Are Member Firms of Corporate Groups Less Risky?

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Abstract

This paper contributes to the literature that seeks to understand how the relationships among members of an industrial group influence firm performance and mitigate risk. We shed light on how the relationship structure in a keiretsu affects the risk and value of its member firms. Our findings help answer the question of why the practice of profit and risk sharing among keiretsu firms does not result in lower risk for these firms. Although the practice of profit and risk sharing among keiretsu firms mitigates risk at the firm level, this also causes the fundamentals of keiretsu firms to become more correlated and hence contributes to an increase in market-level risk. In other words, firm-level risk is being transformed into market-level risk. Since only market-level risk is priced, the observed increase in market-level risk actually destroys shareholders’ wealth. In addition, the heightened correlation essentially diminishes the diversification efficacy of a portfolio of keiretsu firms. In conclusion, our results suggest that the practice of profit and risk sharing, which on the surface seems to be a blessing, may in fact have a detrimental effect on the value of keiretsu firms.

JEL Classifications: G32, G34, L16

Key Words: Business groups, keiretsu, risk decomposition, corporate governance, diversification

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The business group as a form of industrial organization has always been an interesting research topic. Business groups can be found in both industrialized as well as developing nations such as Japan, Korea, India, Germany, and Mexico. These business groups are typically characterized by diversified business lines, extensive trade links, cross shareholdings, and mutual board representations (Dewenter, Novaes, and Pettway, 2001). Among the different forms of business groups, the Japanese keiretsu is perhaps the most well known. Keiretsu is unique in that it is characterized by diversification, information sharing, profit and risk sharing, a capital structure with cross holdings of debt and equity, personnel exchange, intra-keiretsu trade, joint ventures, interlocking boards, and strong ties to a main bank (Hoshi, 1994; Berglöf and Perotti, 1994). An inevitable research question concerns how these unique characteristics affect the profitability, risk, and value of keiretsu firms.

Surprisingly, the literature regarding issues concerning the impact that the structure of the business organization has on firm risk and the wealth of shareholders is scant. Prior studies in keiretsu structure focus primarily on subject matter such as accounting, the stability of accounting profit, and the roles of the main bank and/or shareholders as corporate monitors (Nakatani, 1984; Morck and Nakamura, 1999; Kang and Stulz, 2000). Others include Almeida and Wolfenzon (2006) who demonstrate that countries having a high degree of conglomeration decrease the capital market efficiency and Jameson, Sullivan, and Constand (2000) who find lower Tobin’s Q for the keiretsu firms. They conclude that keiretsu firms have chosen to increase the efficiency of internal monitoring at the expense of market monitoring. However, little explanation is given as to why such a “superior industrial organizational” structure would produce lower firm value. Our objective is to fill this void in the literature.
We investigate the effect of keiretsu structure on the risk of member firms. Instead of comparing the variability in accounting profit, our primary focus is on the differences in the composition of the variance of stock returns between keiretsu and non-keiretsu firms. Through risk decomposition, we are able to analyze the impact that organizational structure has on the shift between various risk components. We employ a model-free risk decomposition method proposed by Campbell, Lettau, Malkiel, and Xu (2001) for this purpose. In this methodology, aggregate firm risk is decomposed into three individual components: 1) market level risk, 2) industry level risk, and 3) firm level risk. Our intention is to investigate how the keiretsu structure and its practice of profit and risk sharing affect the individual risk components.

We confirm that the practice of profit and risk sharing does not lower the overall level of a firm’s risk as measured by the unconditional volatility of a firm’s stock returns. The overall level of firm risk is driven by both systematic and idiosyncratic factors. The evidence we have uncovered suggests that the profit and risk sharing activities among keiretsu firms is indeed associated with a reduction in the idiosyncratic firm level risk. This is consistent with the common expectation that keiretsu firms should have more stable profits as a result of the profit and risk sharing among them. However, the reduction in the idiosyncratic firm level risk is accompanied by an increase in the market level risk, leaving the aggregate firm risk relatively unchanged. This shift from firm level risk to market level risk is brought on by an increase in the correlation of the firms’ fundamentals as a result of their profit and risk sharing activities. Granger causality tests lend support to our assertion that keiretsu firms demonstrate strong evidence of such transformation of firm level risk to market level risk. Alternatively, non-keiretsu firms exhibit little evidence of shifting risk.
Since firm level risk is not priced and market level risk is priced in the capital markets according to the asset pricing theory, a higher market level risk will, in effect, depress the equity value of keiretsu firms and destroy shareholders’ wealth. Additionally, the higher correlations among keiretsu firms’ equity returns also diminish the diversification efficacy of a portfolio of keiretsu firms further eroding shareholders’ wealth. Although several authors (Nakatani, 1984; Hoshi, Kashyap, and Sharfstein, 1990; Hoshi and Ito, 1991) have argued that keiretsu offers various value adding benefits, our results reveal that it is not clear that the keiretsu business structure does, in fact, enhance shareholders’ wealth. We find that keiretsu firms face a tradeoff between lowering their firm level risk and increasing their market level risk.

The rest of the paper is organized as follows. Section I presents the methodology and data sources. Section II discusses the pros and cons of a keiretsu structure, the rationale of risk transferring, and provides some hypotheses for the study. Section III presents mean and variance risk decomposition for keiretsu and non-keiretsu firms, and the lead-lag relationship among the three levels of risk. The implications for shareholder’s diversification efficacy are discussed in Section IV. Finally, Section V provides our conclusions.

I. Methodology and Data

A. Risk Decomposition

For the purpose of this study, we decompose total firm volatility into three components: 1) market level volatility, 2) industry level volatility, and 3) firm level volatility. The decomposition closely follows Campbell et al. (2001). We define:

\[ R_{jit} = \text{excess returns of } j^{th} \text{ stock, in } i^{th} \text{ industry, at time } t \]
\[ R_{it} = \sum_{j \in i} w_{jit} R_{jit} = \text{excess returns of } i_{th} \text{ industry at time } t \]

\[ R_{mt} = \sum_{i} w_{it} R_{it} = \text{market excess returns at time } t \]

where \( w \) represents market value weight. To estimate industry level volatility, Campbell et al. (2001) suggest a market adjusted return model that does not rely on an equilibrium return generating model. Let:

\[ R_{it} = R_{mt} + \epsilon_{it} \] (1)

Since \( R_{mt} \) and \( \epsilon_{it} \) are not orthogonal, it follows that:

\[ \text{Var}(R_{it}) = \text{Var}(R_{mt}) + \text{Var}(\epsilon_{it}) + 2 \text{Cov}(R_{mt}, \epsilon_{it}) \]

\[ = \text{Var}(R_{mt}) + \text{Var}(\epsilon_{it}) + 2 (\beta_{im} - 1) \text{Var}(R_{mt}) \] (2)

Although Equation (2) contains covariance between \( R_{mt} \) and \( \epsilon_{it} \), Campbell et al. (2001) argue that because \( \sum_{i} w_{it} \beta_{im} = 1 \) when all industries are included in the sample, it follows that:

\[ \sum_{i} w_{it} \text{Var}(R_{it}) = \text{Var}(R_{mt}) + \sum_{i} w_{it} \text{Var}(\epsilon_{it}) = \sigma_{mt}^2 + \sigma_{et}^2 \] (3)

Equation (3) implies that knowledge of covariance between \( R_{mt} \) and \( \epsilon_{it} \) is not required in order to estimate the weighted average industry risk. The same reasoning could be applied to individual firms.
\[ R_{jit} = R_{it} + \eta_{jit} \] (4)

and

\[ \sum_{j \in i} w_{jit} \text{Var}(R_{jit}) = \text{Var}(R_{it}) + \sum_{j \in i} w_{jit} \text{Var}(\eta_{it}) = \sigma_{\epsilon t}^2 + \sigma_{\eta t}^2 \] (5)

Therefore,

\[ \sum_i w_{it} \sum_{j \in i} w_{jit} \text{Var}(R_{jit}) = \text{Var}(R_{mt}) + \sum_i w_{it} \text{Var}(\epsilon_{it}) + \sum_i w_{it} \sum_{j \in i} w_{jit} \text{Var}(\eta_{jit}) \]

\[ = \sigma_{\epsilon t}^2 + \sigma_{\epsilon t}^2 + \sigma_{\eta t}^2 \] (6)

We use daily data in the equations below to estimate monthly volatility. In our notation, the subscripts "s" and "t" denote daily and monthly data, respectively. Market level volatility is estimated as:

\[ \text{MKT}_t = \sigma_{mt}^2 = \sum_{s \in t} (R_{ms} - u_m)^2 \] (7)

where \(u_m\) is the weighted average returns using all firms in the sample and the weight is determined using the firms’ market capitalization.

