($t<0$)

b_i = the estimate of the slope term (systematic risk) of the market model based on pre-event data ($t<0$)

p = the length of the event window.

The true abnormal return in post-event periods is

$$(7)\quad \sum_{t=1}^{p} E_{it} = \sum_{t=1}^{p} \left(R_{it} - a_{it} - b_{it} R_{mt}\right) \text{ for } t>0$$

where a_{it} = the true intercept term of the market model on day t

b_{it} = the true slope parameter on day t.

Subtracting (6) from (7) and simplifying shows that the error inherent in the usual cumulative abnormal return can be decomposed as

$$(8)\quad \sum_{t=1}^{p} e_{it} = \sum_{t=1}^{p} (a_{it} - a_i) + \sum_{t=1}^{p} (b_{it} - b_i) R_{mt} + \sum_{t=1}^{p} E_{it}.$$

The error decomposition in expression (8) shows that e_{it} is a biased measure of abnormal return if the systematic risk of the firm after the event, b_{it}, is consistently higher or lower than the estimated pre-event systematic risk, b_i. The direction of the bias depends on two factors[20]: the direction of the change in systematic risk and the sign of the return to the market portfolio.

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[20] We ignore changes in the intercept term.

For an individual firm or a small sample of firms, even if the direction of the change in beta is known, it is still uncertain whether the abnormal performance measures will overstate or understate the true abnormal return, since the sign of the return to the market portfolio over the event window cannot be predicted with much certainty.

Over a large sample of merger events the bias in the cumulative <u>average</u> abnormal return measures will be determined by the product of the average change in systematic risk of the firms and the average return to the market portfolio over the event windows, as shown in equation (9).[21]

$$(9)\quad \sum_{t=1}^{P} \overline{e_{it}} = \sum_{t=1}^{P} \overline{(a_{it} - a_i)} + \sum_{t=1}^{P} \overline{(b_{it} - b_i)} \overline{R_{mt}} + \sum_{t=1}^{P} \overline{E_{it}}.$$

Given a large sample of merger events there will be a large number of event windows spanning different calender dates. The average return over the collection of event windows should be positive since the market portfolio is a collection of all risky assets and must in equilibrium even have a higher expected return than alternative less risky assets. Consequently, the sign of the average change in systematic risk should determine the bias in the abnormal return measures.

The Stillman sample is not a large sample. Therefore, to determine the bias in abnormal performance measures we need to examine both the change in systematic risk after merger related events and the average return to the market portfolio over the event windows.

The monopoly and efficiency hypotheses predict different effects on abnormal performance measures for events which increase and decrease the likelihood of a merger. Thus, it is necessary to examine the bias in abnormal performance measures separately for the two different types of events. Consequently, rather than examining whether systematic risk changes across all events we need to consider the average change in systematic risk and the return to the market portfolio for each type of event. Below the changes in systematic risk are examined separately for each event type.

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[21] This assumes that the change in systematic risk and the return to the market portfolio are uncorrelated across time. The bar in equation (9) is an average over the i firms.

Empirical Results

The last column in Table III is labeled "Type of Event" (Table III is in Section 2) and indicates whether the event increased or decreased the likelihood of a merger taking place. To examine whether the average systematic risk changes for a certain type of event, the average change in beta by event is examined.

The results in Table III show that changes in systematic risk for the rival firms are not random across events. For events which decreased the likelihood ("Type of Event" column has a minus sign) of a merger taking place 7 out of 7 rival firms experienced an increase in systematic risk, with 3 of these changes significant. The average change in beta among these 7 firms is .44.[22] For events which increased the likelihood of a merger taking place ("Type of Event" column has a plus sign) 19 out of 28 rival firms experienced a decrease in systematic risk, with 11 of these changes significant. The average change in beta for the 28 firms was -.07. Examining only those changes in systematic risk that are significant, among events which decreased the likelihood of merger, beta on average changed by .84 (n=3). For events which increased the likelihood of merger, beta on average changed by .21 (n=11).

This result is in spite of one merger in which the results are in stark contrast to the rest of the data. For the Schenely-Buckingham merger the changes in systematic risk for the rival firms are all positive despite the fact that the event under consideration is the announcement of the merger (an event which increases the likelihood of a merger). Table II shows that the acquiring firm had a significant abnormal return on the event day rather than the target firm. In fact the stock market return data revealed that in the month surrounding the merger announcement the target firm suffered an abnormal loss of approximately 7%. It is very rare that a target firm loses this amount of value when they are a target firm in a merger. If this merger is excluded from the sample, the average change in beta for events which increase the

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[22] The average changes in beta reported in the following paragraphs are just the straight averages of the changes in beta in Table III. This averaging procedure ignores contemporaneous correlation of returns across rival firms of the same merger. In a subsequent section of this report we form equal weighted portfolios of rivals to the same merger and thus collapse the daily return to each of the rivals of a merger into a single return. The results using this methodology are discussed later.

TABLE IV

ESTIMATES OF THE SHIFTS IN BETA FOR THE PORTFOLIOS OF RIVAL FIRMS WHEN A MERGER-RELATED EVENT TAKES PLACE

Type Of Event	Change in Beta
Decreases Likelihood of Merger	.391*** (3.59)
Increases Likelihood of Merger	-.169** (2.73)

Absolute t values appear in parenthesis.
* indicates significance at the 10% level.
** indicates significance at the 5% level.
*** indicates significance at the 1% level.

likelihood of a merger becomes -.16 (n=23).

To control for contemporaneous correlation of returns across firms in the same industry, returns of the rival firms for the same merger are pooled into one equally weighted portfolio. After stacking the equally weighted portfolios, we estimate the market model using only pre-event data and again using only post-event data and test for shifts in the estimates of systematic risk. These results are reported in Table IV.

The results in Table IV reinforce the findings of Table III. Systematic risk falls after events which increase the likelihood of a merger and rises after events which decrease the likelihood of merger. Thus, these results show that on average there is an inverse relationship between events that increase (decrease) the likelihood of a merger and the event-induced change in systematic risk. A systematic relationship between the type of merger event and changes in systematic has implications on the abnormal return measures used to test hypotheses regarding the social benefit of mergers. These implications are discussed after the empirical section.

