



The impact of the global financial crisis on firm-level risk of the S&P 500

Impact of the financial crisis

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Abstract

Purpose – This paper aims to assess the impact of the global financial crisis of 2007-09 on the risk structure of S&P 500 firms by examining their market, active, and residual risks before and during the crisis.

Design/methodology/approach – The classic one-factor model is estimated for each firm in the S&P 500 to decompose risk into market, active, and residual components. Five sets of regression estimates based on monthly return data are used: 2002-06, 2003-07, 2004-08, 2005-09, and 2006-10. The estimates provide insight into the risk structure of S&P 500 firms before and during the crisis.

Findings – The average correlation coefficient between S&P 500 firms rose during the crisis from 0.20 to 0.35, an increase of 75 percent. Although the results indicate that active and residual risks are significant across the firms and across the periods, the impact of the financial crisis was mostly on market risk. The increase in risks was pronounced for financial firms, especially insurance companies, and industrial firms, especially “hard” manufacturing.

Research limitations/implications – Because the study focuses on the global financial crisis of 2007-09, researchers should be careful about generalizing the results to the post-crisis period.

Practical implications – Investors should be aware that equity portfolio risk reduction during major crises can be hard to achieve because the average correlation coefficient between stock returns may rise significantly, crimping the efficacy of diversification.

Originality/value – It was very difficult for equity investors to shield themselves from the risk associated with the global financial crisis of 2007-09.

Keywords Financial crisis, Correlation, Market risk, Active risk, Residual risk, MPT, Financial risk, Financial markets

Paper type Research paper

I. Introduction

The global financial crisis of 2007-2009, with its ongoing residual effects, reached into every corner of money and capital markets in the US money market funds that “broke the buck,” unprecedented mortgage delinquencies, and large-scale bank failures triggered a liquidity crisis and a deep recession that precipitated a drop in the US stock market capitalization by more than 50 percent from top to bottom. In addition, as measured by the VIX, volatility reportedly leaped from a low of 9.4 in December 2006 to a high of 89.5 in October 2008, a ninefold jump. These and other similar facts are macro-focused: informative, transparent, and noteworthy.

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Less recognized, but no less significant for equity investors, is an indirect effect of the financial crisis: its impact on the correlations of equity returns. As evidence, across the firms in the S&P 500, the average correlation coefficient for six Dow 30 companies each representing a specific sector of the US economy, based on monthly returns from January 2002 through December 2006, is as follows:

- Coca Cola: 0.20;
- ExxonMobil: 0.10;
- General Electric: 0.21;
- Intel: 0.04;
- Johnson & Johnson: 0.24; and
- Walt Disney: 0.29.

Between December 2006 and December 2010, a period that encompasses the crisis, we witness a significant rise in each of these coefficients, as follows:

- Coca Cola: 0.49;
- ExxonMobil: 0.24;
- Intel: 0.42;
- General Electric: 0.53;
- Johnson & Johnson: 0.53; and
- Walt Disney: 0.46.

In situations such as these, with returns moving so much more strongly together, investors are confronted with two challenges. First, the difficulty of building equity portfolios with significant alphas increases. Second, and arguably more important, the ability to diversify across equity investments, a centerpiece of modern portfolio theory (MPT), becomes crimped. As argued in the financial media (Koh and Spremann, 2008; Ferry and Foster, 2010), the efficacy of MPT largely disappeared when financial advisors, portfolio managers, and investors needed it most: during the global financial crisis. As support for this observation, extensive research has shown that stock investments are much more strongly correlated in market downturns than upturns (Silvapulle and Granger, 2001; Ang and Chen, 2002; Hong *et al.*, 2007; Chua *et al.*, 2009; Ennis, 2009). The problem is extensive, affecting not only investors who select their own stocks but also mutual funds, which are founded on a premise of diversification.

Leaving aside debate about using correlation coefficients as a guide to diversification (Statman and Schneid, 2006), Markowitz acknowledges that the rise in correlation coefficients during the financial crisis constrains the power of diversification to reduce portfolio risk (Markowitz, 2009). However, he argues that MPT has not lost its efficacy, stating that while systematic risk has risen, idiosyncratic, or diversifiable, risk among firms has remained significant. He further states that an application of the conventional one-factor model (Sharpe, 1963) would support his position.