Since \(\sigma_{\epsilon t}^2 = \sum_{s \in t} \epsilon_{is}^2\), where \(\epsilon_{is} = R_{is} - R_{ms}\), industry level volatility can be estimated as:

\[ \text{IND}_t = \sigma_{\epsilon t}^2 = \sum_i w_{it} \sigma_{\epsilon it}^2 \] (8)
Moreover, since:

\[ \sigma^2_{\eta jit} = \sum_{s \in t} \eta^2_{jis}, \text{ and} \]

\[ \sigma^2_{\eta it} = \sum_{j \in i} w_{jit} \sigma^2_{\eta jit}, \]

firm level volatility is estimated as:

\[ \text{FIRM}_t = \sigma^2_{\eta t} = \sum_i w_{it} \sigma^2_{\eta it} \] (9)

B. Description of Data

Our data stretches from January 1976-December 1998 and is derived from the 2001 edition of the Pacific-Basin Capital Markets database (PACAP) containing all Section 1 and Section 2 stocks traded on the Tokyo Stock Exchanges. We suspect that the practice of profit and risk sharing among keiretsu firms may be more prevalent during times of economic hardship. To investigate this phenomenon, we divide the data into two periods: 1) the pre-recession period from 1976-1989 and 2) the recession from 1990-1998.\(^1\) The database has a total of 1,596 firms for the 1976-1989 period (80s) and 1,908 firms for the 1990-1998 period (90s). Thinly traded firms (i.e., firms that have more than 5% missing price information) are excluded from our analysis. After the exclusions, 818 and 1,226 firms remain in the data set for the 1976-1989 and 1990-1998 periods, respectively. We fill in any missing values with the last observed price for the remaining firms. All of the 33 industries in the database are included in our study. The

\(^1\) Several indicators suggest the end of recession near the end of 1998. These indicators include Nikkei Index, real wage growth, productivity growth, and long-term real interest rates. See Agnese and Sala (2009).
industry with the largest capitalization is the banking industry with a total of 25 firms in the 80s and 73 firms in the 90s. The industry with the largest number of firms is electric machinery with a total of 100 and 123 firms in the 80s and 90s, respectively.

Keiretsu firms are manually identified using the 1986/87, 1994, and 1999 issues of *Industrial Grouping in Japan (IGJ)* published by Dodwell Marketing Consultants. Specifically, we use the 1986/1987 IGJ classification for the pre-1990 data, 1994 IGJ for the 1990-1995 data, and 1999 IGJ for data after 1995. The definition of keiretsu is not always clear. Dodwell assigns “degree of inclination to the group” using a rating system of one through four stars. Firms with either a one- or two-star rating are firms that have relatively weak association with the group. We classify all firms into three keiretsu categories: 1) keiretsu, 2) weak keiretsu and 3) non-keiretsu. Keiretsu refers to a group of firms with 3-4 stars while weak keiretsu firms have 1-2 stars. Since not all firms are included in the IGJ, only 632 and 1,063 firms in our sample can be clearly identified as either affiliated with a keiretsu or independent firms during the periods of 1976-1989 and 1990-1998, respectively. Among the 632 firms in our first sample, 327, 124, and 181 are non-keiretsu, weak keiretsu, and keiretsu, respectively. In the 1990s, 562, 201, and 300 are non-keiretsu, weak keiretsu, and keiretsu, respectively. Monthly market level volatility, industry

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2 We restrict our sample to horizontal (or financial) keiretsu firms for a few reasons. First, focusing on this subset will facilitate comparison of our results with the results from earlier studies since previous studies investigate primarily horizontal keiretsu firms. Second, the horizontal keiretsu structure resembles a conglomerate. Unlike a vertical keiretsu which is controlled by a dominant firm in the structure, a horizontal keiretsu exhibits cross shareholding, interlocking directors, and are centered on a main bank. Thus, studying horizontal keiretsu will help to shed light on the impact of conglomerate structure. Third, the vertical keiretsu structure is not as popular; the number of available vertical keiretsu firms is approximately one-fifth that of horizontal keiretsu firms (Jameson et al., 2000). However, a vertical keiretsu firm may also be loosely related to, or a part of a horizontal keiretsu.

3 Japanese keiretsu structure originated from the pre-war Zaibatsu, which are characterized by tight family control. Although Zaibatsu were dissolved after WWII, they re-emerged as keiretsu during the 1950s and 1960s (Berglöf and Perotti, 1994). Shimotani (1995) provides a detailed description of the formation of Matsushita’s distribution keiretsu in which Matsushita Electric, the parent company, aggressively expanded the group by creating operations and distribution subsidiary companies long before WWII. In most cases, a firm is naturally a member of a keiretsu group if it was created by a keiretsu or had a historical tie with the Zaibatsu that later became a keiretsu group. That said, some unrelated suppliers in the auto industry, for example, have the choice to become a member of a business group, which, in turn, often results in a long-term contract providing the suppliers with more stability in their
level volatility, and firm level volatility are estimated using daily data obtained from the PACAP database according to Equations (7), (8), and (9), respectively.

II. Risk Structure of Keiretsu Firms

A. Benefits of a Keiretsu Structure

One of the major characteristics of a keiretsu firm is that member firms often lend a helping hand to other member firms, especially in periods of economic hardship. When a member firm encounters financial difficulties, the main bank and other member firms in the same group come to the rescue by offering easier credit terms, lower commodity prices, and/or an exchange of talented managers. Empirically, Dewenter (2003) finds preliminary evidence of this risk sharing practice among keiretsu business groups. Specifically, she reports that diversification, monitoring, and resource shifting observed for six keiretsu business groups is consistent with risk sharing intentions. Since keiretsu firms are known to share their profits and risks, classic studies citing the keiretsu as a superior industrial organization argue that corporate grouping may be thought of as an insurance scheme in which member firms are both the insurers and insured at the same time (Nakatani, 1984). Given that the practice of profit and risk sharing stabilizes corporate profit, it has been argued that this practice contributed to the stability of the entire Japanese economy in the wake of external shocks such as the oil crisis of 1979.

Moreover, keiretsu firms’ corporate governance structure is characterized by a multi-tier system in which shareholders, main banks, and member keiretsu firms all share in the monitoring responsibility. Therefore, other benefits of a keiretsu structure include lower agency costs and

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business. Nevertheless, companies that were founded after WWII that lack such a historical tie, such as Sony, typically have organizational structures that resemble U.S. firms. Given the above background, keiretsu membership is treated as exogenously determined in our analysis.
financial distress costs due to the linkage between debt and equity financing that reduces the conflict between creditors and shareholders (Nakatani, 1984; Hoshi et al., 1990; Hoshi and Ito, 1991). Hoshi et al. (1990) reason that the lower financial distress cost is expected as financial distress is less costly when financial claims are concentrated. Additionally, keiretsu firms’ managers are not myopic and are able to focus on long-term profitability because of the mutual takeover defense and risk sharing practice (Aoki, 1987, 1990; Sheard, 1989, 1994; Dewenter, 2003). Aoki (1987) argues that keiretsu firms put a large portion of their equity shares in friendly hands such as member firms and the firm’s main bank. Finally, since keiretsu is a more diversified business entity, firms often encounter less business risk.