TABLE V

ESTIMATES OF THE SHIFTS IN BETA FOR THE PORTFOLIOS OF RIVAL FIRMS WHEN A MERGER-RELATED EVENT DOES NOT TAKE PLACE

Type Of Event	Change In Beta
Decreases Likelihood of Merger	-.04 (.50)
Increases Likelihood of Merger	.08 (1.14)

Absolute t values appear in parenthesis.
* indicates significance at the 10% level.
** indicates significance at the 5% level.
*** indicates significance at the 1% level.

Sensitivity to Changes in the Time Periods

To test the sensitivity of the results reported in Table III and Table IV to changes in the pre- and post-event periods, the shifts in beta were reestimated with the following changes: 1) For each merger the pre-event period started and ended 1 month earlier than the pre-event periods reported in Table III, 2) For each merger the post-event periods started and ended each 1 month later then reported in Table III. That is, the 2 months surrounding the merger were left out of the analysis, but the length of time used to compute beta was unchanged.

Using these periods, the average change in beta for the 7 firms who experience events which decrease the likelihood of a merger was .39. The average change in beta for the 28 firms experiencing events which increase the likelihood of a merger was -.10. These results are remarkably similar to the results obtained in Table III. Similar results were also obtained using shorter post-event periods though the significance of the estimates of the change in beta was reduced due to the fewer degrees of freedom in the post-event period.

Event-Induced Changes

To present evidence that the shifts in systematic risk are induced by merger-related events the changes in systematic risk in a period when no merger event has taken place is examined. We use the same firms as in Table III but the pre-event and post-event periods are both prior to the merger-related event. To be precise, the same time periods reported in Table III are used, only 1 year earlier.

Using these time periods only 8 of the 35 firms experienced a significant shift in systematic risk (recall 14 of 35 experienced a significant shift in risk using the time periods in Table III). For the 7 firms that subsequently experience events that decrease the likelihood of a merger the average change in beta was .10 (compared to .43 in Table III). For the 28 firms that subsequently experience events which increase the likelihood of a merger the average change in beta was .005. (compared to -.08 in Table III). To account for the contemporaneous correlation of returns across rival firms Table IV was reproduced using the pre-event time periods described above. The data are grouped by the same classification as in Table IV to demonstrate that the results in Table IV are in fact event-induced.

The results reported in Table V reveal no significant shifts in systematic risk for the respective groups of firms. This suggests that the systematic changes in beta reported in Table IV are event-induced rather than representing the usual beta non-stationarity of the particular firms in the sample.

Systematic Changes in Beta: Implications on the Efficiency Hypotheses and the Monopoly Power Hypothesis

The empirical results reported in Tables III, IV and V provide evidence that merger-related events cause systematic changes in beta.

Table VI summarizes the implications of the changes in systematic risk identified in Table IV on the monopoly power hypothesis, the industry-wide efficiency hypothesis and the merging firm efficiency hypothesis. Below, each entry in Table VI is discussed in detail.[23] We start with events which decrease the likelihood of a merger.

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[23] This discussion is based on the outline of these hypotheses presented in the introduction.

TABLE VI

THE BIAS IN CUMULATIVE AVERAGE ABNORMAL RETURN MEASURES OF RIVAL FIRMS GIVEN CHANGES IN SYSTEMATIC RISK*

R_m	Type of Event	Monopoly Hypothesis	Industry-Wide Efficiency	Merging Firm Efficiency
+	+	Against	Against	Towards
+	-	Against	Against	Towards
-	+	Towards	Towards	Against
-	-	Towards	Towards	Against

*This table gives the bias under the assumption that the changes in systematic risk are inversely related to the type of event as in Table IV.

The event methodology used by Eckbo and Stillman rejects the monopoly power hypothesis[24] based on the observation that after events which decrease the likelihood of a merger, rival firms do not experience an abnormal loss in value. Table IV shows that after events which decrease the likelihood of a merger rival firms experience an increase in their systematic risk. Recall the breakdown of the cumulative average abnormal return measure that is based on pre-event systematic risk, given again by

$$(10) \quad \sum_{t=1}^{P} \overline{e_{it}} = \sum_{t=1}^{P} ((\overline{a_{it} - a_i}) + (\overline{b_{it} - b_i})\overline{R_{mt}} + \overline{E_{it}}).$$

[24] Since the industry-wide efficiency hypothesis has the same predictions as the monopoly power hypothesis Stillman and Eckbo essentially are finding no support for the industry wide efficiency hypothesis. Again as mentioned this is under the assumption that any efficiency gain the merging firm can achieve is available to the rivals and that if all firms realize efficiency gains the industry gains as a whole.

Assuming the intercept of the market model does not change, the average abnormal return based on pre-event systematic risk is[25]

$$(11)\ \sum_{t=1}^{P}(\bar{e}_{it}) = \sum_{t=1}^{P} p(\overline{b_{it} - b_i})\bar{R}_{mt} + \sum_{t=1}^{P}\bar{E}_{it}.$$

Table IV provided empirical evidence that $\sum \overline{(b_{it} - b_i)} > 0$. Therefore if R_{mt} is positive (negative), the abnormal return measure, e_{it}, is actually higher (lower) than the true abnormal return. Consequently, at least for the Stillman data, for events which *decrease* the likelihood of a merger, abnormal return measures based on pre-event systematic risk are potentially overstated (if $\bar{R}_{mt} > 0$).

The monopoly power hypothesis (and industry-wide efficiency) is rejected because of no abnormal loss in value to rival firms after an event which reduces the likelihood of merger. The use of abnormal returns based on pre-event systematic risk, which overstate the true abnormal return, are thus biased against the monopoly power and industry-wide efficiency hypotheses.[26] Again, this is under the assumption that the average return to the market portfolio is positive over the event windows. The abnormal returns are biased towards these hypotheses if the average return to the market portfolio over the event window is negative.

The bias with respect to the merging firm efficiency hypothesis is the opposite. If the merger will result in efficiency gains only to the merging firms an event which decreases the likelihood of merger should cause the rival firms to gain in value. If the average return to the market portfolio over the event window is positive (negative), given the changes in risk identified in Table IV, we know abnormal return measures will be overstated (understated). Therefore if the return to the market portfolio is positive (negative) the usual abnormal return measures will be biased towards (against) the merging firm efficiency hypothesis.

For events which *increase* the likelihood of a merger, Table IV suggests that systematic risk falls ($\overline{(b_{it}-b_i)} < 0$), and

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[25] This assumes that the change in systematic risk is independent of the return to the market portfolio.