As compelling as each side of the argument may be, neither has offered more than casual support for its position. Moreover, although there is ample evidence of a rise in correlations across securities during turbulent periods, there appears to be little

evidence to date, beyond generalizations, on the impact of the financial crisis on both market and diversifiable risks of individual stocks.

These observations lead to two questions that this study addresses. First, to what extent did the financial crisis increase the correlations across equity returns? Second, and in turn, what was the impact of the financial crisis on firm-level risk, both market and diversifiable? The answers to these questions, of course, have implications for the efficacy of MPT. All else held equal, the greater (smaller) the increase in the correlation coefficients, the harder (easier) it is to reduce portfolio risk through diversification.

The questions under study are also of interest with respect to research on idiosyncratic risk (Campbell *et al.*, 2001). It reveals the existence of an upward trend in firm-level idiosyncratic volatility, indicating an increasing presence of diversifiable risk. This finding suggests risk-reduction benefits from diversification even when market risks have been rising.

To address the questions under study, we follow the US stocks represented in the S&P 500, the most widely used benchmark for portfolio performance. The period runs from 2002 through 2010. It encompasses both bear and bull markets, and offers the opportunity to examine the risk of firms before and during the crisis.

We begin with Markowitz's recommendation that the classic one-factor model can be used effectively to address the issue (Sharpe, 1963), as follows:

$$(R_{i,t} - R_f) = \alpha_i + \beta_i(R_{m,t} - R_f) + e_{i,t} \quad (1)$$

where:

$(R_{i,t} - R_f)$ = the return on security i in excess of the risk-free rate R_f .

$(R_{m,t} - R_f)$ = the return on the market in excess of the risk-free rate R_f .

β_i = index of systematic risk.

α_i = security i 's excess return that is independent of the market's excess return.

$e_{i,t}$ = an idiosyncratic term.

We can decompose the equation into three risks: market, active, and residual, as follows:

$$\text{Market : } \beta_i \times \sigma(R_{m,t} - R_f) \quad (2)$$

$$\text{Active : } \sigma[(R_{i,t} - R_f) - (R_{m,t} - R_f)] \quad (3)$$

$$\text{Residual : } \sigma_e \quad (4)$$

where:

σ = standard deviation.

This one-factor specification is not without question. Other approaches are possible, such as multi-factor models (King, 1966; Rosenberg, 1974; Fama and French, 1995). These models, however, are not without issues. For example, recent research that relies on detailed firm-level data from 1963 through 2008, rather than more aggregated portfolio data, which can waste valuable information, shows that the influence of the anomalies that drive multi-factor models is non-existent in large-cap stocks; in fact,

it has been priced away (Cederburg *et al.*, 2011). The research also shows that any remaining anomalies are limited to micro- and small-cap stocks. These findings suggest that criticisms against the traditional CAPM are significantly overstated. Because the current study focuses on firms in the S&P 500, which is comprised of mid- to large-cap stocks, the use of Sharpe's one-factor model seems a reasonable way to address the questions under investigation.

For additional insight, we also look at the following question: is there a pattern across industries? For instance, because the crisis was financial in nature, we expect financial firms to register a larger increase in market risk than non-financial firms, such as those in manufacturing, technology, and services. Among non-financial firms, where was the rise in market risk most pronounced? As part of the purpose of this study, we seek to answer these questions.

The rest of this paper is organized as follows. Section II discusses the data and the estimation periods. Section III presents the findings at both the aggregate and industry-specific levels. Section IV concludes the study.

II. Data

With reference to equation (1), we use a series of regressions to estimate equations (2)-(4) for each firm in the S&P 500. The rates of return are monthly and taken from the University of Chicago's Center for Research in Security Prices and supplemented by data from Bloomberg. There are five sets of regression estimates based on the following five-year periods: 2002-2006, 2003-2007, 2004-2008, 2005-2009, and 2006-2010. These five periods represent the end of the bear market of 2000-2002, the bull market that ran from September 2002 through October 2007, the bear market that occurred from October 2007 through March 2009, and the recovery that followed from March 2009 through December 2010. Given additions to and deletions from the S&P 500 across the periods, as well as data limitations arising from companies with short histories (e.g. Google was not public until August 2004), the average number of companies across all five periods is 463.

