Index Futures, Program Trading, and the Covariability of the Major Market Index Stocks

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INTRODUCTION

"A program trade" is a transaction involving 15 or more stocks traded as a group rather than individually. Since the introduction of stock index futures in 1982, program trading refers primarily to computerized trading strategies, such as stock index arbitrage and portfolio insurance, which involve the simultaneous trading in a portfolio of cash securities and index futures and/or options.[1] Considerable research exists that investigates the effect of index futures on stock market prices. Figlewski (1984), MacKinlay and Ramaswamy (1988), and Modest and Sundaresan (1983) study whether the relative pricing of index futures and the underlying cash securities is efficient. Grossman (1988), Harris (1988), and Stoll and Whaley (1987) examine whether index futures trading increases market price volatility; and Kawaller, Koch and Koch (1987) investigate whether information and market sentiment are transmitted from the futures to the equity market.

In a 1989 study, the authors document a significant increase in the Major Market Index's and its 20 stocks' ("index stocks") percentage systematic risk and covariability following the introduction of index futures and options.[2] The current article extends the earlier study in at least three ways: First, a control portfolio of 20 *nonindex* stocks is included and examined. Such securities are not normally involved in program trades and, therefore, their return behavior should not be influenced by program trading. Second, the index and nonindex stocks' returns on high versus low program trading days are studied separately to provide a more direct

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[1]Hill and Jones (1988) provide an excellent discussion of how various program trading techniques are related, how they differ and how they separately and together might affect stock market prices.
[2]See Martin and Senchack (1989).

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measure of program trading's impact on their correlations. Finally, daily (rather than monthly) price behavior is examined over the period 1980–87 but with the 1987 market crash period excluded. The sensitivity of the tests should increase with daily returns because program trades occur daily and often near the end of a trading day. In addition, daily returns permit a year-by-year analysis of the index stocks' correlations that allows any intertemporal changes to be related to the increasing use of program trades. The market crash is excluded because program trading activities were suspended during and after this unusual event.

One reason why index stocks' percentage systematic risk and correlation may have increased is the "price pressure hypothesis," which states that a large stock sale (purchase) causes a stock's price to decrease (increase) even if no new information is associated with the transaction.[3] In other words, the demand curve for shares is not elastic in the very short-run. Consequently, a large sale or a series of sale orders causes a stock's price to be marked down enough to attract traders that provide the necessary liquidity. These traders are then rewarded for their liquidity services when prices adjust back to their full-information levels after the selling pressure eases. When this phenomenon is generalized to program trading, one should find the portfolio of stocks reacting similarly and this increases their degree of comovement.

Another reason why program trading affects stock returns is the so-called "cascade theory," which says that program selling exacerbates declines in stock prices. Portfolio insurers sell index futures rather than the cash securities to hedge market risk, which decreases futures prices relative to the cash market index. This decline relative to cash prices induces index arbitragers to purchase futures and sell the underlying stocks. Such activity transmits to the stock market the initial bearish impact of portfolio insurance selling in the futures market. Selling pressure in the cash market causes further declines in cash prices, which triggers additional selling of index futures that is again transmitted to the cash market by arbitragers and so on.

The MMI and its component stocks are studied because they are major components of all index futures/options contracts, and all have equity options traded on them. Even though the S&P 500 futures contract is more actively traded than the MMI, the MMI stocks represent the largest U.S. corporations, are widely held by institutional investors, and are an integral part of program trades. Therefore, any fundamental changes in these stocks' price behavior are relatively more important to investors and are more likely to be observed than with nonindex stocks.[4] The MMI also appears to be a more easily arbitraged or insured portfolio because fewer stocks are involved. On the other hand, the MMI is a *price-weighted* index, which makes it more difficult to replicate in the cash market.

IMPLICATIONS OF PROGRAM TRADING

One possible result of synchronously trading portfolios of index stocks is an increase in the comovement of their returns. This increased comovement should be

[3]For example, see Harris and Gurel (1986), Kraus and Stoll (1972), and Scholes (1972).

[4]On December 31, 1987, for instance, the total market value in billions of dollars of the following indexes was:

MMI	$456	NYSE Composite	$2,171
S&P 500	1,736	Wilshire 5000	2,315

Thus, the 20 MMI stocks were, respectively, 26 and 20 percent of the S&P 500's and Wilshire 5000 Equity Index's market values.

reflected in their systematic risk component and return correlations being higher subsequent to index futures and options trading. Because many investment strategies use securities' return correlations, the effect of program trading on stock behavior has a number of implications.

Security Analysis. A stock with relatively high nonsystematic risk relative to its systematic risk generates returns that deviate more from overall market movements because it responds more to firm-specific news that does not affect other stocks. Because of this unique behavior, such stocks are more difficult to follow and require closer monitoring. On the other hand, they offer the analyst more opportunity to utilize special expertise and knowledge concerning the security. Conversely, stocks with relatively higher market sensitivity respond more to macroeconomic events than high nonsystematic risk stocks do. Because market-sensitive stocks have fewer surprises specific to them, there is less reward to devoting research resources to them. Similarly, stocks that are actively traded as part of program trading may exhibit such a high degree of correlation with the market and among themselves that the expected payoff to analyzing and monitoring such stocks is greatly diminished.