[26] Eckbo and Weir claim that "Section 7 complaints, which threaten the survival of efficient mergers, will not, in most cases, harm rival firms. Complaints lessen the danger to rivals of increased competition due to the merger, but do not devalue the information released earlier. We disagree with this statement. A complaint reduces the likelihood that a rival will be able to use the information via a merger.

therefore if the average return to the market portfolio is positive ($\bar{R}_{mt}>0$) abnormal returns based on pre-event systematic risk are understated.

Both the industry-wide efficiency and monopoly power hypothesis predict positive abnormal gains to rival firms around the announcement of events which increase the likelihood of a merger. The merging firm efficiency hypothesis predicts an abnormal loss to rival firms after such events. Consequently, if the average return to the market portfolio is positive abnormal returns to rival firms based on pre-event systematic risk are biased against showing support for the monopoly power and industry-wide efficiency hypothesis and towards support for the merging firm efficiency. The opposite biases result from a negative average return to the market portfolio.

Corrections for the Bias

To correct the bias in abnormal return measures estimates of b_{it} are needed. Since time series data is used to estimate systematic risk, the true systematic risk on any day during the event window is unknown and must be proxied by an estimate of the average systematic risk. The use of post-event data to estimate post-event systematic risk is one such proxy. The shortcoming of this proxy is that it will overcompensate for the bias in the abnormal return measure if the revaluation of rival firms is not completed on the event day.

In the next part of this section abnormal returns based on pre- and post-event systematic risk are therefore used to bound the true abnormal return to rival firms after the unexpected release of merger-related information.

Cumulative Average Residuals Based on Pre- and Post-Event Systematic Risk

In this section cumulative average abnormal performance of the rival firms based on pre-event systematic risk and post-event systematic risk are used to duplicate the Eckbo methodology and examine whether the inferences from the data depend on systematic risk.[27]

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[27] Recall that the Eckbo methodology uses cumulative average abnormal performance (therefore it is over a sample of mergers) of rivals experiencing the same type of event. For rivals of the same target firm an equal weighted portfolio is formed. In our case the Stillman data is used to

For each merger in our sample the abnormal performance relative to a merger-related event is obtained from the following regression,

$$(12)\quad R_{it} = a_i + b_i R_{mt} + c_i d + e_{it}.$$

where R_{it} = the return to an equal weighted portfolio of rivals to merger i on day t,

R_{mt} = the return to the proxy for the market on day t,

d = 1 if during the event window
0 otherwise.

The coefficient on the market return proxy is an estimate of the systematic risk of the portfolio of firms while the coefficient on the event window dummy represents the average one-day abnormal return to the portfolio of rival firms to the ith merger.

Equation (12) is estimated using both pre-event data (plus the data during the event window) and post-event data (plus the data during the event window). The pre- and post-event periods that were used for Table III are used in estimating equation (12).[28] Following the work of Eckbo (1985) the length of the event windows were chosen to be (-20,+10), (-10,+5) and (-3,+3).

To summarize samplewide abnormal performance we group the portfolio of rival firms by whether the event under consideration lowered or raised the probability of the merger and compute the following abnormal performance measure for each type of event,

$$(13)\quad CAR = \frac{p}{N} \sum_{i=1}^{N} c_i$$

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construct the same performance measures only it is done for performance measures that are based on estimates of systematic risk using pre-event data and post-event data.

[28] The estimates of systematic risk will not be identical to those in Table III because some of the days that were part of the estimation period in Table III are now treated as event days.

where c_i is the estimated coefficient on the dummy variable, p is the number of days in the event window, N is the number of the specific type of merger event and CAR is the cumulative average abnormal performance across the N firms that experienced the event.

The CAR does not take account of the fact that each firm's estimated c_i has a different variance. To utilize this information we standardize each c_i by its standard error and test whether the average of these are different than zero. Assuming that the N mergers are independent events, the appropriate t-statistic is

$$(14) \quad t_p = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \left(\frac{c_i}{SE_i} \right)$$

where SE_i is the standard error of c_i from the OLS regression of equation (12). In the results section we report the CAR and the test statistic based on the standardized CAR's.

Empirical Results

Table VII reports the cumulative average abnormal return measures based on pre- and post-event systematic risk for the portfolios of rivals experiencing the two types of events.

The results in Table VII suggest that abnormal performance measures are sensitive to the particular systematic risk that is used to adjust the realized return. This is true for events which increase and decrease the likelihood of a merger. Below we discuss the implications of the estimates of the pre- and post-event abnormal return measures for the inferences concerning the hypotheses outlined above.

For events which increase the likelihood of a merger taking place we find that cumulative average abnormal returns based on post-event systematic risk are higher than their pre-event counterparts regardless of the particular event window. Thus, for these events, using post-event systematic risk to adjust realized returns provides more support for the monopoly power and industry-wide efficiency hypotheses than does the use of pre-event systematic risk.[29]

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[29] This is consistent with Table VI. The average return to the market portfolio around the 10 positive events is positive. The average change in systematic risk around these events was negative. Table VI shows that under these conditions abnormal returns based on pre-event systematic

TABLE VII

CUMULATIVE AVERAGE ABNORMAL RETURNS TO THE PORTFOLIOS OF RIVAL FIRMS BASED ON PRE AND POST EVENT ESTIMATES OF THE MARKET MODEL

Type of Event	Pre-Event			Post-Event		
	Event Window			Event Window		
	(-20,10)	(-10,5)	(-3,3)	(-20,10)	(-10,5)	(-3,3)
Increases Likelihood of Merger (n=10)	.026 (1.24)	.020* (2.14)	.009 (1.48)	.046** (2.31)	.029*** (3.45)	.012* (1.80)
Decreases Likelihood of Merger (n=2)	.008 (.25)	-.002 (.12)	.014 (1.23)	.0372 (1.40)	.009 (.63)	.015 (1.36)

Absolute value of t-values appear in parenthesis
* indicates significance at the 10% level
** indicates significance at the 5% level
*** indicates significance at the 1% level

It is particularly interesting to note that under the pre-event systematic risk the abnormal performance measure for the windows (-20,10) and (-3,3) show no significant positive abnormal return to the rival firms around events which increased the likelihood of merger. This "no result" would cause researchers to conclude that the evidence is inconsistent with both the monopoly power hypothesis and the industry-wide efficiency hypothesis. The abnormal performance of the rival firms over the identical windows are significantly greater than zero under the post-event systematic risk, results which are

risk would be biased against the monopoly and industry-wide efficiency hypotheses.

consistent with both hypotheses.[30] Therefore, for events which increase the likelihood of a merger the use of post-event systematic risk rather than pre-event systematic risk can affect the conclusions of "event studies". To examine whether the data is entirely consistent with the monopoly hypothesis we also need to consider events which decrease the likelihood of a merger.