The returns on the S&P 500 (as approximated by the Vanguard Index Trust 500, in light of the individual investor's ability to replicate the index) serve as the independent variable and the returns on the three-month Treasury bill account for the risk-free returns. We begin with January 2002 because the year includes a 22 percent drop in the S&P 500, marking a low point for the index in September of that year and eclipsed only by the market low in March 2009. Between September 2002 and October 2007, the S&P 500 enjoyed a run that generated an annual return of over 15 percent. We end the regression period, however, in December 2006. This is not only in keeping with the convention of using five years of monthly data, but also in recognition that the rise in stock prices had already begun to slow by the first quarter of 2007 and the VIX had begun its ninefold ascent. They occurred in line with the announcement of delinquency problems emerging with sub-prime mortgages and a subsequent and significant drop in the equity prices of home builders. The period also serves as a benchmark for assessing the impact of the financial crisis on the stocks of firms that make up the S&P 500.

III. Results

A. Correlations

The results in Table I address the first question under study. They show the correlation coefficients by sector and for selected firms across the periods of study. There are two

	2002-2006	2003-2007	2004-2008	2005-2009	2006-2010
<i>Index/sector</i>					
S&P 500	0.2021	0.1683	0.2703	0.3128	0.3500
Agriculture	0.1939	0.1960	0.2837	0.3045	0.3369
Mining	0.4908	0.4760	0.5942	0.5615	0.5387
Manufacturing-all	0.2848	0.2280	0.3505	0.4104	0.4530
Hard	0.3444	0.3018	0.4212	0.4913	0.5264
Soft	0.2351	0.2049	0.3482	0.4259	0.4600
Technology	0.3804	0.2743	0.3655	0.3997	0.4451
Services-all	0.1942	0.1843	0.2719	0.3090	0.3432
Financial	0.3093	0.3067	0.3636	0.4464	0.4648
Health care	0.1227	0.1355	0.2623	0.2824	0.3278
Others	0.2478	0.2213	0.2876	0.3119	0.3505
Utilities	0.4307	0.4473	0.4850	0.5207	0.5480
<i>Global industrial classification</i>					
Consumer staples	0.1817	0.1641	0.2740	0.2677	0.3016
Consumer discretionary	0.2705	0.2673	0.3464	0.3990	0.4305
Energy	0.5526	0.5370	0.6205	0.6110	0.5967
Financials	0.3093	0.3067	0.3636	0.4464	0.4648
Health care	0.1227	0.1355	0.2623	0.2824	0.3278
Industrials	0.3124	0.2968	0.4158	0.4740	0.5233
Materials	0.3266	0.2981	0.3727	0.4222	0.4420
Technology	0.3902	0.2536	0.3463	0.3776	0.4172
Utilities	0.4307	0.4473	0.4850	0.5207	0.5480
<i>Notable correlations by firm</i>					
Alcoa	0.3380	–	–	–	0.4971
Dover	0.3240	–	–	–	0.4855
Honeywell	0.3237	–	–	–	0.5037
KLA-Tencor	0.3327	–	–	–	0.4881
MetLife	0.2476	–	–	–	0.4917
PPG Industries	0.1136	–	–	–	0.4973
Apollo Group	0.0105	–	–	–	0.0339
Biogen	0.0271	–	–	–	0.2220
H&R Block	0.0241	–	–	–	0.1868
Stericycle	–0.002	–	–	–	0.1218
Newmont Mining	0.1136	–	–	–	0.1077
Southwest Energy	0.1408	–	–	–	0.1346

Table I.
The average correlation coefficients of the S&P 500, various sectors of the US economy across two methods of disaggregation, and selected firms from 2002-2006 to 2006-2010

breakdowns, with the lower half of the table showing sectors according to the Global Industrial Classification: consumer staples, consumer discretionary, energy, financials, health care, industrials, materials, technology, and utilities. As readily seen, the average correlation coefficient is 0.2021 across the firms that make up the S&P 500 during 2002-2006 and is even lower during 2003-2007, 0.1683. Examples of selected stocks with the highest average correlation coefficients across all firms include Alcoa, Dover, Honeywell, and KLA-Tencor, all in the range of 0.32-0.34. On the opposite end, we have the Apollo Group, Biogen, H&R Block, and Stericycle, with all correlations in the range of –0.002-0.030.

The story is much different when 2006-2010 is the focus. The average correlation coefficient jumps to 0.3500, an increase of 75 percent compared to 2002-2006 and an increase of 108 percent compared to 2003-2007. The coefficient of 0.3500 aligns remarkably well with research on market downturns for the 1990s (Silvapulle and Granger, 2001).