In theory, the relatively stable profit of keiretsu member firms should reduce their risk and lower their cost of capital. Furthermore, the internal monitoring system provided by the keiretsu corporate governance systems is said to reduce agency cost. These factors presumably enhance keiretsu firm value. Such arguments, however, were challenged in the wake of a prolonged recession that has plagued many Japanese firms since the late 1980s. In fact, using pre-recession data, Jameson et al. (2000) find keiretsu firms do not have higher firm value than independent firms. Based upon the above arguments, we first examine the hypotheses that keiretsu firms have higher shareholder returns, but lower risk. The nulls are:

\[ H_1: R_{keiretsu} = R_{non-keiretsu} \]
\[ H_2: \sigma_{keiretsu} = \sigma_{non-keiretsu} \]

B. Why Would Keiretsu Managers Transfer Risk?
The practice of risk sharing produces an intended or unintended result; a reduction in firm level idiosyncratic risk at the expense of an increase in systematic risk. This happens because risk sharing leads directly to a reduction in firm level volatility, but at the same time this act increases the correlation between keiretsu firms’ fundamentals and results in a transfer of firm level risk to market level risk. We develop a simple model to illustrate this intuition below.

Consider a keiretsu with $N$ firms that are identical except for the fact that they experience non-synchronous random shocks to their cash flows. Let the cash flow for firm $i$ be equal to $C_i$. Further, let the rate of return for firm $i$ be represented as $r_i = A \times C_i + B$ where $A$ and $B$ are some constants.\(^4\) Since we are assuming that the firms experience non-synchronous random shocks to their cash flows, we can rewrite the equation for the rate of return simply as $r_i = \psi + \epsilon_i$, where $\epsilon_i \sim N(0, \sigma^2)$, $\rho(\epsilon_i, \epsilon_j) = 0$ and $\psi$ is a constant that embodies, in part, a common determinant of the cash flows to the firms. Given that our goal is to model the impact of profit and risk sharing among keiretsu firms, we further assume that the $N$ keiretsu firms share their cash flows equally. This leads to:

$$r_i = \sum_{i=1}^{N} (\psi + \epsilon_i) / N = \text{some constant} + \sum_{i=1}^{N} \epsilon_i / N$$

Consequently, the return variance for firm $i$ will be given by:

$$\sigma_i^2 = Var(\sum_{i=1}^{N} (\epsilon_i) / N) = \frac{1}{N^2} \sum_{i=1}^{N} \sigma^2 = \frac{\sigma^2}{N}$$

\(^4\) This formulation, no doubt an oversimplification, is consistent with the constant growth discount model.
Hence, there is a reduction in the firm level risk by a factor of $1/N$. Had there been no sharing of cash flows among the keiretsu firms, the return variance for each firm would have been

$$\sigma^2_i = Var(\epsilon_i) = \sigma^2_i.$$ However, the reduction in firm level risk comes at a cost to the firm. Notice that the return correlation between firm $i$ and $j$ is now:

$$\rho(r_i, r_j) = \rho(\frac{\sum_{i=1}^{N} (\epsilon_i)}{N}, \frac{\sum_{j=1}^{N} (\epsilon_j)}{N}) = 1 \text{ for all } i \text{ and } j \quad (11)$$

The increase in correlation in the returns to the firms will lead to an increase in the market level risk. In contrast, when there is no risk sharing among the keiretsu firms, the correlation coefficient between any two firms will, by assumption, be zero. Consequently, all risk due to idiosyncratic shocks remains at the firm level. Clearly, we have overly simplified the situation in our model to emphasize our point. However, we believe that the overall message conveyed by our simple model is still valid as long as there is some degree of cash flow sharing among keiretsu firms.

Before we test this notion, it is worthwhile to first contemplate why a manager would want to shift risk from the firm level to the market level. We can think of two plausible explanations. The first explanation is that business group managers unintentionally and unknowingly transfer firm level risk to the market level through their risk sharing practice. The objective of these group managers is to stabilize profit and avoid losses. They, however, may not realize that the practice of profit and risk sharing reduces firm level risk only at the expense of an increase in market level risk. Hence, any failure to reduce the total risk is an unintended outcome.
A second plausible answer is that the managers knowingly transfer firm level risk to market level risk. What prompts the managers to transfer risk from firm level to market level? To understand the rationale and motivation of this action, we look into the corporate governance literature for insight. It has been debated whether Japanese managers do, in fact, pursue the objective of maximizing shareholders’ wealth while running their firms. Milgrom and Roberts (1992) conclude that “Japanese firms are not run in the interests of their shareholders.” Within the keiretsu structure, a “main bank” is often the center of the business group. Since the main bank represents the largest debtholder of the keiretsu firms, it has every interest in ensuring that member firms are able to meet their debt obligation. When member firms are not profitable or have relatively low profits, the main bank often steps in to appoint a new director and/or replace the incumbent managers. Therefore, Aoki (1990) and Kester (1991) argue that the top priority of a member firm is to earn enough profit to service its debt. The management of keiretsu firms often sees negative income or the inability to meet debt obligations as a more serious blow than the failure to maximize shareholders’ wealth. Under this pressure to maintain stable profits, firm managers could intentionally shift risk from the firm level to the market level through profit and risk sharing.

Empirical evidence regarding this notion, however, is not without controversy. Although Kaplan (1994) finds that Japanese executive turnover and compensation are related to both accounting earnings and stock returns, he also finds that the fortune of Japanese executives are more sensitive to adverse changes in earnings, but less sensitive to poor performance in stock returns than their U.S. counterparts. This suggests that keiretsu managers weigh firm level risk more heavily than the market level risk. Based upon these arguments, two testable null hypotheses are stated as:
H₃: Keiretsu MKT = Non-keiretsu MKT

H₄: Keiretsu FIRM = Non-keiretsu FIRM

C. Risk Sharing During Periods of Economic Hardship

Is profit and risk sharing more prevalent during periods of economic hardship? Anecdotal evidence would suggest so. But why would risk sharing affect risk components non-uniformly over different time periods? We speculate that although profit and risk sharing is a common practice for the keiretsu firms, this practice is less prevalent during periods of sound economic performance as firms are less likely to perform poorly during periods of economic expansion. Thus, the need for profit and risk sharing during periods of sound economic performance is less urgent. Alternatively, this practice is likely to be more widespread during periods of economic hardship as the number of poorly performing firms increase. Consistent with this notion, Kim and Limpaphayom (1998) find no significant correlation between ownership and financial leverage under normal conditions. However, when firms begin to exhibit signs of distress, keiretsu financial institution equity owners intervene to moderate the use of debt. Kang and Shivdasani (1995) indicate that the likelihood of top executive non-routine turnover is related to the firm’s negative operating income which is more likely to occur during periods of economic hardship. Kang and Shivdasani (1997) find Japanese corporations that experience substantial operating income decreases are more likely to downsize, diversify, and increase management turnover. Hoshi et al. (1990) report that firms in industrial groups invest more and sell more after the onset of distress than non-group firms. This leads to the following hypothesis:
H₅: Risk shifting from the firm level to the market level is more evident during periods of economic hardship.

III. Empirical Evidence

A. Stock Returns and Standard Deviation

Some descriptive statistics of our sample are reported in Tables I and II. In Table I, average monthly stock returns during the 1976-1989 period for non-keiretsu (Class 0), weak keiretsu (Class 1 & 2), and keiretsu (Class 3 & 4) firms are 0.0678%, 0.0692%, and 0.0705%, respectively. During the period of 1990-1998, we observe that all mean returns are negative (-0.0328%, -0.0323%, and -0.0370%, respectively), reflecting a period of economic hardship. We conduct a t-test to see if stock returns are different across keiretsu classes and between economic regimes. The results confirm that mean monthly stock returns are not distinguishable across keiretsu classes although returns are uniformly larger during the 1976-1989 period than during the 1990-1998 period irrespective of keiretsu classes. These preliminary statistics simply suggest that keiretsu firms did not create more shareholder wealth than non-keiretsu firms; therefore, the null of Hypothesis 1 is not supported. This is consistent with Jameson et al. (2000). The results in Table I, however, seem to suggest that shareholders’ values are affected to some degree by the economic conditions in Japan.⁵

Insert Table I about here.