For events which decrease the likelihood of a merger taking place abnormal returns based on post-event systematic risk are higher than those based on the pre-event risk estimate, especially for the event window (-20,10). For the event window (-20,10) the pre-event cumulative average residual is .0084 with a t-value of .25 while for the post-event measure it is .0379 with a t-value of 1.40.[31]

These results support the conclusions of Eckbo and Stillman both of who found no support for the monopoly power hypothesis based on the lack of an abnormal loss to rivals after events which decrease the likelihood of merger. Under the monopoly hypothesis, rival firms should experience abnormal losses after an event which decreases the chance that the merger will occur. Since the abnormal gains based on post-event systematic risk were greater than those based on pre-event risk, the post-event abnormal gains provide even stronger evidence that the data do not support either the monopoly power hypothesis or the industry-wide efficiency hypothesis.

To summarize, the monopoly power hypothesis and industry-wide hypothesis require that rival firms react to merger-related information in two ways: rivals should gain in value after events which increase the likelihood of a merger,

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[30] An abnormal gain to rival firms after events which increase the likelihood of a merger is also found in Eckbo's analysis of rival firms. Eckbo's data set is much larger than Stillman's but includes the mergers that Stillman's data set contains. Stillman found no abnormal gain to rival firms on the event date. The results in this study show that had an event window been used along with a post-event estimate of systematic risk Stillman would have found that the rivals do gain after events which increase the likelihood of a merger.

[31] These results are consistent with Table VI. It was shown that after events which decrease the likelihood of a merger the rivals experience an increase in systematic risk. The average return to the market portfolio over event windows is negative. Therefore we would expect the post-event abnormal return measures to be higher than the pre-event measures.

and lose in value after events which decrease the likelihood of a merger. The empirical evidence shows that though the rivals did have significant increases after events which increase the likelihood of merger, *they did not* have a significant abnormal loss after events which decrease the likelihood of a merger. The evidence for the events which decrease the likelihood of a merger is based on only 7 rival firms of 2 mergers, though similar results have been found by Eckbo in a much larger data set. Eckbo interprets these results as consistent with "the information theory". This states that while the merger announcement increases the potential for efficiencies to rivals the complaint announcement does not diminish the value of this information. Therefore rivals should gain in value after the announcement and not lose after the complaint. This is essentially a mixture of the industry-wide and merging firm efficiency argument.

Conclusion

Changes in systematic risk cause traditional abnormal return measures to be biased. Conclusions regarding the nature of a merger based on the abnormal returns to rival firms might be falsely drawn if no corrections are made for this bias, especially in light of the large changes in systematic risk identified in Section 2. However, even when we compensated for the bias the abnormal return measures the conclusions regarding the monopoly power hypothesis remains intact.

In particular, for the Stillman data dealing with contested mergers, the abnormal return measures of rival firms based on either pre-event systematic risk or post-event systematic risk are not consistent with the monopoly power hypothesis. After events which decreased the likelihood of a merger the rival firms did not experience a significant abnormal loss in value, evidence which is contrary to the monopoly power hypothesis.

The finding that there is no significant abnormal change in value for the rival firms around "negative" events raises interesting questions since these firms experience a large and significant change in their systematic risk. On the one hand, the abnormal return measures suggest that the merger event has no significant impact on rival firms. On the other hand, the large and significant changes in systematic risk suggests that the merger event is having an effect on the rival firms. These conflicting pieces of evidence will be discussed in the conclusion of the report.

SECTION 4

CONCLUSION

The use of capital market data to assess the economic effects of mergers and acquisitions has become quite popular. The combination of conventional industrial organization theory hypotheses and "event based" statistical tests have provided empirical procedures which help to discriminate between mergers that give rise to monopoly power and those that give rise to efficiency gains. These empirical procedures are based on the abnormal performance of rival firms around events which affect the probability that a merger in the respective industry will occur.

The standard abnormal performance measure of an event test is the predicted market model residual in post-event periods where the predicted return is conditioned on pre-event market model estimates. Therefore the underlying assumption is that the systematic risk is stationary over time, and in particular is not affected by the event itself.

The model of systematic risk developed in the appendix predicts that the systematic risk of rival firms is endogenous to event studies. The empirical evidence strongly supports the notion that systematic risk is endogenous. Additionally, these changes in systematic risk are correlated with whether the event increases or decreases the likelihood of a merger in the industry.

These systematic changes in the beta of the rival firms have implications on the current "event test" methodology which uses pre-event estimates of systematic risk to compute post-event abnormal return measures.. The bias in abnormal return measures depends on the product of the change in systematic risk and the average return to the market portfolio. In particular, if the average return to the market portfolio over the event window is positive, the changes in systematic risk identified in this report will bias abnormal return measures away from supporting the monopoly power hypothesis. If, over the event window, the average return to the market portfolio is negative, abnormal performance measures based on pre-event systematic risk will be biased towards supporting the monopoly power hypothesis.

The results show that abnormal performance measures

after merger related events are sensitive to changes in systematic risk. Using the Stillman data set of challenged horizontal mergers, it is shown that computing abnormal performance measures of rival firms based on post-event estimates of systematic risk results in much higher abnormal returns to the rival firms after the announcement of a merger.

In this sample of mergers the abnormal performance measures of rival firms based on post-event systematic risk were also higher than the measures based on pre-event risk around events which decreased the likelihood of a merger. Therefore, for the challenged horizontal mergers in the Stillman data set, the use of post-event systematic risk to compute abnormal performance measures around complaint announcements enhances the conclusions of Eckbo: namely that because rival firms do not experience significant negative abnormal returns around a complaint announcement, there is no support for the monopoly power hypothesis.

Since the rival firms did not have significant abnormal changes in value after events which decreased the likelihood of a merger, it is then surprising that rival firms did experience large and significant increases in their systematic risk. These changes in systematic risk appear to be event-induced indicating that the merger events have an economic impact on rival firms. Below, in the section on future research, possible explanations for these somewhat puzzling results are discussed.