Diversification Potential. If the correlations among index stocks increase, their diversification potential may be reduced significantly. If so, the traditional view of diversifying across industries to reduce unsystematic risk needs to be amended for index stocks, and the universe of institutional stocks considered for investment purposes needs to be widened to eliminate nonsystematic risk with a reasonable number of securities.

Asset Allocation Decisions. Asset allocation studies are usually done every two or three years to determine an optimal asset mix, such as 40 percent equity, 50 percent fixed income, and 10 percent money market securities. The portfolio manager rebalances the mix periodically if market conditions alter relative asset values. Asset allocation models often use Monte Carlo simulation to estimate the likely range of outcomes associated with each mix. These simulations rely explicitly or implicitly on estimates of return correlations across asset classes, which usually are based on historical returns. Models that use simulation analysis often assume that risks and correlations remain constant over the forecast period, which may be as much as three-to-five years into the future. If program trading alters the systematic risk component and the structure of the covariation among institutionally-traded stocks, then historically-based values need to be adjusted to properly reflect new market dynamics.

RESEARCH METHODOLOGY

Data Description

Daily returns (with dividends) for the individual stocks are from the *CRSP Daily Return File,* 1987 Edition, for the 1980–1987 time period. The MMI returns are calculated from the daily closing index prices provided by the Chicago Board of Trade. The returns for the market proxies, the CRSP equally- and value-weighted indexes, as well as the S&P 500 Index are also from the *CRSP Daily Return File.* The sample of returns is divided into three subperiods relative to the initial trading of index futures and the initial trading date of the MMI futures contract as follows:

Starting Date	Ending Date	Test Period Designation
January 2, 1980	January 31, 1982	Pre-futures period
February 1, 1982	July 23, 1984	Transition period
July 24, 1984	October 9, 1987	Post-futures period

Index futures trading began in February 1982 with the Value Line Composite Index. Most index options trading began in early 1983 and MMI futures began trading in July 1984.[5] Early discounts on index futures and low futures/options open interest indicate that, initially, program trading was not a major factor in these markets; in fact, a persistent mispricing between the futures and cash market existed through 1984[6] (see Figlewski (1984) and Modest and Sundaresan (1983)). The rapid growth in index futures and option volume and open interest did not occur until after mid-1984.

Nevertheless, index trading may have had an influence on index stocks' behavior in the *transition period* before MMI futures trading began; therefore, this time period is treated separately. The post-futures trading period ends on October 9, 1987 to avoid any possible statistical distortions associated with the market crash. The sample of returns is further divided by calendar year. This allows documentation of any transitional changes in the correlation matrix of the index stocks. Finally, because 1987 was such an unusual year for financial markets, that year is examined in more detail by dichotomizing this trading period into high and low program trading intensity days.

To determine whether any changes in the MMI stocks' percentage systematic risk and correlation structure are due to program trading activity or secular changes in the general market, a control sample of *nonindex* stocks is evaluated. This portfolio consists of twenty firms whose total equity market value on December 31, 1984 was between $750 million and $1 billion. Because they are smaller than the MMI stocks and are not a member of an index with a traded futures or option contract, these stocks' returns should not reflect the influence of program trading activities.

[5]The initial trading month for the more actively traded index-related contracts are:

Index Futures	Index Futures Options	Index Options
S&P 500-April 1982	S&P 500-January 1983	S&P 100-March 1983
NYSE-May 1982		S&P 500-January 1983
MMI- July 1984		MMI-July 1983

[6]As an indication of the degree of mispricing, the decline in the S&P 500 futures mispricing from May 1982 through September 1987 as measured by the range and average monthly difference between the largest premium and largest discount are as follows:

Year	Largest Premium to Fair Value	Largest Discount to Fair Value	Range	Average Monthly Difference
1982 (June)	2.59%	−4.14%	6.73%	2.85%
1983	1.39	−1.52	2.91	1.33
1984	2.42	−0.55	2.97	1.46
1985	1.70	−0.75	2.45	1.19
1986	1.01	−1.17	2.18	1.19
1987 (Sept)	0.74	−0.88	1.62	1.07

Source: M. A. Zurack and W.W. Toy, "Stock Index Trading: A Five-Year Review through September 1987," Goldman, Sachs & Co., October 1987.

Statistical Tests

To assess any changes in percentage systematic risk, the following linear regression or market model is used initially:

$$R_{i,t} = a_i + b_i R_{M,t} + e_{i,t} \tag{1}$$

where a_i and b_i are the MMI's or index stock's intercept and systematic risk parameters; $R_{i,t}$ is the daily return on the MMI or index stock; $R_{M,t}$ is the daily return on the equally- or value-weighted CRSP index (with dividends); and $e_{i,t}$ is the residual error term for day t. An equally-weighted market index is selected because it is less susceptible to the influence of program trading than a value-weighted index, i.e., it is less sensitive to the price behavior of large-capitalized firms which dominate the composition of index futures. Nevertheless, both types of index are used because the MMI is a *price-weighted* index, and it is not clear which market proxy is more representative of the weighting scheme inherent in the MMI. Because a price-weighted index value is disproportionately influenced by higher price-per-share stocks, however, the MMI may behave more like a value-weighted index because the larger MMI firms also tend to be higher price-per-share stocks.