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⁵ We partition data according to keiretsu classes and time regimes. This point will be further elaborated in Section III where analysis of volatility decomposition is conducted.
We present the average monthly standard deviation of stock returns across keiretsu classes and economic regimes in Table II. The statistics indicate that standard deviations increase in magnitude across keiretsu classes. That is, non-keiretsu firms have the lowest standard deviations (in both economic regimes), and the standard deviations become larger when the keiretsu relationship is strengthened. We conduct a t-test to examine the statistical significance of this difference. The results demonstrate that irrespective of economic regimes, both weak keiretsu and keiretsu firms have significantly higher standard deviations (measurement of unconditional risk) than non-keiretsu firms. This preliminary evidence indicates that contrary to general belief, keiretsu firms do not offer a lower risk investment for their shareholders; hence, Hypothesis 2 is not supported by the data. Again, the impact that economic conditions have on the shareholder risk can be seen by the t-tests presented in the bottom rows of Table II. The tests present significant differences in standard deviations between economic regimes irrespective of keiretsu classes.\(^6\)

B. Mean and Variance Decomposition of Volatility

The results presented in Tables I and II are contrary to general beliefs. In particular, if firms in a corporate group practice profit and risk sharing, why don’t they have lower total risk? Previous studies have failed to answer this question, and we believe the answer can be found in the risk decomposition analysis discussed in Section II. Our interest is in the dynamics of the individual risk components rather than the aggregate risk. We decompose the total volatility of

\(^6\) In addition to the t-tests for differences in means as shown in Tables I and II, we also calculate the median values and conduct the Wilcoxon Ranksum test for differences in medians. The Wilcoxon Ranksum test results reach the same conclusions as the t-test.
keiretsu and non-keiretsu groups into three individual components: 1) market level volatility (MKT), 2) industry level volatility (IND), and 3) firm level volatility (FIRM) following Equations (7), (8), and (9), respectively. We then plot these risk components in a series of figures.

Figures I, II, and III plot the three risk components for the keiretsu, weak keiretsu, and non-keiretsu firms over the entire sampling period. In Figure I, two observations are noted. First, keiretsu firms appear to have slightly larger MKT than non-keiretsu firms and this phenomenon is particularly noticeable over the period after 1987. The difference between non-keiretsu and weak keiretsu firms, however, is less obvious. Second, MKT is, on average, higher during the recession periods consistent with the findings in the U.S. that economic recession accounts for most of the volatility (Hamilton and Lin, 1996). Figure II plots the IND for keiretsu and non-keiretsu firms. Average IND is lower in the post-1990 period. The differences in IND between keiretsu and non-keiretsu firms are not clear. Figure III plots the FIRM for keiretsu and non-keiretsu firms. In Figure III, it appears that contrary to what is observed for MKT, keiretsu firms seem to have lower FIRM than non-keiretsu firms. We speculate that this is an outcome of the profit and risk sharing among these firms. Weak keiretsu firms, however, seem to have higher FIRM. Similar to the MKT, FIRM is also higher during the recession periods.

While Figures I-III provide a visual view of the volatility components, numerical risk decomposition results are reported in Table III to better gauge the differences. We report these risk decomposition results based upon three classes of keiretsu firms and two time regimes. In
Table III, descriptive statistics of the three volatility components for keiretsu and non-keiretsu firms are reported. All volatility measures are value-weighted annualized variances scaled up by a factor of $10^2$.

For the period of 1976-1989, the keiretsu group, on average, has larger MKT (1.810 vs. 1.352), slightly larger IND (3.501 vs. 3.423), and lower FIRM (4.999 vs. 5.631) than the non-keiretsu group. Conversely, the weak keiretsu group has the lowest MKT and the highest FIRM among all three groups. The lower FIRM of the keiretsu group is consistent with the notion that keiretsu firms ought to have more stable profits, an outcome of the profit and risk sharing among keiretsu firms.

During the period of 1990-1998, however, we see some notable changes in the mean volatility levels. First, mean volatility components are higher during the recession periods. Second, keiretsu firms still have higher MKT and lower FIRM than non-keiretsu firms. Third, weak keiretsu firms experience the greatest increase in MKT (from 1.244 in 1976-1989 to 4.373 in 1990-1998).\(^7\) This last observation may imply that the weak keiretsu group has very loose connections during the years of economic expansion, but a much stronger relationship during the recession.

In the last row, we determine the ratio of MKT/FIRM by dividing these two mean volatility levels. Since volatility level lacks a “benchmark” for comparison, we feel this ratio

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\(^7\) Non-parametric test of differences in medians between the two periods are statistically significant at the one percent level for MKT and IND in all keiretsu groups, and significant for FIRM at the five percent level in weak-keiretsu group. However, since volatility level lacks a “benchmark” for comparison, we conduct more tests in Table IV.
conveys more information. For example, during the period of 1976-1989, the MKT/FIRM is 23.99% and 36.21% for the non-keiretsu and keiretsu firms, respectively implying that in a relative sense, keiretsu firms have larger MKT than non-keiretsu firms. The ratio for the weak keiretsu firms is 20.46%. During economic recession periods, this ratio for all corporate groups increased substantially. For the non-keiretsu group, the ratio increases from 23.99% to 51.96%, a 116% increase. For the keiretsu group, however, the rate of increase is even greater, a 151% gain (from 36.21% to 90.71%). Hence, this preliminary evidence is consistent with our contention that keiretsu firms reduce firm level risk at the expense of an increase in market level risk during periods of economic hardship. This same ratio analysis reveals a more striking result for the weak keiretsu group. The ratio for this group of firms is 20.46% in the period from 1976-1989, but leaps to 61.08% in the latter period (a 200% increase). While the ratio analysis is more informative than the level analysis, a formal test of this hypothesis will be conducted in the next section.

C. Individual Risk Components’ Contribution to Total Risk

In addition to the above findings, in Table IV we construct various relative risk levels based upon data of absolute risk levels and report the mean and variance of the contributions of each individual risk component (MKT, IND, or FIRM) to the total risk (i.e., MKT+IND+FIRM) for all keiretsu and non-keiretsu samples. We also perform a test of the differences in volatility components between different classes of keiretsu and non-keiretsu firms.

Before presenting the statistics, we first highlight the visual cues provided in Figures IV, V, and VI. These figures illustrate that: 1) FIRM has the largest share of total risk irrespective of keiretsu class or time regime, 2) when compared with other groups, the keiretsu group has the
largest MKT contribution and the lowest FIRM contribution irrespective of time regime, 3) the contribution of MKT increases in the contraction periods, 4) the contribution of FIRM and IND decreases in the contraction periods, and 5) the contribution of MKT and FIRM almost converges for the keiretsu group during the contraction periods. These visual cues suggest that economic conditions have a significant impact on the total risk as well as the individual risk components and the impact is greater for keiretsu firms.

Insert Figures IV, V, and VI about here.

In Panel A of Table IV, we report descriptive statistics for the mean and variance decomposition of individual risk components’ contribution to total risk. Our results are in agreement with the visual cues seen in Figures IV-VI. We find that for keiretsu firms, the contribution of MKT to total risk is higher (17.56% vs. 12.98% for the booming years, and 39.11% vs. 27.09% for the contraction years) while the contribution of FIRM to total risk is lower (48.48% vs. 54.12% for the booming years, and 43.12% vs. 52.14% for the contraction years) than that of non-keiretsu firms. These results are consistent with the premise that keiretsu firms experience lower firm level risk as a consequence of their practice of profit and risk sharing. This practice inadvertently increases market level risk through heightened correlations in firm fundamentals. Weak keiretsu firms, however, have slightly lower (higher) MKT (FIRM) than that of the non-keiretsu firms in the booming years. In the contraction years, this relationship is reversed. This evidence is consistent with the seemingly casual keiretsu relationship of weak keiretsu firms becoming much closer during periods of economic hardship.