Future Research

One possible explanation for the difference in the empirical results may arise because changes in systematic risk are estimated using a long pre-event and post-event time period while the abnormal return measures are estimated over a short event-window. If the systematic risk of the firm permanently changes as a result of a merger the long pre-event and post-event time periods help identify the change in systematic risk. To identify an abnormal return only the period during which the merger event is occurring should be used, since non-event days introduce only noise and obscure the signal to noise ratio of the cumulative average residual. Hence, it may be more difficult to identify abnormal return performance than changes in systematic risk.[32] This would

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[32] This is true because of several reasons. The choice of the wrong event window can seriously affect the abnormal return measures, especially the significance of the measure. In addition the correct standard error variance on the abnormal return measure is the prediction error from the market model.

suggest that economic hypotheses regarding the source of the gain to merger that predict differences in changes in systematic risk may yield more powerful statistical tests than tests that rely on abnormal return performance.

The model presented in the appendix is a step in this direction. The model analyzes the effect of a merger event on the systematic risk of the rival firms. The change in systematic risk is decomposed into two components. The first component shows that changes in the value of the firm caused by the merger results in an inverse change in systematic risk.[33] The second component captures how the merger event changes the expected future riskiness of the firm's cash flows. Without further modeling we cannot determine whether changes in the monopoly power of the firm increases or decreases this term.[34] Under the assumption that increases in monopoly power decrease the riskiness of future cash flows the shifts in systematic risk can be shown to be consistent with the monopoly power hypothesis. Therefore, a rigorous model of this second component may provide for predictable differences in changes in risk after merger events, allowing for the statistical tests discussed above.

A second explanation of these conflicting results may involve omitted variables. If the "one-factor" market model is not appropriate, the results regarding both the changes in risk and abnormal returns may be inappropriate. A "multi-factor" market model may provide different estimates of the change in the riskiness of the firm's return.

Future research is clearly required to better understand

This involves the standard error of the parameters of the market model and the variance of the return to the market model during the event window. Clearly the estimates of the change in systematic risk involve the standard error of only the pre-event and post-event estimates of systematic risk.

[33] For a derivation of this result see the appendix. The intuition behind the result is the following. Prior to a merger event the firm's cash flows have a given amount of riskiness. The systematic risk is given by the per-value amount of this riskiness (the riskiness divided by the value). A sudden increase in value as a result of the merger event which does not change the riskiness of the cash flows, will therefore imply that the given amount of riskiness is spread out over a larger base of value.

[34] There are some models that suggest that in fact gains in monopoly power decrease the riskiness of cash flows (McCormick and Maloney, 1983).

why firms which experience no abnormal return performance experience large and significant shifts in systematic risk. Other useful research would be to examine whether these results concerning changes in systematic risk differ across data sets with different types of mergers, as has been done with abnormal performance measures.

In light of the results concerning the changes in systematic risk identified in the Stillman data and the potential low power of the tests that use abnormal performance measures, to totally dismiss the monopoly power hypothesis because of insignificant abnormal returns to rival firms seems premature.

APPENDIX A

In this appendix we outline a simple model of the determinants of the systematic risk of a firm and relate this model to changes in systematic risk of rival firms after the announcement of a merger.

Single Period Model of Systematic Risk

Consider a firm that produces a single product in amount Q, sells it at the end of a single production period at price P, which is uncertain before the sale date. In order to produce this output, the firm must hire two inputs differentiated by price and payment date characteristics. One input, denoted in amount by K, is purchased and paid for before production commences and totally depreciates at the end of the period. This factor, the capital of the firm, has a price which is arbitrarily normalized to unity. The second factor, denoted by L, is hired before production begins at a total cost per unit denoted by w, which is not completely known until payment is due at the end of the production period. If V_o denotes the initial value of the firm, the single period return to firm i is

$$(A1)\quad R_i = \frac{\tilde{P}_i Q_i - \tilde{w}_i L_i}{V_{io}} - 1.$$

In equilibrium, if the firm owns no unique resources and is a perfect competitor in both its output and input markets,

$$(A2)\quad V_{io} = K_i$$

where K_i is the value of the firm's capital stock. Equation (A2) states the result that in a perfectly competitive environment the value of the firm equals the replacement cost of its capital stock.

We assume that equilibrium in the capital market exists and is described by the Capital Asset Pricing Model (CAPM). As a result, the systematic risk of a firm is the relevant measure of its risk in investors' portfolios. The firm's systematic risk is given in equation (A3),

$$(A3)\quad B_i = \frac{\mathrm{Cov}(\tilde{R}_i, \tilde{R}_m)}{\mathrm{Var}(\tilde{R}_m)}$$

where B_i = the systematic risk of the firm (beta).

$\tilde{R}_m$ = the return to the market portfolio.

Combining equations (A1), (A2) and (A3) yields a specification for the systematic risk of the firm given by equation (A4),

$$(A4)\quad B_i^c = \frac{Q_i}{K_i}\frac{\mathrm{Cov}(\tilde{P}_i^c,\tilde{R}_m)}{\mathrm{Var}(\tilde{R}_m)} - \frac{L_i}{K_i}\frac{\mathrm{Cov}(\tilde{w}_i,\tilde{R}_m)}{\mathrm{Var}(\tilde{R}_m)}$$

where the superscript c designates the beta risk and price associated with a competitive firm, the subscript i identifies the firm and R_m is again the return on the market portfolio. The extension to multiple inputs and outputs is immediate.

It can be shown the expression for systematic risk (A4) can be derived from profit maximization of the firm and the market clearing conditions of the capital asset pricing model. For such a derivation see Appendix B.

If the firm possesses monopolistic power, either in its output market or in its input market, the value of the firm will exceed the replacement value of its capital stock. In the monopoly case, this premium is the capitalized value of monopoly profits. Monopolistic power on the input side is a result of either monopolistic market power in the resource markets or ownership of unique resources. This input-side monopolistic power will cause the firm's value to exceed the replacement value of its elastically supplied capital resource by the discounted value of the cost savings afforded by the monopolistic position. These considerations imply that the systematic risk of a firm with monopolistic power is given by,

$$(A5)\quad B_i^M = \frac{Q_i}{V_{io}}\frac{\mathrm{Cov}(\tilde{P}_i^M,\tilde{R}_m)}{\mathrm{Var}(\tilde{R}_m)} - \frac{L_i}{V_{io}}\frac{\mathrm{Cov}(\tilde{w}_i,\tilde{R}_m)}{\mathrm{Var}(\tilde{R}_m)}$$

$$= \frac{K_i}{V_{io}}\left[\frac{Q_i}{K_i}\frac{\mathrm{Cov}(\tilde{P}_i^M,\tilde{R}_m)}{\mathrm{Var}(\tilde{R}_m)} - \frac{L_i}{K_i}\frac{\mathrm{Cov}(\tilde{w}_i,\tilde{R}_m)}{\mathrm{Var}(\tilde{R}_m)}\right]$$

$$= \frac{1}{q_i}\left[\frac{Q_i}{K_i}\frac{Cov(\tilde{P}_i^M,\tilde{R}_m)}{Var(\tilde{R}_m)} - \frac{L_i}{K_i}\frac{Cov(\tilde{w}_i,\tilde{R}_m)}{Var(\tilde{R}_m)}\right]$$

where the M superscript denotes the beta for the firm with monopoly power and q_i denotes "Tobin's q", the ratio of the current market value of the firm to the current replacement cost of its capital stock. For a firm with monopolistic power $q_i > 1$.[35]