During 2006-2010, as Table I shows, the stocks with the highest average correlations, in the range of 0.48-0.51, include Alcoa, Honeywell, KLA-Tencor, MetLife, and PPG Industries. The stocks with the lowest correlations, in the range 0.03-0.14, are Apollo Group, Newmont Mining, Southwest Energy, and Stericycle.

The rise in the average correlation coefficient of the S&P 500 is consistent with the increases in the sectors of the index. In particular, health care went from a sector with significant diversification potential during 2002-2006 to one with less diversification potential by 2006-2010, as seen in the jump in the average correlation from 0.1227 to 0.3270, an increase of 167 percent. Soft manufacturing, as represented, for example, by beverage producers and clothing manufacturers, shows a surge in its correlations from 0.2351 to 0.4600, a near doubling that constrains diversification. Agriculture also displays a noticeable increase in its correlation, from 0.1939 to 0.3369, also reducing the potential for diversification.

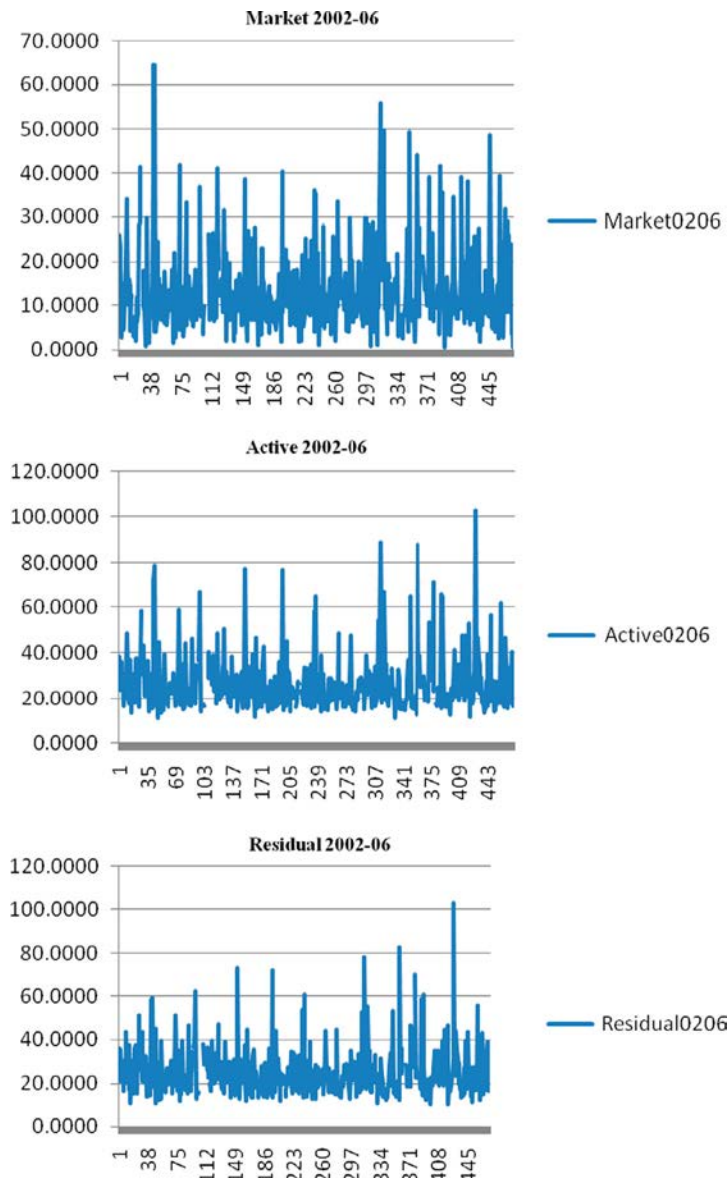
In addition, the results reveal insights that only add to the concern of risk-averse investors interested in holding well-diversified portfolios. Mining, "hard" manufacturing, and utilities – three sectors in the upper-half of the table – and energy, industrials, and utilities – three sectors in the lower-half of the table – each have correlations in excess of 0.50 during 2006-2010.

Interestingly, not all correlation coefficients display an increase over the period. The coefficients actually declined for six sectors in the upper half of the table and for five sectors in the lower half between 2002-2006 and 2003-2007, as also reflected in the decline in the average correlation coefficient of the S&P 500 from 0.2021 to 0.1683. The technology sector in the lower half exhibits the largest decline, by 35 percent, in part because of the unwinding of the technology boom of the 1990s. This is evidence that the correlations did not begin to increase significantly until 2008, suggesting that investors did not anticipate the depth and breadth of the crisis until it became full-blown, with the bankruptcy of Lehman Brothers playing a significant role.