The total risk or variance of the MMI or stock returns, $s^2(R_i)$, as defined by the market model is $s^2(R_i) = b_i^2 s^2(R_M) + s^2(e_i)$, where the first and second terms on the right-side of the equation are, respectively, the magnitudes of systematic and nonsystematic risk. This equation can be further rewritten in terms of percentages by dividing both sides by $s^2(R_i)$ or $1 = r^2 + s^2(e_i)/s^2(R_i)$. The first term on the right-hand side is now the *percentage* of total risk due to systematic risk or, alternatively, the coefficient of determination of the market model, and the second term is the proportion of total risk due to the nonsystematic variation in the MMI or index stocks' returns. This relationship suggests that one measure of the impact of program trading on stock behavior is to compare the r^2 over the three subperiods.

Another set of tests is conducted with the return correlations between the MMI and the two market indices and among the individual index stocks. The index stocks' correlation coefficient matrix is estimated for each time period. These correlations are summarized by using an average of each stock's correlations with the other 19 MMI stocks for each subperiod. These average correlations are then compared across each time period to test for significant changes. Similar tests are performed on the nonindex stocks.

EMPIRICAL RESULTS

In the next section, eq. (1) is used to estimate the MMI's and index stocks' market model parameters over the pre-futures, transition, and post-futures periods to determine if there are any significant interperiod changes in their values. The following section contains tests for any significant changes in the correlations among the index stocks over various time periods. These tests are performed also on the control sample of nonindex stocks to separate the influence of program trading activity from other market forces that might have caused any change in the MMI stocks' correlation structure. A final section presents a closer examination of the index and nonindex stocks' average correlations in 1987 by using a daily measure of program trading intensity.

Table I
COMPARISON OF THE MMI AND S&P 500 INDEXES' MARKET MODEL PARAMETERS USING EQUALLY-WEIGHTED CRSP (EWCRSP) AND VALUE-WEIGHTED CRSP (VWCRSP) INDEXES AS MARKET PROXIES OVER THREE SUBPERIODS, 1980–1987

Legend:
Pre-Futures: **January 2, 1980–January 31, 1982**
Transition: **February 1, 1982–July 23, 1984**
Post-Futures: **July 24, 1984–October 9, 1987**

		Time Period	Level of Systematic (Beta)	Percentage Systematic (r^2)	Correlation Coefficient
A. MMI vs.					
	EWCRSP:	Pre-Futures	0.837*	0.479	0.692
		Transition	1.126*	0.617	0.785**
		Post-Futures	1.124*	0.588	0.767**
	VWCRSP:	Pre-Futures	0.955*	0.760	0.872
		Transition	1.099*	0.886	0.941**
		Post-Futures	1.127*	0.880	0.938**
B. S&P 500 vs.					
	EWCRSP:	Pre-Futures	0.934*	0.715	0.846
		Transition	1.157*	0.767	0.876**
		Post-Futures	1.155*	0.742	0.862**
	VWCRSP:	Pre-Futures	0.992*	0.986	0.993
		Transition	1.069*	0.989	0.994
		Post-Futures	1.091*	0.987	0.994

*Statistically significant beyond the 0.1 percent level.
**A pairwise comparison between the pre-futures versus the transition and the post-futures correlations indicates that both two-period correlation comparisons are statistically different from each other beyond the 1.0 percent level of significance.

Relationship of MMI to the Market

Table I presents a comparison of the level of and percentage systematic risk for the MMI and S&P 500 indexes before and after futures trading began. The S&P 500 index is included for comparative purposes because it is a broader-based market index and has the most actively-traded index futures contract and the second most actively-traded index option contract. From Panel A, the MMI beta is less than one relative to both the EWCRSP and VWCRSP indexes in the pre-futures trading period, but shifts upward significantly in the post-futures trading period.[7] The MMI's

[7]To test for the significance of the changes in the level of systematic risk, a linear switching regression model is constructed that allows a determination of whether the model parameters have shifted following MMI futures trading, i.e.,

$$R_{i,t} = \alpha_i + \alpha_i' D + b_i R_{M,t} + b_i'(D \cdot R_{M,t}) + e_{i,t}$$

where D is a dummy variable that assumes the value of zero for each day during the pre-futures trading period and a value of one for the transition or post-futures period. In this model, α_i' and b_i' reflect the changes, respectively, in the intercept and slope (level of systematic risk) parameters after January 1982. Thus, if b_i' is found to differ significantly from zero, then the hypothesis that no change in this parameter occurred subsequent to MMI futures trading can be rejected. The four changes in the beta coefficients for the MMI versus the EWCRSP and VWCRSP indexes in the transition and post-futures trading periods in Table I are statistically different from zero at the one percent level of significance.

percentage systematic risk and return correlation with the market increases significantly in the transition and post-futures period. Note in Panel B, however, that while the S&P 500 is more highly correlated with both market proxies than the MMI, its overall relationship with the market remains unaltered throughout the entire time period. This finding suggests that any changes may be restricted to only larger index stocks. Such stocks are more likely to be influenced by program trading because they are common to most program trading strategies. These results also indicate that the MMI's behavior became more related to the general market, especially in the case of a value-weighted market index.