Multi-Period Model of the Firm and Firm Systematic Risk

The single period model of firm systematic risk is extended to multiple periods by separating firm cash flows into those received by the firm in the immediate future and more distant future cash flows. The single period return on the firm i is,

$$(A6)\quad \tilde{R}_i = \frac{\tilde{P}_iQ_i - \tilde{w}_iL_i + \tilde{V}_{i1}}{V_{io}} - 1$$

where $\tilde{V}_{it}$ = value of firm i at time t and the time subscript o designates the beginning of the current period and 1 denotes the beginning of the next production-sales period. For simplicity, V_{i1} is the value of the firm at the beginning of period one net of any new investment and capital structure changes the firm may undertake in period 1. By definition,

$$(A7)\quad \tilde{V}_{i1} = (1 - \tilde{d}_i)\tilde{k}_{i1}K_i$$

where $\tilde{d}_i$ = depreciation rate of the current capital stock at time 1 which is random at time 0

$\tilde{k}_{i1}$ = market price of a unit of firm i's vintage 0 capital at end of first period which is random at time 0.

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[35] For a proof of this relationship between Tobin's q measure and monopoly power see Lindenberg and Ross (1981).

Using (A7) expression (A6) can be written as

$$(A8)\quad \tilde{R}_i = \frac{\tilde{P}_i Q_i}{V_{io}} - \frac{\tilde{w}_i L_i}{V_{io}} + \frac{K_{io}}{V_{io}}(1-\tilde{d}_i)\tilde{k}_{i1} - 1.$$

If capital is time-homogeneous,

$$(A9)\qquad (1 - \tilde{d}_i)K_{io} = \tilde{K}_{i1}.$$

Equations (A9) and (A7) imply

$$(A10)\quad \tilde{k}_{i1} = \frac{\tilde{V}_{i1}}{\tilde{K}_{i1}} = \tilde{q}_{i1}$$

where q_{i1} is the value of "Tobin's q" for firm i at the beginning of the period 1 which is a random variable at time 0.

Under these assumptions, the firm's systematic risk is

$$(A11)\quad \frac{Cov(\tilde{R}_i,\tilde{R}_m)}{Var(\tilde{R}_m)} = \frac{Q_i}{V_{io}}\frac{Cov(\tilde{P}_i,\tilde{R}_m)}{Var(\tilde{R}_m)} - \frac{L_i}{V_{io}}\frac{Cov(\tilde{w}_i,\tilde{R}_m)}{Var(\tilde{R}_m)}$$

$$+ \frac{K_{io}}{V_{io}}\frac{Cov((1-\tilde{d}_i)\tilde{q}_{i1},\tilde{R}_m)}{Var(\tilde{R}_m)}.$$

Assuming that the depreciation rate is independent of q_{i1} and R_m, and under the assumption of multivariate normality,

$$(A12)\quad Cov(\tilde{d}_i\tilde{q}_{i1},\tilde{R}_m) = E(\tilde{d}_i)\, Cov(\tilde{q}_{i1},\tilde{R}_m)$$

Substitution shows that the systematic risk of a firm can be

written as

$$(A13) \quad B_i = \frac{Q_i}{V_{io}} \frac{Cov(\tilde{P}_i,\tilde{R}_m)}{Var(\tilde{R}_m)} - \frac{L_i}{V_{io}} \frac{Cov(\tilde{w}_i,\tilde{R}_m)}{Var(\tilde{R}_m)}$$

$$+ \frac{K_{io}(1-E(\tilde{d}_i))Cov(\tilde{q}_{i1},\tilde{R}_m)}{V_{io}\ Var(\tilde{R}_m)} .$$

Expression (A13) can be rewritten as

$$(A14) \quad B_i = \frac{1}{q_{io}} \left[\frac{Q_i}{K_{io}} \frac{Cov(\tilde{P}_i^M,\tilde{R}_m)}{Var(\tilde{R}_m)} - \frac{L_i}{V_{io}} \frac{Cov(\tilde{w}_i,\tilde{R}_m)}{Var(\tilde{R}_m)} \right.$$

$$\left. + \frac{(1-E(\tilde{d}_i))Cov(\tilde{q}_{i1},\tilde{R}_m)}{Var(R_m)} . \right]$$

The stochastic nature of the future value of the firm's "q measure" represents the uncertainty of future cash flows.

Systematic Risk and Merger Events

The model of systematic risk presented above can be used to examine the effects of merger related events (merger announcements, complaints by the Federal Trade Commission, etc.) on the systematic risk of any firm affected by the merger, including rival firms. Since the "event test" methodology relies on the risk adjusted abnormal returns to rival firms to distinguish between anti-competitive mergers and pro-competitive mergers it is important to analyze the circumstances under which the systematic risk of rival firms is altered by a merger proposal.

Equation (A14) shows the determinants of systematic risk and can be used to analyze how the systematic risk of rival firms is affected by unexpected information regarding the

likelihood of a merger taking place.[36]

Suppose that a merger agreement is announced that investors expect to have monopoly power ramifications or give rise to industry wide efficiency gains. The announcement of this firm combination will immediately be reflected in the rival firms market value as investors anticipate any future monopoly gains or synergy gains.[37] The change in the market value of the rival firm implies that the firm's "q measure" also changes since this is the ratio of the current market value of the firm to the current replacement cost of its capital stock. Consequently, the inverse of Tobin's "q" measure which is the term outside the brackets in equation (A30) is lower after the announcement of the merger.