The last row of Panel A presents the ratio of the contribution of MKT versus FIRM. These
statistics are identical to the numbers reported in Table III. These ratios reinforce the notion that keiretsu firms have relatively higher (lower) MKT (FIRM), and this finding is the strongest during the periods of economic hardship.

Insert Table IV about here.

We subject our argument to further tests by computing a t-test of the differences in the means of volatility components between different classes of keiretsu and non-keiretsu firms, the results (p-values) of which are reported in Panel B. For the period from 1976-1989, we find that both MKT and FIRM are significantly different between non-keiretsu and keiretsu firms, and between weak keiretsu and keiretsu firms. Alternatively, there is no difference between non-keiretsu and weak keiretsu firms in any of the three counts of risk measures. For the period from 1990-1998, the differences in the means of volatility components between keiretsu and non-keiretsu groups becomes much stronger. Even for IND, which is generally not significantly different between keiretsu and non-keiretsu groups, it is now significantly different. Therefore, the contrast between different classes of keiretsu groups becomes more significant during periods of economic hardship. Keiretsu structure and economic conditions thus have a non-trivial effect on the behavior of the individual risk components. These results are largely consistent with our conjecture that keiretsu firms have higher (lower) market level (firm level) risk than non-keiretsu firms. In other words, we reject Hypotheses 3 and 4.

Panel C reports the results using a Wilcoxon Ranksum non-parametric test of differences in medians. These results are qualitatively similar to that shown in Panel B. In Panel D, we also report the non-parametric test results for the differences in volatility component medians.
between two time regimes according to keiretsu classes. All volatility components significantly
differ between two regimes for all keiretsu classes with only one exception, FIRM for
independent firms. These results further affirm our contention that economic conditions have a
significant effect on the behavior of risk components.

In Panel E of Table IV, we report results for the decomposition of the variance of total
risk for all keiretsu groups. For the keiretsu sample, the share of MKT’s contribution to the
variance of total risk increases dramatically from 12.39% in the 1976-1989 period to 26.51% in
the 1990-1998 period. For the non-keiretsu sample, the same statistic actually decreases from
14.5% to 13.53%. For the keiretsu group, the share of FIRM’s contribution decreases slightly
from 11.08% to 10.99%, while the same statistic for the non-keiretsu sample increases from
11.38% to 13.08%. For the weak keiretsu group, the changes are even more profound. MKT’s
contribution increases from 9.07% to 21.36%, while the FIRM’s contribution drops from 29.34%
to 14.44%. All of these statistics reinforce the idea that keiretsu firms lower their firm level risk
through profit and risk sharing, and this practice is more evident and prevalent during periods of
economic hardship. This practice, nevertheless, increases the market level risk. These
preliminary results are consistent with our contention that keiretsu firms shift risk from FIRM to
MKT. In the following section, we test this hypothesis (Hypothesis 5) using the Granger
causality test.  

D. Granger Causality Analysis

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8 There is also some evidence consistent with our theory as there are more cases of weak-keiretsu becoming stronger
keiretsu and non-keiretsu becoming keiretsu firms as we advance into recession years. The statistics are as follows:
38 cases of Class 1 & 2 becoming Class 3 & 4 from the 80s-90s; 15 cases of Class 3 & 4 becoming Class 1 & 2
from the 80s-90s; 18 cases of non-keiretsu becoming keiretsu from the 80s-90s; and no case of keiretsu becoming
non-keiretsu from 80s-90s.
In Table V, we investigate the Granger causality tests for the three risk components. If our thinking concerning the risk transfer mechanism for keiretsu firms has merit, Granger causality tests should reveal significant lead-lag relations between the risk components for keiretsu firms, but not for non-keiretsu firms. In particular, we need to verify whether FIRM Granger causes MKT. We use trivariate vector autoregressions (VAR) for this purpose.

Trivariate VAR for the MKT is specified as:

\[
MKT_t = \sum_{i=1}^{l} \alpha_i MKT_{t-i} + \sum_{i=1}^{l} \beta_i IND_{t-i} + \sum_{i=1}^{l} \gamma_i FIRM_{t-i} + \pi_t
\] (12)

Trivariate VAR for IND and FIRM are constructed in a similar manner. All the \(p\)-values for Granger causality trivariate VAR tests are reported in Table V. The null hypothesis that lags one through \(l\) of the series indicated in the row does not help to forecast the series indicated in the column conditional on the other risk components in the VAR. For each VAR equation, the lag length \(l\) is chosen using a likelihood ratio statistic, \(LR = (T - c)(\log |\Sigma_r| - \log |\Sigma_u|)\), where \(T\) is the number of observations, \(c\) is the degree of freedom correlation, and \(\Sigma_r, \Sigma_u\) denotes the determinant of the error covariance matrices from the restricted and unrestricted models, respectively. The correction factor, \(c\), recommended by Sims (1980) is the number of variables in each unrestricted equation of the VAR model.
In the period from 1976-1989, almost all lagged risk components Granger causes their own risk components, but we rarely observe cross Granger causal relations between the risk components at the 1% significance level. More importantly, FIRM does not Granger cause MKT irrespective of keiretsu classes, suggesting no risk shifting from firm level to market level during expansion periods.

Significant changes in this result are found during economic contraction periods. During the period 1990-1998, FIRM does not Granger cause MKT for the non-keiretsu firms. For the weak keiretsu and keiretsu firms, however, FIRM significantly Granger causes MKT. This result is consistent with our argument that firms in a keiretsu group increasingly share risk and profits during times of economic hardship, thus shifting risk from the firm level to the market level leaving total risk unchanged. For the keiretsu group, we also find many significant cross-component causalities. This is a significant departure from the boom years.

To summarize, the Granger causality tests support our contention that in keiretsu firms, firm level risk is lowered at the expense of an increase in market level risk as a consequence of the practice of risk sharing during periods of economic hardship. Nevertheless, such strategic action does not necessarily reduce the risk of the company; it merely transfers risk from the firm level (FIRM) to the market level (MKT).

IV. Implications for Shareholders’ Wealth

Although the practice of profit and risk sharing among keiretsu firms can reduce the risk of keiretsu firms, it only reduces the firm level risk at the expense of an increase in market level risk, leaving total risk the same. That is, idiosyncratic firm level risk is being transferred into systematic market level risk. This shifting of risk is detrimental to shareholders’ wealth as
Idiosyncratic risk is not priced whereas market level risk is priced in capital markets.\(^9\) The greater degree of market level risk will increase shareholders’ required rate of return and, consequently, decreases firm value. Additionally, profit and risk sharing among keiretsu firms will most likely increase the correlation in the firms’ fundamentals and, as a result, will lead to an increase in the correlation of equity returns. The increase in the level of equity returns correlation coupled with the increase in the concentration of market level risk will reduce the diversification efficiency for shareholders. To demonstrate this point, let us consider an equally-weighted portfolio of \(n\) assets where the portfolio variance is given by:

\[
\sigma_{ew}^2 = \frac{\sigma_i^2}{n} + \sigma_{ij}^2 \left(1 - \frac{1}{n}\right) = \frac{\sigma_i^2}{n} + \bar{\rho}_{ij} \sigma_i^2 \left(1 - \frac{1}{n}\right) \tag{13}
\]

where \(\sigma_i^2\) is the average firm variance, \(\sigma_{ij}^2\) is the average covariance, and \(\bar{\rho}_{ij}\) is the average correlation between firms. An increase in the level of the market level risk and the correlation correspond to an increase in \(\sigma_i^2\) and \(\bar{\rho}_{ij}\) in this equation. It is clear that this will lead to an