Relationship of the Index Stocks to the Market

Table II contains information on the percentage systematic risk for the MMI's 20 component stocks. Panel A indicates that, on average, the individual MMI stocks

Table II
SUMMARY AND INDIVIDUAL STATISTICS FOR THE PERCENTAGE SYSTEMATIC RISK (r^2) OF THE INDIVIDUAL MMI STOCKS VERSUS THE EQUALLY-WEIGHTED CRSP (EWCRSP) AND VALUE-WEIGHTED CRSP (VWCRSP) INDEXES OVER THE THREE SUBPERIODS, 1980–1987

Legend:
Pre-Futures: January 2, 1980–January 31, 1982
Transition: February 1, 1982–July 23, 1984
Post-Futures: July 24, 1984–October 9, 1987

	Market Index	Pre-Futures Period	Transition Period	Post-Futures Period
A. SUMMARY STATISTICS				
AVERAGE	EWCRSP	0.206	0.267	0.234
AVERAGE	VWCRSP	0.305	0.380	0.353
B. INDIVIDUAL STATISTICS				
Company Name				
1. American Express	EWCRSP	0.201	0.331	0.288
	VWCRSP	0.300	0.415	0.415
2. American T&T[a]	EWCRSP	0.113	0.164	0.211
	VWCRSP	0.175	0.271	0.354
3. Chevron	EWCRSP	0.220	0.223	0.137
	VWCRSP	0.442	0.348	0.203
4. Coca Cola	EWCRSP	0.187	0.193	0.261
	VWCRSP	0.207	0.304	0.400
5. Dow Chemical	EWCRSP	0.242	0.274	0.317
	VWCRSP	0.382	0.375	0.411
6. DuPont	EWCRSP	0.253	0.333	0.318
	VWCRSP	0.324	0.440	0.423
7. Eastman-Kodak	EWCRSP	0.168	0.186	0.192
	VWCRSP	0.340	0.326	0.299
8. Exxon	EWCRSP	0.268	0.262	0.183
	VWCRSP	0.459	0.392	0.304
9. General Electric	EWCRSP	0.333	0.367	0.349
	VWCRSP	0.426	0.520	0.554

Table II—Continued

	Market Index	Pre-Futures Period	Transition Period	Post-Futures Period
10. General Motors	EWCRSP	0.217	0.325	0.220
	VWCRSP	0.274	0.487	0.347
11. IBM	EWCRSP	0.163	0.377	0.248
	VWCRSP	0.391	0.621	0.429
12. International Paper	EWCRSP	0.286	0.265	0.199
	VWCRSP	0.322	0.335	0.304
13. Johnson & Johnson	EWCRSP	0.181	0.213	0.259
	VWCRSP	0.275	0.306	0.378
14. Merck & Co.	EWCRSP	0.161	0.248	0.253
	VWCRSP	0.230	0.305	0.366
15. 3M	EWCRSP	0.236	0.362	0.272
	VWCRSP	0.323	0.495	0.435
16. Mobil	EWCRSP	0.090	0.245	0.114
	VWCRSP	0.303	0.357	0.176
17. Philip Morris	EWCRSP	0.210	0.195	0.261
	VWCRSP	0.282	0.317	0.389
18. Procter & Gamble	EWCRSP	0.199	0.197	0.213
	VWCRSP	0.226	0.294	0.343
19. Sears	EWCRSP	0.183	0.355	0.292
	VWCRSP	0.237	0.506	0.430
20. USX	EWCRSP	0.202	0.215	0.101
	VWCRSP	0.188	0.191	0.099
SAMPLE SIZE (Trading Days)		525	626	798

[a]AT&T, which resulted from a court-ordered breakup of the Bell System, received about 23 percent of the former company's assets. Therefore, post-divestiture date after 1983 are not comparable to the pre-divestiture data.

experience a monotonic increase in the percentage of systematic risk (r^2) over the three time periods. This increase averages over 14 percent from the pre- to post-futures trading period, regardless of the market proxy used (from 0.206 to 0.234 using the EWCRSP index and 0.305 to 0.353 where the VWCRSP index is used). These results suggest that program trading increases systematic behavior.

Panel B contains details of the individual MMI stocks. Most stocks experience an increase in their systematic relationship to the market in the transition and post-futures periods when compared to the pre-futures period. For example, compared to the pre-futures period when using the EWCRSP index, 16 out of the 20 stocks' percentage systematic risk increase from the pre-futures to the transition period. Similarly, 16 of 20 stocks' post-futures systematic risk measures are higher than their comparable pre-futures measure although two companies' measures (Exxon and International Paper) decrease in both comparisons. The results seem to indicate that, in general, the MMI and its component stocks have experienced a major structural shift in their systematic relationship with the market following the introduction of index futures trading.

Table III contains analogous tests to those presented in Table II except for the sample of nonindex stocks. Panel A of this table reveals that the systematic compo-

Table III
PERCENTAGE SYSTEMATIC RISK OF SMALLER NONINDEX STOCKS VERSUS THE EQUALLY-WEIGHTED CRSP (EWCRSP) AND VALUE-WEIGHTED CRSP (VWCRSP) INDEXES OVER THE THREE SUBPERIODS, 1980–1987

Legend:
Pre-Futures: January 2, 1980–January 31, 1982
Transition: February 1, 1982–July 23, 1984
Post-Futures: July 24, 1984–October 9, 1987