The merger announcement will not affect the first two terms inside the bracketed expression in equation (A14). This is because the merger announcement does not affect the current period operating characteristics of the firm. Operating characteristic changes of the rival firm (output-capital and input-capital ratios), if any, take time to change and will not be implemented until future production periods. Likewise, the covariance of current period prices and wages with the return to the market portfolio should not change since the merging firms have not yet consolidated.[38] The unexpected announcement of the merger agreement will affect the expected future values of prices, output-capital and labor-capital ratios. These changes are accounted for by the covariance of the future value of Tobin's "q" with the return on the market portfolio (the last expression in equation (A14)). Therefore, the expression for the change in systematic risk after the announcement of a merger is

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[36] The expression for systematic risk can be used to examine the affect of a merger related event on the target and acquiring firm's systematic risk also. In this report, the focus is limited to the rival firms to a merger.

[37] Recall that under the industry wide efficiency hypothesis and the monopoly power hypothesis rival firms should have an increase in their market value.

[38] For certain types of durable products the current price of the output may be affected by changes in the future value of the cash flows. The assumption made in the model is that the covariance of prices and wages with the return to the market portfolio is not affected by the announcement.

$$(A15)\ \Delta B_i = \Delta \frac{1}{q_{io}} \left[\frac{Q_i}{K_{io}} \frac{Cov(\tilde{P}_i, \tilde{R}_m)}{Var(\tilde{R}_m)} - \frac{L_i}{K_{io}} \frac{Cov(\tilde{w}_i, \tilde{R}_m)}{Var(\tilde{R}_m)} \right.$$

$$\left. + \Delta \frac{(1-E(\tilde{d}_i))Cov(\tilde{q}_{i1}, \tilde{R}_m)}{Var(\tilde{R}_m)} \right].$$

where $$\Delta \frac{1}{q_{io}} = \frac{K_{io}}{V'_{io}} - \frac{K_{io}}{V_{io}}$$

and V'_{io} is the market value of the firm after the merger information is reflected in the capital markets.

The important aspect of equation (A15) is that merger events which change the value of the firm should also immediately affect the firm's systematic risk since the value of Tobin's q measure changes when the value of the firm changes. In other words, systematic risk is endogenous to merger event studies.

The sign of the change in systematic risk after the announcement of a merger depends on the change in Tobin's "q" measure and the change in the covariance of future values of Tobin's "q" with the return to the market portfolio.

In general the model of systematic risk developed in this appendix does not predict the sign of the change in systematic risk given an event which increases the value of the firm. This is because the effect of a merger event on the covariance of future values of Tobin's "q" measure cannot be determined within the framework of this model.

Under the strong assumption that the covariance of future values of Tobin's "q" with the return on the market portfolio are not affected by the merger, we can write equation (A15) as,

$$(A16)\ \Delta B_i = \Delta \frac{1}{q_{io}} \left[\frac{Q_i}{K_{io}} \frac{Cov(P_i, R_m)}{Var(R_m)} - \frac{L_i}{K_{io}} \frac{Cov(w_i, R_m)}{Var(R_m)} \right].$$

When rival firms gain in value after the announcement of the merger,

$$V'_{io} > V_{io}$$

and so,

$$\Delta B < 0.$$

Equation (A16) indicates that under the assumption that future values of Tobin's "q" measure are covariance stationary with the return on the market portfolio there is an inverse relationship between the changes in firm value that occur because of the merger announcement and changes in systematic risk. The immediate change in the market value of the firm due to the expectation of future cash flows changes the base over which a given amount of risk is spread. For example, an immediate increase in the value of the firm decreases the risk associated with each unit of value, thereby reducing the firm's systematic risk.

Relaxing the strong assumption that the covariance of the future Tobin's "q" measure (a measure of the riskiness of future cash flows) with the return to the market portfolio is stationary introduces an indeterminacy in the sign of the change in systematic risk induced by a merger announcement, since our model does not predict the sign of $Cov(q_{i1},R_m)$.

If additional structure is imposed, the sign of the change in the covariance of Tobin's "q" with the return to the market portfolio can be determined. For example, McCormick and Maloney (1985) hypothesize that the combination of two firms allows for increased production smoothing. In times of high demand two firms operating independently or under one management will be at full capacity. Under low demand conditions, they hypothesize that it is more efficient for two plants under one management to handle idle capacity than it is for independently operated plants. In times of low demand the reduction in profits will be less dramatic. This implies that a merger announcement may lower the covariance of the expected future cash flows with the return to the market portfolio. Announcements of mergers that result in increased monopoly power also may lower the covariance of the expected future cash flows with the return to the market portfolio. It is plausible that monopoly power may allow the monopolist to attenuate the effects of demand shocks on its output price, although this has not been developed within a formal model. Combining these effects strengthens the theoretical justification for expecting a merger announcement to reduce the covariance term.

Cross-sectional empirical studies generally support the proposition that market power is associated with lower systematic risk. Work by Sullivan (1977) and Moyer and Chatfield (1981) support the hypothesis that market power and systematic risk are inversely related.

If the announcement of mergers that will result in either efficiency gains or increased monopoly power lowers the covariance of future cash flows of the rival firm with the return to the market portfolio, the further reduction in systematic risk will enhance the reduction caused by the increase in the rival firm's market value.

APPENDIX B

In this appendix we develop the expression (A4) in Appendix A from the microeconomic analysis of the firm and the market clearing conditions of the capital asset market.

The Model

At time one consumers purchase equity shares that yield income which is used for the purchase of goods and services at time two. It is assumed that a nominally riskless asset exists and equity is trades in a perfectly competitive asset market that satisfies the sufficient conditions for the two-parameter asset pricing model.

For simplicity assume that firms exist for a single period (dates one through two) and are liquidated. Production requires a single period and all output is sold at date two. Assume that firms are endowed with a given technology and must purchase capital and variable inputs at time one before they have exact knowledge of the market prices of their output and their variable inputs that they will pay at time two. It is assumed that capital is perfectly divisible, depreciates completely during the production period and is purchased at time one at a known price normalized to unity. Firms finance the fixed costs associated with their purchase of capital at time one by selling equity shares in the time two realized value of the firm. Equity owners receive the liquidating value of the firm as the return on their investments. Assume firms choose factor inputs to maximize the time one market value of their outstanding securities. For simplicity, assume labor is the only variable input required for production. The generalization to multiple factor inputs is immediate.

All N firms in this economy are perfect competitors in both their output and factor input markets. At time one, management's knowledge of factor and output prices is unknown and characterized by probability distributions.