---

\(^9\) Theoretically, only systematic risk is priced, but not idiosyncratic risk. Empirically, Lau, Quay, and Ramsey (1974) present evidence that systematic risk is priced in the Japanese stock markets. Their study, however, is quite dated. Therefore, we conduct further tests using more recent data to verify whether market risk is indeed priced while idiosyncratic risk is not priced in Japanese equity markets. We formally test the validity of CAPM using monthly data from 1976-1998 for all firms in the PACAP database. Our test involves a three step process. In the first step, we calculate an individual firm’s \(\beta\) for each month using a regression of each security’s excess returns on the market excess returns for the past 36 months. In the second step, we sort the estimated \(\beta\)s in ascending order and use them to form ten portfolios. Each portfolio contains approximately 10% of the stocks with the first portfolio containing stocks with the lowest estimated betas and the tenth portfolio containing stocks with the highest estimated betas. We then compute the monthly excess returns for these portfolios and match them with the monthly market excess returns. This, in turn, allows us to estimate the monthly individual portfolio’s \(\beta\) using a regression of each portfolio’s excess returns on the market excess returns for the past 36 months. In the last step, we collect the monthly portfolio’s \(\beta\) and variance of the residuals from the regression in Step Two and match these monthly data to each portfolio’s average excess returns for the next 36 months. Using this data, we run a regression of the monthly forward looking portfolio excess returns on the estimated portfolio’s \(\beta\) and residual variance. Our results confirm that market risk is priced while idiosyncratic risk is not priced for Japanese stocks.
increase in the portfolio variance, and, therefore, to less efficient diversification. Since all keiretsu firms have significant cross shareholdings, the lower equity value as a result of increasing market level risk and the reduction in the diversification efficacy have a potential negative impact on the value of keiretsu member firms. Ironically, this unintended outcome is the result of intended risk sharing that was argued to be the strength of the keiretsu industrial organization.

To demonstrate the higher correlations in the firms’ fundamentals that lead to poor diversification for shareholders, we investigate the behaviors of the average pair-wise correlations over time and report our results in Figures VII and VIII. In Figure VII, we plot the equally-weighted mean pair-wise correlation across all stocks in our sample. The number of correlation pairs varies over time. We calculate more than 10 million pairs of correlation coefficients over the 23-year horizon. Stock correlations during the pre-crash period are very low (averaging around 10%) for all keiretsu and non-keiretsu firms. Keiretsu firms, however, consistently experience higher correlations than weak keiretsu firms, which in turn have higher correlations than non-keiretsu firms. This is expected due to the stronger connections in the fundamentals of keiretsu firms through activities such as information sharing, inter-trading with each other, and extensive cross shareholdings. During the contraction periods, correlation coefficients increase dramatically for keiretsu, weak keiretsu, and non-keiretsu firms. A similar increase in stock correlations during the bear market has also been reported by Bekaert and Wu (2000) for U.S. markets. The differences in the magnitude of correlations between keiretsu and non-keiretsu firms, however, have widened to approximately 15% in most of the contraction years. The increases in pair-wise correlations certainly have an adverse effect on portfolio
diversification and this effect is particularly acute for shareholders who have invested predominantly in keiretsu firms (i.e., other keiretsu member firms and/or the firm’s main bank).  

Insert Figures VII and VIII about here.

To see how the effectiveness of diversification is eroded by the increase in correlation and market level risk, we construct portfolios of various sizes of keiretsu, weak keiretsu, and non-keiretsu firms and calculate their portfolio standard deviations. Figure VIII illustrates the plots of these portfolio standard deviations versus their sizes. As predicted by theory, portfolio standard deviations decline rapidly as the number of stocks in the portfolios increase. A 100-stock portfolio eliminates virtually all idiosyncratic risk. Figure VIII also indicates that the keiretsu portfolios consistently exhibit larger standard deviations than the weak keiretsu and non-keiretsu portfolios. The difference is quite striking. For example, a 20-stock non-keiretsu portfolio achieves the same diversification effectiveness as a 150-stock keiretsu portfolio. A business group portfolio, therefore, is effectively more risky than a portfolio of independent firms.

V. Concluding Remarks

In this paper, we study the risk of Japanese business groups by decomposing total volatility into three components: 1) firm level volatility, 2) industry level volatility, and 3) market level volatility. The model-free risk decomposition methodology adopted from Campbell et al. (2001) is employed in this study. Using this methodology, we are able to pinpoint how the

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10 We also test the difference in means (t-test) and in medians (ranksum test) between the correlation levels in the two periods. Both the t-test and the non-parametric test are statistically significant at the 1% level.
practice of profit and risk sharing among keiretsu firms affects the firms’ individual component risks and their shareholders’ wealth. Specifically, we find that total volatility increases during periods of recession. Contrary to popular belief, however, we do not find that keiretsu firms have lower stock return volatility than non-keiretsu firms. In fact, keiretsu firms have higher risk, but lower stock returns than non-keiretsu firms. During economic recession periods, the practice of profit and risk sharing among keiretsu firms is more prevalent and allows keiretsu firms to lower their firm level risk. The reduction in firm level risk, however, is obtained at the expense of higher market level risk. Hence, firm level risk is transferred to market level risk.

The transfer of firm level risk to market level risk is supported by Granger causality tests during periods of economic hardship. Nevertheless, Granger causality tests failed to demonstrate causality between firm level risk and market level risk for non-keiretsu firms indicating the absence of this risk transfer. This finding is consistent with the contention that the practice of profit and risk sharing is more prevalent for keiretsu firms during periods of economic hardship.

Furthermore, we find that firms with weak keiretsu structure do not exhibit a great deal of profit or risk sharing activity during booming years, but this activity, as evidenced by the Granger causality tests, increases substantially during times of economic hardship. Since only market risk is priced, transferring risk from the firm level to the market level reduces firm value and is detrimental to shareholders’ wealth. The negative impact on shareholder wealth is further compounded by an increase in the correlation of keiretsu firms’ stock returns. As cross shareholdings are widespread among keiretsu firms, profit and risk sharing, in effect, lowers the corporate group value consistent with the suggestion that keiretsu firms have lower Tobin’s Q (Jameson et al., 2000). It is also consistent with our statistics that keiretsu firms do not have higher stock returns or lower risk.
Corporate groups are common in many countries. According to some previous studies, corporate groups are superior industrial organizations as they provide member firms benefits such as stability, mutual takeover defense, reduced financial distress cost, effective corporate governance, and risk diversification. The evidence we provide in this study raises questions regarding the economic value of corporate groups. We find that the practice of profit and risk sharing among keiretsu firms is destructive to shareholders’ wealth in that the reduction in firm level risk is achieved at the expense of an increase in market level risk that is priced in the capital markets.\textsuperscript{11}

Suggestions for future studies along this vein of research include expanding the tests to corporate groups in other countries and testing the impact that corporate diversification has on firm value and firm risk. The traditional argument for a conglomerate is the achievement of diversification at the firm level, making the firm less risky. The counter argument is that shareholders could always diversify their portfolios more efficiently than a firm could diversify its assets. We find additional evidence in support of the latter and argue that diversification and risk sharing at the firm level may actually destroy shareholders’ value.

\textsuperscript{11} This conclusion is consistent with the finding in a survey study (Frankel, 1991), which shows that the cost of capital was lower in Japan in the 1980s than in the U.S., but was raised to the U.S. market level after 1990.
References


*Business History*, 37, 54-69.