		Market Index	Pre-Futures Period	Transition Period	Post-Futures Period
A. SUMMARY STATISTICS					
	AVERAGE	EWCRSP	0.120	0.117	0.112
	AVERAGE	VWCRSP	0.105	0.112	0.104
B. INDIVIDUAL STATISTICS					
	Company Name				
1.	Alco Standard	EWCRSP	0.042	0.094	0.122
		VWCRSP	0.019	0.069	0.111
2.	Ames Dept. Stores	EWCRSP	0.158	0.154	0.083
		VWCRSP	0.095	0.117	0.083
3.	Analog Devices	EWCRSP	0.195	0.246	0.191
		VWCRSP	0.148	0.178	0.172
4.	Arkla Inc.	EWCRSP	0.164	0.130	0.038
		VWCRSP	0.172	0.121	0.031
5.	Boston Edison	EWCRSP	0.033	0.048	0.085
		VWCRSP	0.023	0.050	0.086
6.	Central Illinois P.S.	EWCRSP	0.060	0.070	0.128
		VWCRSP	0.039	0.083	0.133
7.	Delmarva P & L	EWCRSP	0.107	0.072	0.101
		VWCRSP	0.097	0.081	0.103
8.	Harsco Corp.	EWCRSP	0.056	0.065	0.081
		VWCRSP	0.029	0.053	0.052
9.	Idaho Power	EWCRSP	0.065	0.097	0.113
		VWCRSP	0.045	0.090	0.102
10.	IPALCO Enterprises	EWCRSP	0.089	0.076	0.181
		VWCRSP	0.069	0.082	0.200
11.	Irving Bank	EWCRSP	0.098	0.154	0.068
		VWCRSP	0.063	0.139	0.061
12.	Kansas City P&L	EWCRSP	0.121	0.062	0.121
		VWCRSP	0.091	0.051	0.092
13.	Kansas P&L	EWCRSP	0.083	0.075	0.091
		VWCRSP	0.074	0.094	0.104
14.	Murphy Oil	EWCRSP	0.261	0.203	0.130
		VWCRSP	0.326	0.222	0.113
15.	Olin Corp.	EWCRSP	0.221	0.201	0.207
		VWCRSP	0.205	0.201	0.189
16.	Premier Industrial	EWCRSP	0.086	0.079	0.116
		VWCRSP	0.050	0.054	0.081
17.	Rochester Gas & Electric	EWCRSP	0.044	0.039	0.097
		VWCRSP	0.027	0.037	0.070

Table III—Continued

	Market Index	Pre-Futures Period	Transition Period	Post-Futures Period
18. Rorer Group	EWCRSP	0.096	0.112	0.044
	VWCRSP	0.084	0.129	0.035
19. Staley Continental	EWCRSP	0.179	0.134	0.125
	VWCRSP	0.228	0.131	0.127
20. Telex Corp.	EWCRSP	0.251	0.219	0.120
	VWCRSP	0.211	0.267	0.128
SAMPLE SIZE (Trading Days)		525	626	798

[a]EW and VW refers to the equally- and value-weighted CRSP index (with dividends), respectively.

nent of these stocks' risk remains relatively stable over the three subperiods and even declines slightly from the pre- to the post-futures period. There also is a rather dramatic difference in the size of the systematic risk component as a percent of total risk. The nonindex firms average about half the percentage systematic risk compared to the MMI stocks. Panel B shows a mixture of changes in the systematic risk components for the individual stocks. In 11 of 20 cases the systematic risk of the firm declines between the pre- and transition periods where the EWCRSP index is used. Similarly, when the pre- and post-futures period are compared, 10 of 20 cases produce a smaller systematic risk component.

In sum, the results presented in Tables II and III indicate that the systematic risk component of stocks that are commonly involved in program trading activities increases over the period spanning the introduction of index futures and options. The nonindex stocks show little evidence of increased systematic risk.

Relationship of the Index Stocks to Each Other

By Subperiod. Tables IV and V present the average correlations by subperiod for the MMI stocks and the nonindex stocks, respectively. Figures at the bottom of Table IV indicate that the overall average correlation among MMI stocks' returns increases from 0.331 to 0.364 or about 10 percent over the three subperiods. The greatest change occurs in the transition period where it increases 16 percent over the pre-futures period's average correlation. With regard to each stocks' correlation coefficients, only two of the 20 stocks, Eastman-Kodak and USX, have a lower correlation with the other index stocks when the pre-futures and transition periods are compared. Note that although the post-futures period average correlation (found at the bottom of Table IV) declines slightly when compared to the transition period results, only four companies (Chevron, Eastman Kodak, IBM, and USX) have lower average correlations in the final period than in the pre-futures period. A comparison of the average correlations for the twenty MMI stocks indicates that both the transition and post-futures correlations are significantly different than the pre-futures values at the one percent level. These results indicate that the common covariation of the MMI stocks' price movements have increased significantly since the introduction of index futures.