B. Risks

Moving to the risk of each stock in the S&P 500, and to address the second question under study, we see that Figure 1 shows the respective fluctuations of the annualized market, active, and residual risks from January 2002 through December 2006, which pre-dates the crisis. In contrast, Figure 2 shows the risks from January 2006 through December 2010, which encompasses the crisis. Careful examination of both sets of figures suggests that neither active nor residual risk shows a marked increase between the two periods. That said, the figures indicate the presence of diversifiable risk, which aligns with Markowitz's observation.

In contrast to active and residual risks, market risk shows an upward movement between the two periods. For instance, Figure 1 registers 12 instances in which market risk is at least 30 percent and 16 instances in which it is at least 40 percent. By 2006 through 2010, however, 38 firms register a market risk of at least 40 percent. The companies registering the highest market risks (although not labeled in the figure but shown in Table II), and somewhat surprising given they do not belong to the sector with the highest risk, are technology firms, such as Advanced Micro Devices and Unisys. The risk of Unisys climbed to 67 percent, as the company's stock price fell from \$9.70 in July 2007 to \$0.28 by March 2009 before the company issued a 1:10 stock split in October 2009.



Note: None shows signs of a significant increase

Figure 1.
The respective fluctuations of market, active, and residual risks from January 2002 through December 2006

Table II presents the three risks of the S&P 500, by sector and by period, according to the Global Industrial Classification system. None of the risks shows a rising tendency until after 2007 and only market risk displays an increase. This implies that the equity markets did not begin to anticipate the crisis until it had become apparent, despite signs of it emerging in early 2007 with the onset of the sub-prime mortgage problem (Lo, 2009).

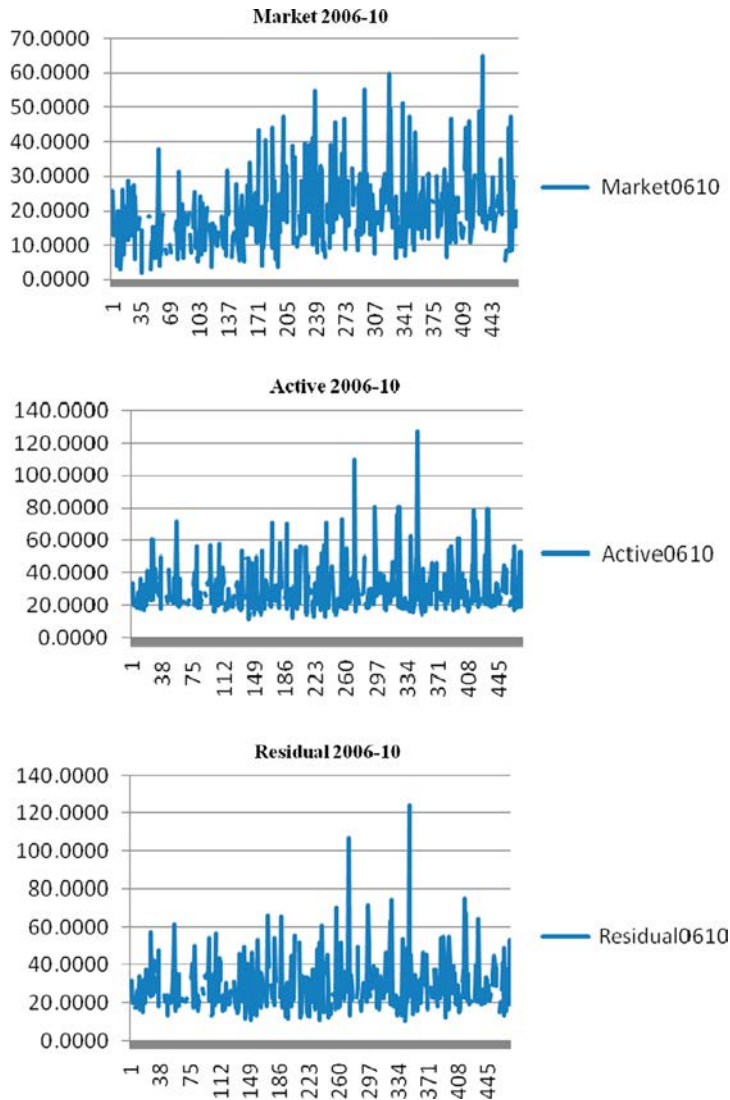


Figure 2.
The respective
fluctuations in active,
market, and residual risks
from January 2006
through December 2010