Table I. Average Daily Returns of an Equally Weighted Index Over a Month

This table reports the mean returns for our entire sample partitioned by time and classes of keiretsu. To compute the statistics for average firm returns, we first compute the mean daily return of each firm for each month over the period from 1976-1989, and from 1990-1998. We then calculate the average of the mean daily returns for all firms in the sample. Keiretsu Class 0 is non-keiretsu firms, Classes 1&2 are weak keiretsu firms, and Classes 3&4 are keiretsu firms. A t-test is used to test the difference between means. Under the assumption of unequal variances, the approximate $t$ statistic is computed as $t = (\bar{x}_1 - \bar{x}_2)/\sqrt{w_1 + w_2}$, where $w_1 = [(s_1^2)/(n_1)]$, and $w_2 = [(s_2^2)/(n_2)]$. The formula for Satterthwaite’s (1946) approximation for the degrees of freedom for the approximate $t$ statistic is: $df = [(w_1 + w_2)^2]/(([(w_1)^2/(n_1-1)]+[(w_2)^2/(n_2-1)])].$ Refer to Steel and Torrie (1980) for more information.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Keiretsu Class</td>
<td>0 (n=327)</td>
<td>1&amp;2 (n=124)</td>
</tr>
<tr>
<td>Mean</td>
<td>0.000678</td>
<td>0.000692</td>
</tr>
<tr>
<td>t-test (p-value)</td>
<td>0.9348</td>
<td>0.9363</td>
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<tr>
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<td>0 vs. 1&amp;2</td>
<td>1&amp;2 vs. 3&amp;4</td>
</tr>
<tr>
<td>Years</td>
<td>80s vs. 90s</td>
<td>80s vs. 90s</td>
</tr>
<tr>
<td>t-test (p-value)</td>
<td>0.0029***</td>
<td>0.0074***</td>
</tr>
</tbody>
</table>

*** denotes statistical significance at the 1% level.
**Table II. Average Monthly Standard Deviation of Returns of an Equally Weighted Index**

This table reports the standard deviation of returns over each month for our entire sample partitioned by time and classes of keiretsu. To compute the statistics for average firm returns, we first compute the mean daily return of each firm over the period from 1976-1989, and from 1990-1998. We then calculate the average of the mean daily returns for all firms in the sample. The average firm returns standard deviation is the standard deviation of the mean daily returns for all firms in the sample. Keiretsu Class 0 is non-keiretsu firms, Classes 1&2 are weak keiretsu firms, and Classes 3&4 are keiretsu firms. A t-test is used to test the difference between means. Under the assumption of unequal variances, the approximate t statistic is computed as $t' = (\bar{x}_1 - \bar{x}_2) / \sqrt{w_1 + w_2}$, where $w_1 = [(s_1^2/n_1)]$, and $w_2 = [(s_2^2/n_2)]$. The formula for Satterthwaite's (1946) approximation for the degrees of freedom for the approximate t statistic is: $df = \left[\frac{((w_1 + w_2)\cdot\text{df}))}{((w_1^2/n_1-1) + (w_2^2/n_2-1))}\right]$. Refer to Steel and Torrie (1980) for more information.

<table>
<thead>
<tr>
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<tbody>
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<td>0 (n=327)</td>
<td>0.004684</td>
<td>0.010492</td>
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<tr>
<td>1&amp;2 (n=124)</td>
<td>0.005417</td>
<td>0.012599</td>
</tr>
<tr>
<td>3&amp;4 (n=181)</td>
<td>0.005612</td>
<td>0.012808</td>
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<table>
<thead>
<tr>
<th>Keiretsu Class</th>
<th>0 vs. 1&amp;2</th>
<th>1&amp;2 vs. 3&amp;4</th>
<th>0 vs. 3&amp;4</th>
<th>1&amp;2 vs. 3&amp;4</th>
<th>0 vs. 3&amp;4</th>
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</thead>
<tbody>
<tr>
<td>t-test (p-value)</td>
<td>0.0280**</td>
<td>0.5845</td>
<td>0.0062***</td>
<td>0.0113**</td>
<td>0.8150</td>
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<table>
<thead>
<tr>
<th>Keiretsu Class</th>
<th>Years 80s vs. 90s</th>
<th>80s vs. 90s</th>
<th>80s vs. 90s</th>
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</thead>
<tbody>
<tr>
<td>t-test (p-value)</td>
<td>0.0000***</td>
<td>0.0000***</td>
<td>0.0000***</td>
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</tbody>
</table>

*** and ** denote statistical significance at the 1% and 5% level, respectively.
Table III. Mean of Volatility Components

This table reports descriptive statistics for the various risk components. MKT is the market volatility, IND is the industry level volatility, and FIRM is the firm level volatility. All measures are value-weighted variances. Mean and standard deviation of the annualized variances are multiplied by 100.

<table>
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<tbody>
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<td></td>
<td>0 (n=327)</td>
<td>1&amp;2 (n=124)</td>
</tr>
<tr>
<td>Keiretsu Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MKT</td>
<td>1.351</td>
<td>1.244</td>
</tr>
<tr>
<td>IND</td>
<td>3.423</td>
<td>3.404</td>
</tr>
<tr>
<td>MKT/FIRM</td>
<td>23.99%</td>
<td>20.46%</td>
</tr>
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</table>
Table IV. Mean and Variance Decomposition of Individual Risk Components’ Contribution to Total Risk

This table presents the shares of MKT, IND, and FIRM in the total mean and variance of the volatility of a typical stock from our entire sample. MKT is the market level volatility, IND is the industry level volatility, and FIRM is the firm level volatility. All measures are value-weighted variances, constructed from daily data. We define the volatility of a typical stock, \( \sigma_T^2 = \sigma_M^2 + \sigma_I^2 + \sigma_F^2 \). Then, for the mean of volatility,

\[
1 = E(MKT_t) / E(\sigma_M^2) + E(IND_t) / E(\sigma_I^2) + E(FIRM_t) / E(\sigma_F^2)
\]

\[
1 = Var(MKT_t) / Var(\sigma_M^2) + Var(IND_t) / Var(\sigma_I^2) + Var(FIRM_t) / Var(\sigma_F^2)
\]

\[+ 2Cov(MKT_t, IND_t) / Var(\sigma_M^2) + 2Cov(MKT_t, FIRM_t) / Var(\sigma_M^2)
\]

\[+ 2Cov(FIRM_t, IND_t) / Var(\sigma_I^2)
\]

We report the share of the variance of MKT in the MKT row and MKT column, the share of the covariance of MKT and IND in the MKT row and IND column, and so forth.

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<thead>
<tr>
<th>Years</th>
<th>1976-1989 (n=327)</th>
<th>1990-1998 (n=300)</th>
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<tr>
<td>MKT</td>
<td>12.98%</td>
<td>11.60%</td>
</tr>
<tr>
<td>IND</td>
<td>32.90%</td>
<td>31.72%</td>
</tr>
<tr>
<td>FIRM</td>
<td>54.12%</td>
<td>56.68%</td>
</tr>
<tr>
<td>MKT/FIRM</td>
<td>23.99%</td>
<td>20.46%</td>
</tr>
</tbody>
</table>

Panel A: Mean of Volatility Components

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Keiretsu Class</td>
<td>0 vs. 1&amp;2</td>
<td>1&amp;2 vs. 3&amp;4</td>
</tr>
<tr>
<td>MKT</td>
<td>6.21E-01</td>
<td>1.88E-01</td>
</tr>
<tr>
<td>IND</td>
<td>3.60E-01</td>
<td>1.88E-01</td>
</tr>
<tr>
<td>FIRM</td>
<td>3.24E-01</td>
<td>8.76E-01</td>
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Panel B: T-test (p-value) for Differences in Volatility Component Means between Different Classes of Keiretsu and Non-Keiretsu Firms

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Keiretsu Class</td>
<td>0 vs. 1&amp;2</td>
<td>1&amp;2 vs. 3&amp;4</td>
</tr>
<tr>
<td>MKT</td>
<td>4.92E-01</td>
<td>1.84E-01</td>
</tr>
<tr>
<td>IND</td>
<td>3.82E-01</td>
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<td>FIRM</td>
<td>6.70E-01</td>
<td>1.53E-11</td>
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Panel C: Wilcoxon Non-Parametric Test (p-value) for Differences in Volatility Component Medians between Different Classes of Keiretsu and Non-Keiretsu Firms