Table V contains similar results for the control sample. Note that the average correlations for all 20 stocks (bottom of Table V) decline from the pre- to transition period by almost 10%. This is followed by an increase in the post-futures period; however, the post-futures period average increases less than four percent. Once

Table IV
AVERAGE CORRELATION COEFFICIENTS OF THE INDIVIDUAL MMI STOCKS' RETURNS OVER THE THREE SUBPERIODS, 1980–1987

Legend:
Pre-Futures: January 2, 1980–January 31, 1982
Transition: February 1, 1982–July 23, 1984
Post-Futures: July 24, 1984–October 9, 1987

Company Name	Pre-Futures Period	Transition Period	Post-Futures Period
American Express	0.346	0.391	0.373
American T&T[a]	0.250	0.332	0.372
Chevron	0.315	0.357	0.292
Coca-Cola	0.277	0.377	0.388
Dow Chemical	0.377	0.388	0.385
DuPont	0.366	0.419	0.404
Eastman Kodak	0.390	0.379	0.352
Exxon	0.338	0.370	0.360
General Electric	0.405	0.459	0.470
General Motors	0.334	0.441	0.371
IBM	0.399	0.494	0.386
International Paper	0.319	0.364	0.356
Johnson & Johnson	0.333	0.355	0.377
Merck	0.304	0.334	0.374
3M	0.359	0.447	0.429
Mobil	0.275	0.352	0.280
Philip Morris	0.351	0.358	0.367
Procter & Gamble	0.295	0.356	0.373
Sears	0.325	0.442	0.393
USX	0.267	0.255	0.180
Average	0.331	0.383	0.364

[a]AT&T, which resulted from a court-ordered breakup of the Bell System, received about 23 percent of the former company's assets. Therefore, post-divestiture date after 1983 are not comparable to the pre-divestiture data.

Table V
AVERAGE CORRELATION COEFFICIENTS FOR SMALLER NONINDEX STOCKS OVER THE THREE SUBPERIODS, 1980–87

Legend:
Pre-Futures: January 2, 1980–January 31, 1982
Transition: February 1, 1982–July 23, 1984
Post-Futures: July 24, 1984–October 9, 1987

Company Name	Pre-Futures Period	Transition Period	Post-Futures Period
Alco Standard	0.087	0.111	0.135
Ames Dept. Stores	0.144	0.143	0.117
Analog Devices	0.140	0.144	0.140
Arkla	0.137	0.122	0.068

Table V—Continued

Company Name	Pre-Futures Period	Transition Period	Post-Futures Period
Boston Edison	0.114	0.112	0.164
Central Illinois P.S.	0.145	0.125	0.168
Delmarva P&L	0.132	0.132	0.178
Harsco Corp.	0.094	0.105	0.109
Idaho Power	0.139	0.120	0.169
IPALCO Enterprises	0.148	0.135	0.212
Irving Bank	0.151	0.144	0.093
Kansas City P&L	0.159	0.119	0.165
Kansas P&L	0.150	0.140	0.164
Murphy Oil	0.137	0.134	0.094
Olin	0.142	0.160	0.157
Premier Industrial	0.103	0.093	0.134
Rochester Gas & Electric	0.102	0.113	0.152
Rorer Group	0.105	0.108	0.065
Staley Continental	0.146	0.108	0.118
Telex Corp.	0.153	0.137	0.119
Average	0.131	0.118	0.136

again there is a *lower* overall level of the average correlations among the control sample firms than is the case among the MMI stocks. A statistical test for the equality of the pre-futures period correlations with those of both the transition and post-futures averages fails to reject the null hypothesis of no difference. In sum, the three-period analysis of the average correlations among the various member stocks in the MMI portfolio and the nonindex stocks indicates that program trading activities may well have increased the interrelationship among the affected index stocks.

By Calendar Years. The intertemporal nature of the MMI stocks' higher covariability is analyzed to determine if this shift is associated with increased index trading. To accomplish this, the index stocks' correlation matrices are recalculated for each calendar year. The individual and overall average correlation coefficients are reported in Table VI. In general, the average correlations exhibit an undulating pattern over the eight years. At the bottom of this table, after a peak of 0.458 in 1982, the overall average correlation across stocks trends lower until 1985. From there, the overall average correlation begins to escalate until it peaks in 1987 at 0.411.

Table VII contains the year-by-year average correlation results for the control sample. The magnitude of the average correlations are smaller than their MMI counterparts. The undulating pattern of average correlations found at the bottom of Table VI is evident in Table VII only during the early years of the test period. In fact, following 1984, the averages actually increase from 0.112 to 0.168. This trend is consistent with the earlier observation in Table V that the average correlation among the control sample stocks is 0.136 for the period July 24, 1984 through October 9, 1987 but 0.118 in the transition period. This finding suggests the possibility that smaller, nonindex stocks may have experienced the same type of secular increase in correlations as the MMI stocks but experienced it later.