It is assumed that firms are price takers not only in the traditional competitive sense, but also that firms behave as if their production decisions do not affect the certainty equivalent prices they face.

In this framework, the value of a firm at time two is given by the value of the firm's income from its production decisions made at time one,

$$(B1)\quad V_{i2} = P_{i2}Q_i - w_{i2}L_i ,$$

where Q_i represents the output of the firm and L_i, its labor input. The time one value of the firm is given by the equilibrium condition of the two-parameter (CAPM) asset pricing model,

$$(B2)\quad V_{i1} = (1 + R_f)^{-1}\,[E(\tilde{V}_{i2}) - dB_i^*]$$

$$d = [E(\tilde{V}_{m2}) - (1 + R_f)V_{m1}]$$

$$B_i^* = \mathrm{Cov}(\tilde{V}_{i2},\tilde{V}_{m2})/\mathrm{Var}(\tilde{R}_{m2})$$

$$= (V_{i1}/V_{m1})B_i$$

$$B_i = \mathrm{Cov}(\tilde{R}_i,\tilde{R}_m)/\mathrm{Var}(\tilde{R}_m)$$

where V_{it} represents the value of an asset at time t, V_{mt} represents the value of the market portfolio of risky assets at time t, R_i is the return on the ith asset, R_f is the return on the nominally riskless asset and R_m is the return on the market portfolio of all risky assets over this period. B_i is the usual measure of an asset's systematic or nondiversifiable risk in the CAPM.

At time one, the firm purchases capital and labor in order to maximize the value of its equity which is given by expression (B2). Substituting (B1) into (B2) allows the firm's objective to be stated as,

$$(B3)\quad \underset{K_iL_i}{\mathrm{Max}}\ [Q_i\,\mathrm{CEQ}(\tilde{P}_{i2}) - L_i\,\mathrm{CEQ}(\tilde{w}_{i2})] - K_i$$
$$\text{subject to}\ \ Q_i = F_i(K_i,L_i),$$

where K_i is the value of capital inputs purchased by the firm, $F_i(.)$ is its production function and $\mathrm{CEQ}(P_{i2})$ and $\mathrm{CEQ}(w_{i2})$ are the firm's CAPM certainty equivalent wages and prices. Rewriting the expression in terms of the more general cost minimization problem, expression (B3) becomes,

$$(B4)\quad \underset{Q_i}{\mathrm{Max}}\ \{\mathrm{CEQ}(\tilde{P}_{i2})Q_i - \mathrm{Min}_{K_iL_i}\,[L_i\mathrm{CEQ}(\tilde{w}_{i2}) + K_i - (Q_i - F_i(K_i,L_i))]\}$$

Under conventional production function curvature assumptions

the minimization problem can be solved for the firm's certainty equivalent cost function, $CEQ(C_i(Q_i))$. The maximization problem can be restated as,

$$(B5)\quad \underset{Q}{\text{Max}} \quad Q_i CEQ(\tilde{P}_{i2}) - CEQ(\tilde{C}_i(Q_i)).$$

The necessary condition for an optimum is,

$$(B6)\quad CEQ(\tilde{P}_{i2}) = dCEQ(\tilde{C}_i(Q_i))/dQ_i.$$

The long-run condition of competitive equilibrium requires

$$(B7)\quad Q_i CEQ(\tilde{P}_{i2}) = CEQ(\tilde{C}_i(Q_i)).$$

Conditions (B6) and (B7) together require that

$$(B8)\quad CEQ(\tilde{P}_{i2}) = CEQ(\tilde{C}_i(Q_i))/Q_i = CEQ(\tilde{ATC}_i(Q_i)),$$

where $CEQ(\tilde{ATC}_i(Q_i))$ is the certainty equivalent average total cost of producing Q_i for firm i. Expression (B8) is the condition of competitive equilibrium under uncertainty.

The firm's certainty equivalent average total cost is given by,

$$(B9)\quad CEQ(\tilde{ATC}_i(Q_i)) = [(L_i/Q_i)[E(\tilde{w}_{i2}) - dCov(\tilde{w}_{i2},\tilde{V}_{m2})]](1+R_f)^{-1} - (K_i/Q_i)$$

Rearranging the expression for the time one value of the firm (B2) and utilizing the equilibrium condition that $CEQ(\tilde{P}_{i2}) = CEQ(\tilde{ATC}_i(Q_i))$ or

$$(B10)\quad E(\tilde{P}_{i2}) - dCov(\tilde{P}_{i2},\tilde{V}_{m2}) = (L_i/Q_i)[E(\tilde{w}_{i2}) - dCov(\tilde{w}_{i2},\tilde{V}_{m2})] + (K_i/Q_i)(1+R_f)$$

it is apparent that in a competitive equilibrium the time one

value of the firm equals the value of its capital stock,

$$(B11)\quad V_{i1} = K_i.$$

Conditions (B11) and (B10) of competitive equilibrium allow the CAPM systematic risk of the firm to be expressed as,

$$(B12)\quad B_i = \mathrm{Cov}(\tilde{R}_i,\tilde{R}_m)/\mathrm{Var}(\tilde{R}m) = (V_{m1}/V_{i1})B_i^*,$$

$$(B13)\quad B_i = (K/K_i)[Q_i\mathrm{Cov}(\tilde{P}i_2,\tilde{V}_{m2})/\mathrm{Var}(\tilde{R}_{m2}) - L_i\mathrm{Cov}(\tilde{w}_{i2},\tilde{V}_{m2})/\mathrm{Var}(\tilde{V}_{m2})],$$

$$K = \sum K_i$$

or,

$$(B14)\quad B_i = (Q_i/K_i)[\mathrm{Cov}(\tilde{P}_{i2},\tilde{R}_m)/\mathrm{Var}(\tilde{R}_m)] - (L_i/K_i)[\mathrm{Cov}(\tilde{w}_{i2},\tilde{R}_m)/\mathrm{Var}(\tilde{R}_m)].$$

Expression (B14) shows that a firm's systematic risk or beta is a weighted combination of more fundamental risk components. The weights attached to these constituent betas are functions of the firm's production function parameters and moments of the output and input price distributions faced by the firm. The weight attached to the firm's output price beta will be its ex-ante optimal output-capital ratio and the weights attached to its input-price betas will be its ex-ante optimal individual factor input-capital ratios.

Expression (B14) is identical to expression (A4) in Appendix A. Therefore the expression for systematic risk given in Appendix A can be derived from the microeconomic foundations of the firm.

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