Note: Only market risk displays an increase

B.1. Market risk. Looking at market risk again, we see that it did not begin to rise until the 2004-2008 period. In fact, we note that the materials and technology sectors actually register notable declines during 2003-2007 compared to 2002-2006 (as reflected in the decline in the average correlation coefficient of the S&P 500 and a decline in the risk of the S&P 500 from approximately 13 to 9 percent), with technology registering a 36 percent decline, or from about 25 to 16 percent. Utilities, owing to their regulated structure, are the only area that does not display significant change over the entire set of periods.

Sector	2002-2006	2003-2007	2004-2008	2005-2009	2006-2010
<i>Market risk</i>					
S&P 500 (%)	12.5980	8.5079	12.8199	16.0401	17.9404
Consumer staples	6.6683	6.5476	9.2817	9.8807	10.7204
Consumer discretionary	12.0625	12.4845	14.9589	19.7445	21.2758
Energy	11.4512	10.3276	15.3782	16.5488	17.3838
Financial	9.7156	10.6116	15.3663	23.2877	24.0630
Health care	7.7146	8.5578	12.0925	12.6009	13.2400
Industrial	11.3169	10.9591	14.751	19.2231	21.0859
Materials	14.6170	11.0000	14.3492	19.0053	20.1826
Technology	25.2365	16.4673	17.9459	18.5328	19.6688
Utilities	9.2288	8.5287	8.2140	8.9351	9.4663
<i>Notable market risks by firm</i>					
Advanced Micro Devices (%)	42.3904	-	-	-	38.9157
Unisys	27.4535	-	-	-	66.7119
MetLife	11.2708	-	-	-	35.5000
Prudential	6.8100	-	-	-	48.8800
Citigroup	15.7188	-	-	-	50.5811
Bank of America	6.5903	-	-	-	42.7935
Goldman Sachs	15.0394	-	-	-	25.5239
Morgan Stanley	19.7666	-	-	-	26.3012
Boeing	9.7032	-	-	-	22.7790
Caterpillar	17.2452	-	-	-	32.7272
Johnson & Johnson	4.3780	-	-	-	10.4833
Pfizer	8.1813	-	-	-	12.6935
Best Buy	8.3415	-	-	-	21.7952
Disney	16.8692	-	-	-	24.8414
Proctor & Gamble	2.3712	-	-	-	9.5865
<i>Active risk</i>					
Consumer staples (%)	20.4983	18.1504	19.9002	21.3439	21.6454
Consumer discretionary	28.2366	26.1944	31.1475	36.4204	36.3767
Energy	29.9322	26.9783	29.9832	31.6229	30.7346
Financial	18.1132	16.7761	26.0716	35.0798	35.6902
Health care	26.7748	23.6254	23.2664	23.9434	25.1415
Industrial	21.0057	18.3162	18.9177	22.1302	22.1778
Materials	26.3894	21.9820	24.2816	28.7052	28.7900
Technology	37.1387	30.1063	29.2856	29.8304	29.1598
Utilities	19.8746	19.0643	17.1322	19.4838	19.7239
<i>Residual risk</i>					
Consumer staples (%)	19.3804	17.6351	18.9134	19.9756	19.9582
Consumer discretionary	27.8715	25.6407	30.4630	35.3762	35.3388
Energy	29.2153	27.1404	29.5759	31.3409	30.5892
Financial	17.3901	17.4331	25.4913	32.7439	33.3299
Health care	25.9289	23.2664	23.9434	25.1415	24.9115
Industrial	20.5658	18.2012	18.5726	21.2547	21.2624
Materials	25.5853	21.6435	23.6005	26.9290	26.9526
Technology	34.4046	29.7080	28.6824	29.1722	28.4151
Utilities	18.6806	18.8975	19.4838	18.0824	17.9092

Table II.
The market, active, and
idiosyncratic risks by
sector for each of the
five periods

As a group, between 2002-2006 and 2006-2010, the companies registering the greatest increase in market risks are, not surprisingly given the nature of the crisis, financial, which collectively show a jump of nearly 2.5 times, or from 10 to 24 percent. However, the companies with the greatest increases within this group are not banks but insurance firms – undoubtedly due in part to the fallout at American International Group – such as MetLife and Prudential. Taken together, as shown in Table II, their risks more than tripled.