Table VI

TRANSITIONAL PATTERN OF AVERAGE CORRELATION COEFFICIENTS OF THE INDIVIDUAL MMI STOCKS BY CALENDAR YEARS, 1980–1987

Company Name	1980	1981	1982	1983	1984	1985	1986	1987
American Express	0.358	0.327	0.505	0.289	0.393	0.335	0.403	0.345
American T&T[a]	0.264	0.267	0.425	0.264	0.291	0.322	0.398	0.406
Chevron	0.334	0.394	0.400	0.323	0.283	0.196	0.278	0.404
Coca Cola	0.283	0.283	0.430	0.293	0.411	0.228	0.422	0.439
Dow Chemical	0.376	0.375	0.447	0.337	0.380	0.320	0.390	0.420
DuPont	0.395	0.334	0.498	0.348	0.413	0.238	0.418	0.484
Eastman Kodak	0.374	0.417	0.523	0.231	0.332	0.315	0.318	0.411
Exxon	0.348	0.330	0.432	0.355	0.264	0.259	0.400	0.443
General Electric	0.406	0.406	0.548	0.375	0.465	0.397	0.470	0.513
General Motors	0.331	0.334	0.502	0.360	0.437	0.338	0.365	0.376
Int'l Bus. Machine	0.403	0.398	0.548	0.429	0.491	0.385	0.345	0.383
International Paper	0.325	0.310	0.446	0.283	0.353	0.224	0.357	0.418
Johnson & Johnson	0.314	0.358	0.440	0.270	0.332	0.262	0.363	0.495
Merck & Co.	0.352	0.235	0.414	0.277	0.317	0.312	0.390	0.398
3M	0.375	0.346	0.531	0.351	0.400	0.324	0.451	0.459
Mobil	0.276	0.283	0.398	0.342	0.262	0.178	0.295	0.355
Philip Morris	0.348	0.353	0.457	0.267	0.370	0.217	0.357	0.443
Procter & Gamble	0.328	0.266	0.454	0.264	0.335	0.222	0.403	0.433
Sears	0.328	0.327	0.518	0.386	0.375	0.327	0.427	0.402
USX	0.273	0.253	0.242	0.302	0.301	0.224	0.116	0.194
Average	0.340	0.330	0.458	0.317	0.360	0.281	0.368	0.411

[a]AT&T, which resulted from a court-ordered breakup of the Bell System, received about 23 percent of the former company's assets. Therefore, post-divestiture data after 1983 are not comparable to the pre-divestiture data.

Table VII

TRANSITION MATRIX OF AVERAGE CORRELATION COEFFICIENTS FOR SMALLER NONINDEX STOCKS BY CALENDAR YEARS, 1980–1987

Company Name	1980	1981	1982	1983	1984	1985	1986	1987
Alco Standard	0.130	0.053	0.137	0.085	0.089	0.130	0.185	0.138
Ames Dept. Stores	0.136	0.162	0.165	0.124	0.107	0.110	0.133	0.128
Analog Devices	0.156	0.124	0.124	0.163	0.163	0.087	0.133	0.182
Arkla	0.179	0.093	0.155	0.099	0.072	0.022	0.094	0.175
Boston Edison	0.143	0.091	0.140	0.096	0.106	0.168	0.155	0.189
Central Illinois P.S.	0.169	0.130	0.125	0.113	0.115	0.134	0.188	0.188
Delmarva P&L	0.172	0.106	0.144	0.073	0.133	0.137	0.207	0.207
Harsco Corp.	0.116	0.083	0.144	0.075	0.097	0.090	0.117	0.143
Idaho Power	0.146	0.134	0.140	0.124	0.053	0.136	0.213	0.194
IPALCO Enterprises	0.174	0.125	0.160	0.114	0.123	0.188	0.211	0.270
Irving Bank	0.172	0.135	0.172	0.126	0.131	0.110	0.191	0.052
Kansas City P&L	0.161	0.164	0.159	0.105	0.111	0.143	0.197	0.200
Kansas P&L	0.179	0.129	0.161	0.109	0.108	0.159	0.185	0.183
Murphy Oil	0.165	0.107	0.166	0.122	0.088	0.053	0.092	0.148
Olin	0.154	0.126	0.194	0.129	0.140	0.087	0.203	0.206

Table VII—Continued

Company Name	1980	1981	1982	1983	1984	1985	1986	1987
Premier Industrial	0.092	0.114	0.108	0.072	0.108	0.153	0.129	0.138
Roch. Gas & Elec.	0.108	0.105	0.095	0.096	0.131	0.151	0.176	0.158
Rorer Group	0.113	0.104	0.094	0.103	0.090	0.014	0.069	0.143
Staley Continental	0.182	0.100	0.118	0.111	0.090	0.116	0.107	0.188
Telex Corp.	0.147	0.159	0.153	0.090	0.178	0.099	0.150	0.110
Average	0.150	0.117	0.143	0.106	0.112	0.114	0.157	0.168

Table VIII
AVERAGE CORRELATION COEFFICIENTS OF THE INDIVIDUAL MMI STOCKS' RETURNS OVER HIGH VS. LOW INTENSITY PROGRAM TRADING DAYS, JANUARY 2–OCTOBER 9, 1987

Company Name	High Intensity Days[a]	Low Intensity Days	All Trading Days
American Express	0.415	0.311	0.345
American T&T[b]	0.569	0.348	0.406
Chevron	0.615	0.308	0.404
Coca Cola	0.532	0.403	0.439
Dow Chemical	0.598	0.344	0.420
DuPont	0.631	0.418	0.484
Eastman Kodak	0.572	0.356	0.411
Exxon	0.564	0.383	0.443
General Electric	0.645	0.455	0.513
General Motors	0.524	0.304	0.376
IBM	0.565	0.289	0.383
International Paper	0.547	0.364	0.418
Johnson & Johnson	0.643	0.424	0.495
Merck & Co.	0.550	0.341	0.398
3M	0.612	0.395	0.459
Mobil	0.567	0.248	0.355
Philip Morris	0.642	0.369	0.443
Proctor & Gamble	0.649	0.343	0.433
Sears	0.579	0.316	0.402
USX	0.360	0.150	0.194
Average	0.569	0.343	0.411

[a]"High Intensity Days" are defined to be those trading days in which program trading volume in shares was equal to or greater than four percent of the total New York Stock Exchange volume in shares; otherwise, they are defined as a "Low Intensity Day."