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Keiretsu Class</td>
<td>0 vs. 1&amp;2</td>
<td>1&amp;2 vs. 3&amp;4</td>
</tr>
<tr>
<td>MKT</td>
<td>9.23E-01</td>
<td>6.24E-01</td>
</tr>
</tbody>
</table>

Panel D: Wilcoxon Non-Parametric Test (p-value) for Differences in Volatility Component Medians Between Two Time Regimes
### Table IV. Mean and Variance Decomposition of Individual Risk Components’ Contribution to Total Risk (Continued)

#### Panel E: Variance Decomposition

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>MKT</td>
<td>IND</td>
<td>FIRM</td>
<td>MKT</td>
<td>IND</td>
<td>FIRM</td>
</tr>
<tr>
<td>Class 0</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>MKT</td>
<td>14.50%</td>
<td>24.67%</td>
<td>11.85%</td>
<td>17.93%</td>
<td>22.43%</td>
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</tr>
<tr>
<td>IND</td>
<td>17.24%</td>
<td>20.37%</td>
<td>12.06%</td>
<td>20.98%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIRM</td>
<td>11.38%</td>
<td></td>
<td></td>
<td>13.08%</td>
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<td></td>
</tr>
<tr>
<td>Classes 1&amp;2</td>
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<td></td>
</tr>
<tr>
<td>MKT</td>
<td>9.07%</td>
<td>16.31%</td>
<td>9.53%</td>
<td>15.25%</td>
<td>29.00%</td>
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</tr>
<tr>
<td>IND</td>
<td>14.76%</td>
<td>20.98%</td>
<td></td>
<td>5.23%</td>
<td>14.73%</td>
<td></td>
</tr>
<tr>
<td>FIRM</td>
<td>29.34%</td>
<td></td>
<td></td>
<td>14.44%</td>
<td></td>
<td></td>
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<tr>
<td>Classes 3&amp;4</td>
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<td></td>
</tr>
<tr>
<td>MKT</td>
<td>12.39%</td>
<td>19.78%</td>
<td>14.87%</td>
<td>17.37%</td>
<td>28.67%</td>
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<tr>
<td>IND</td>
<td>18.13%</td>
<td>23.74%</td>
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<td>4.15%</td>
<td>12.31%</td>
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</tr>
<tr>
<td>FIRM</td>
<td>11.08%</td>
<td></td>
<td></td>
<td>10.99%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** denotes statistical significance at the 1% level.
Table V. Granger Causality Analysis of Individual Risk Components Trivariate Analysis

This table reports the p-values of Granger-causalit y VAR tests. Trivariate VAR for the MKT can be specified as:  
\[ \text{MKT}_t = \sum_{i=1}^{l} \alpha \text{MKT}_{t-i} + \sum_{i=1}^{l} \beta \text{IND}_{t-i} + \sum_{i=1}^{l} \gamma \text{FIRM}_{t-i} + \pi_t \]. Trivariate VAR for the IND and FIRM are constructed in a similar manner. The null hypothesis that lags one through \( l \) of the series indicated in the row does not help to forecast the series indicated in the column conditional on the other variables in the VAR. For each VAR equation, the lag length \( l \) is chosen using a likelihood ratio statistic, \( LR = (T - c) \left( \log |\Sigma_e| - \log |\Sigma_r| \right) \) where \( T \) is the number of observation, \( c \) is the degree of freedom correlation, and \( \Sigma_e, \Sigma_r \) denote the determinants of the error covariance matrices from the restricted and unrestricted models, respectively.

The correction factor, \( c \), recommended by Sims (1980) was the number of variables in each unrestricted equation of the VAR model. MKT is the market level volatility, IND is the industry level volatility, and FIRM is the firm level volatility. All measures are value-weighted variances constructed from daily data.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>MKT,</td>
<td>IND,</td>
<td>FIRM,</td>
<td>MKT,</td>
</tr>
<tr>
<td>Class 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MKT,</td>
<td>0.001***</td>
<td>0.019</td>
<td>0.137</td>
<td>0.463</td>
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<tr>
<td>IND,</td>
<td>0.033</td>
<td>0.000***</td>
<td>0.598</td>
<td>0.000***</td>
</tr>
<tr>
<td>FIRM,</td>
<td>0.554</td>
<td>0.359</td>
<td>0.000***</td>
<td>0.037</td>
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<tr>
<td>Classes 1&amp;2</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MKT,</td>
<td>0.297</td>
<td>0.073</td>
<td>0.400</td>
<td>0.824</td>
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<tr>
<td>IND,</td>
<td>0.000***</td>
<td>0.000***</td>
<td>0.360</td>
<td>0.000***</td>
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<tr>
<td>FIRM,</td>
<td>0.952</td>
<td>0.574</td>
<td>0.801</td>
<td>0.003***</td>
</tr>
<tr>
<td>Classes 3&amp;4</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>MKT,</td>
<td>0.454</td>
<td>0.028</td>
<td>0.000***</td>
<td>0.163</td>
</tr>
<tr>
<td>IND,</td>
<td>0.088</td>
<td>0.000***</td>
<td>0.562</td>
<td>0.028</td>
</tr>
<tr>
<td>FIRM,</td>
<td>0.696</td>
<td>0.134</td>
<td>0.000***</td>
<td>0.000***</td>
</tr>
</tbody>
</table>

*** denotes statistical significance at the 1% level.
Figure I. Annualized Market Volatility (MKT) for the Keiretsu, Weak Keiretsu, and Non-Keiretsu Sample.

MKT is the market level volatility. All measures are value-weighted variances constructed from daily data.
Figure II. Annualized Industry Volatility (IND) for the Keiretsu, Weak Keiretsu, and Non-Keiretsu Sample

IND is the industry-level volatility. All measures are value-weighted variances constructed from daily data.
Figure III. Annualized Firm Volatility (FIRM) for the Keiretsu, Weak Keiretsu, and Non-Keiretsu Sample

FIRM is the firm level volatility. All measures are value-weighted variances constructed from daily data.
Figure IV. Percentage Contribution to Total Volatility by the Three Volatility Series for the Keiretsu Sample

Monthly total volatility is calculated as the sum of MKT, IND, and FIRM for each month from January 1976-December 1998. Monthly percentage contribution of each volatility component is consequently the ratio of each volatility component over the total volatility in each month.

% Contribution to Total Volatility for Class 3&4

- MKT
- IND
- FIRM
Monthly total volatility is calculated as the sum of MKT, IND, and FIRM for each month from January 1976-December 1998. Monthly percentage contribution of each volatility component is consequently the ratio of each volatility component over the total volatility in each month.
Figure VI. Percentage Contribution to Total Volatility by the Three Volatility Series for the Non-Keiretsu Sample

Monthly total volatility is calculated as the sum of MKT, IN, and FIRM for each month from January 1976-December 1998. Monthly percentage contribution of each volatility component is consequently the ratio of each volatility component over the total volatility in each month.

% Contribution to Total Volatility for Non-Keiretsu

Time

Percentage

76 78 80 82 84 86 88 90 92 94 96 98
Figure VII. Stock Correlations Over Time

The plot reports the equally weighted mean pair-wise correlation across all stocks in our sample. The solid line (short dotted line, long-dotted line) traces the path of the mean correlation value for the Keiretsu (weak keiretsu, non-Keiretsu) firms in each year constructed using daily data over the previous one year.
This is a plot of annualized portfolio standard deviation against the number of stocks in a portfolio for the keiretsu sample (solid line), weak keiretsu sample (short dotted line), and the non-keiretsu sample (long dotted line). Portfolio standard deviation is calculated each year from daily data within the year for randomly selected portfolios containing from one stock to 150 stocks.