Again, because it was a financial crisis, it is insightful to note the increases in market risk for large investment and money-center banks. For example, as shown in Table II, the risk of Goldman Sachs rose from 15 to 26 percent, an increase of 73 percent, while the risk at Morgan Stanley increased from 20 to 26 percent. Interestingly, the rise in the market risk of each of these investment banks, while certainly significant, was not nearly as pronounced as that in the insurance industry despite the demise of Bear Stearns and Lehman Brothers, two major investment banks. The increase in risk of both investment banks is also no match for the rise endured by investors in Citigroup, from 16 to 51 percent, and by those in Bank of America, from 7 to 43 percent.

Beyond financial firms, the rise in market risks across all sectors beginning in 2008 indicates the broad impact of the crisis. While only the technology and utility sectors came away comparatively unscathed, they each contain major exceptions. Although not reported in the table for brevity, investors in Microsoft had to withstand a 50 percent rise in market risk and dividend-seeking investors in Southern, a large utility, witnessed an increase from 1 to 6 percent.

As shown in Table II, the health-care, industrial, and consumer discretionary sectors display the largest increases in risk. The health-care sector registers a near-doubling between the beginning and ending periods. Individual firm examples are Johnson & Johnson, whose risk more than doubled, and Pfizer, whose risk increased by 62 percent. The same applies to the industrial sector. Boeing's risk, for example, rose from 10 to 23 percent while Caterpillar's increased from 17 to 33 percent. Holders of consumer discretionary stocks, such as Best Buy and Disney, fared no better, with Best Buy's risk jumping from 8 to 22 percent. Even investors in consumer staples firms, such as Procter & Gamble, experienced a relatively large rise in market risk.

The numbers suggest, in light of financial media reports and academic research, that it was difficult to have contained a significant rise in portfolio risk during the financial crisis. Equity investors who were over-weighted, for example, in selected utilities and technology stocks would have fared better than equity investors in other combinations. However, it would have been hard to have known this before the crisis. As indicated in Table II, the best investors could have hoped for would have been to have contained the rise in portfolio risk by avoiding the financial, industrial, and consumer discretionary sectors.

Additional tests reveal that the biggest effects of the crisis, which occurred from mid-2008 through the first quarter of 2009, have dissipated very slowly. During 2010, while the VIX, for example, did not reach anywhere close to its high of 89.5 in 2008, it ranged from 16.2 to 48.2. As a result, the correlations across equities remained elevated throughout 2010.

B.2. Active and residual risks. With two exceptions between the two end periods, none of the sectors displays a significant increase in active risk, which can also be thought of as "tracking error," or the extent to which the returns deviate from those of the benchmark.

The consumer discretionary sector displays an increase from 28 to 36 percent, or by approximately 29 percent. The other sector – not surprisingly given the difficulties it encountered with derivative investments, mortgage-backed securities, and counterparty risk during the crisis – is financial, registering a doubling from 18 to 36 percent. As in the case of market risk, the technology sector shows a decline from 37 to 29 percent.

This is not to imply, however, that active risk is not significant. Its size for the period of 2006-2010, which encompasses the financial crisis, ranges from approximately 20 percent in the utility sector to 36 percent in the consumer discretionary sector, which suggests room for diversification just as Markowitz has inferred. However, much depends on the extent to which the equities selected are correlated. The higher the correlations, the more difficult it is to reduce portfolio risk.

Similar conclusions may be drawn for residual risk. Again, only the consumer discretionary and financial sectors show significant increases, and of like magnitude compared to the active risks, while the technology area displays a decline from 34 to 28 percent, or about 18 percent. Interestingly, both risks are close in size, and together suggest significant room for diversification. But as pointed out, the success of the diversification effort ultimately rests with the sizes of the correlation coefficients. While the jump, on average, in the correlations among S&P 500 firms from 0.20 to 0.35 between 2002-2006 and 2006-2010 is certainly cause for concern, it is beyond the scope of this paper to determine the trigger point at which diversification efforts are frustrated. That being said, at this stage, the evidence suggests that the impact of the financial crisis on firm-level market risk has limited the efficacy of MPT.