[b]AT&T, which resulted from a court-ordered breakup of the Bell System, received about 23 percent of the former company's assets. Therefore, post-divestiture date after 1983 are not comparable to the pre-divestiture data.

By Program Trading Intensity. Because program trading reached its zenith in 1987, the returns samples are dichotomized into high and low intensity program trading days to explore more closely the influence of program trading. The results of

Table IX
AVERAGE CORRELATION COEFFICIENTS FOR SMALLER NONINDEX STOCKS' RETURNS OVER HIGH VS. LOW INTENSITY PROGRAM TRADING DAYS, JANUARY 2–OCTOBER 9, 1987

Company Name	High Intensity Days[a]	Low Intensity Days	All Trading Days
Alco Standard	0.019	0.158	0.138
Ames Dept. Stores	0.145	0.121	0.128
Analog Devices	0.123	0.194	0.182
Arkla	0.199	0.169	0.175
Boston Edison	0.141	0.201	0.189
Central Illinois P. S.	0.228	0.203	0.210
Delmarva P&L	0.169	0.235	0.216
Harsco Corp.	0.168	0.139	0.143
Idaho Power	0.155	0.202	0.194
IPALCO Enterprises Util.	0.217	0.280	0.270
Irving Bank	0.198	0.036	0.052
Kansas City P&L	0.201	0.209	0.200
Kansas P&L	0.125	0.205	0.183
Murphy Oil	0.236	0.120	0.148
Olin	0.113	0.223	0.206
Premier Industrial	0.095	0.151	0.138
Rochester Gas & Elec.	0.081	0.182	0.158
Rorer Group	0.170	0.135	0.143
Staley Continental	0.178	0.196	0.188
Telex Corp.	0.007	0.175	0.110
Average	0.148	0.177	0.168

[a]"High Intensity Days" are defined to be those trading days in which program trading volume in shares was equal to or greater than four percent of the total New York Stock Exchange volume in shares; otherwise, they are defined as a "Low Intensity Day."

these tests are reported in Tables VIII and IX. An index of program trading intensity and daily measurements of this index are adopted from Grossman (1988). This index is defined as "...the total number of program orders (purchases plus sales, measured in shares) as a percentage of total NYSE orders."[8] As part of the Brady Commission study (1988), Grossman and the NYSE estimate the index or percentage values on a daily basis from January 2–October 30, 1987. This article defines a "high intensity program trading day" to be one in which program trading accounts for four percent or more of total volume. The period of study begins January 2, 1987 and ends October 9, 1987. Of the 196 trading days in the January–October period, 81 are classified as high intensity days; the remaining 115 days are designated as

[8]A second definition of program trading intensity used by Grossman is the number of program orders (in shares) as a percentage of Designated Order Turnaround (DOT) orders (in shares) for the day. The first definition is chosen for this study because there are program trades that do not use the DOT system and, hence, the second definition is not as broad or encompassing a measure of program trading activity, although the two index definitions are highly related. In fact, even these two measures are somewhat deficient in that program trades also occur off-exchange in the over-the-counter market or overseas on the London Stock Exchange.

low-intensity days. The median high intensity index value is 5.05 percent, with a range of 4.07 percent (June 1) to 18.94 percent (June 19). For the low intensity days, the median index value is 2.75 percent, with the lowest index value being 0.86 percent (March 10).

Table VIII presents the average correlations among the MMI stocks for all 196 trading days and for high and low program trading intensity days. Notice that the overall average correlation of 0.411 is simply the average reported earlier in Table VI for all of 1987. When the trading days are divided by degree of program trading intensity, however, the overall average correlations on high and low intensity days are 0.569 and 0.343, respectively. This provides strong evidence that program trading increases the index stocks' covariability. A paired sample, one-tailed t-test of high versus low intensity days with 19 degrees of freedom yields a statistically significant and higher correlation for each index stock, with a p-value beyond 0.1 percent. In addition, all 20 MMI stock's average correlations are higher on the high program trading intensity days.

Table IX contains the control sample results for the high versus low program trading intensity samples. The average correlations among these firms actually *declines* for the high program trading intensity days. In fact, there are only seven instances when the average correlation for a particular firm is higher for the high program trading intensity days. In the remaining 13 cases the average correlation among the control firms decline on the high program trading intensity days. Here the results strongly suggest that the increased correlation among the MMI stocks is associated with program trading activities and is not a result of a market wide or secular trend toward higher correlation among individual firm's stock returns.

CONCLUDING COMMENTS

This research examines more closely whether the advent of index futures and options trading in 1982 has led to an increase in index stocks' daily return covariation. Because program trading strategies involve the simultaneous buying/selling of a portfolio of index stocks, the systematic relationship between price changes in these stocks and the general market may have increased in the post-futures period. Synchronous trading also may have led to a higher degree of comovement among index stocks' prices. The empirical evidence supports a sizable and statistically significant increase in percentage systematic risk for the MMI and its component stocks relative to the market. An increase in average correlation among index stocks also is found that appears to be linked to increased program trading activities. The evidence finds that nonindex stocks do not exhibit a similar pattern of increased correlations. This suggests that program trading may primarily affect larger capitalized stocks in market indexes such as the MMI and S&P 500. One reason is that such stocks are integral components of any program trade, whereas nonindex stocks are not.

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