IV. Conclusion

The global financial crisis of 2007-2009 reached deeply into the corners of financial markets, reverberating across money market funds, mortgage-backed securities, and equities. These macro effects are well known. The micro effects, however, are less known, one of which is the rise in correlation coefficients at the firm level. Another is the resulting impact on firm-level risks. The relevance of these micro effects is seen in financial media reports in which the efficacy of MPT has come under increasing scrutiny.

Using monthly return data for all firms in the S&P 500 from 2002 through 2010, we find that the average correlation coefficient of the S&P 500 rose from 0.20 to 0.35 during the crisis, an increase of 75 percent. We also find that market risks increased significantly across all sectors, except for technology and utilities. Not surprising, given the nature of the crisis, the largest increases in market risk are in the financial sector.

The increases in market risk across the sectors are large. They increased by 2.5 times for financial firms, with insurance firms experiencing the biggest jumps, even greater than those of commercial and investment banks. They nearly doubled in the health care and industrial sectors. While an apparent rise in diversifiable risk did not occur, evidence suggests the risk was significant, allowing for portfolio risk reduction through diversification. The extent to which this was achievable, however, depends on the extent to which the rise in correlation coefficients constrains it. This is an issue for future research. In the meantime, given the significant rise in firm-level market risks that occurred during the crisis, a rise that lingered throughout 2010, it seems reasonable to conclude that the impact of the recent global financial crisis on firm-level market risk has significantly limited the efficacy of MPT.

References

- Ang, A. and Chen, J. (2002), "Asymmetric correlations of equity portfolios", *Journal of Financial Economics*, Vol. 63 No. 3, pp. 443-494.
- Campbell, J., Lettau, M., Malkiel, B.G. and Xu, Y. (2001), "Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk", *Journal of Finance*, Vol. 56 No. 1, pp. 1-43.
- Cederburg, S., Davies, P. and O'Doherty, M. (2011), "Asset-pricing anomalies at the firm level", working paper, University of Iowa, Iowa City, IA.
- Chua, D.B., Kritzman, M. and Page, S. (2009), "The myth of diversification", *Journal of Portfolio Management*, Vol. 36 No. 1, pp. 26-35.
- Ennis, R. (2009), "The uncorrelated return myth", *Financial Analysts Journal*, Vol. 65 No. 6, pp. 6-7.
- Fama, E. and French, K. (1995), "Size and book-to-market factors in earnings and returns", *Journal of Finance*, Vol. 50 No. 1, pp. 131-155.
- Ferry, J. and Foster, M. (2010), "Back to the drawing board", *Wall Street Journal*, available at: <http://online.wsj.com/article/SB10001424052702303960604575158141978114692.html>
- Hong, Y., Tu, J. and Zhou, G. (2007), "Asymmetries in stock returns: tests and economic evaluation", *Review of Financial Studies*, Vol. 20 No. 5, pp. 1547-1581.
- King, B. (1966), "Market and industry factors in stock price behavior", *Journal of Business*, Vol. 39 No. 1, pp. 139-190.
- Koh, F. and Spremann, K. (2008), "Managing wealth in financial crisis", *The Business Times*, available at: www.asiaone.com/Business/My%2BMoney/Building%2BYour%2BNest%2BEgg/Investments%2BAnd%2BSavings/Story/A1Story20081222-109709.html
- Lo, A. (2009), "Regulatory reform in the wake of the financial crisis of 2007-08", *Journal of Financial Economic Policy*, Vol. 1 No. 1, pp. 4-43.
- Markowitz, H. (2009), "Crisis mode: modern portfolio theory under pressure", *Investment Professional*, Vol. 2 No. 3, pp. 54-57.
- Rosenberg, B. (1974), "Extra-market components of covariance in security returns", *Journal of Financial and Quantitative Analysis*, Vol. 9 No. 2, pp. 263-273.
- Sharpe, W.F. (1963), "A simplified model for portfolio analysis", *Management Science*, Vol. 9 No. 5, pp. 277-293.
- Silvapulle, P. and Granger, C.W.J. (2001), "Large returns, conditional correlation, and portfolio diversification: a value-at-risk approach", *Quantitative Finance*, Vol. 1 No. 5, pp. 542-551.
- Statman, M. and Schneid, J. (2006), "Measuring the benefits of diversification and the performance of money managers", *Journal of Investment Consulting*, Vol. 7 No. 3, pp. 21-31.

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