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MARKET VOLATILITY: CAUSES AND CONSEQUENCES

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Recent studies have argued that stock market volatility is not constant over time. For example, Schwert[1] has estimated monthly volatility from 1836 to 1987. Figure 1†† displays his estimates. Schwert measures volatility by calculating the standard deviation of daily returns for each month for a portfolio of stocks. As Figure 1 illustrates, volatility is very high during the Great Depression—the standard deviation is frequently above ten percent, compared to a normal range of two to six percent. Volatility was also greater during the 1857 and 1907 recessions and during the OPEC oil crisis. Schwert concludes that these are predictable and persistent changes in the level of volatility.

In this paper, I want to address two basic questions: (1) What can be said about the causes of the volatility changes; and (2) Why do we care how volatile these prices are?

I
CAUSES—THE LONG RUN

The first important question is whether volatility changes simply reflect changes in other markets. For example, is there a similar pattern in exchange rate volatility, interest rate volatility, or commodity price volatility? While I do not have data that covers the 150-year period that Schwert collected, Figure 2 presents data from 1967 to 1987: Figure 2a shows the variability of the dollar relative to foreign currencies (the breakdown of the Bretton Woods agreement in the early 1970s stands out clearly in this data); Figure 2b shows what has happened to interest rates; Figure 2c displays the variability in iron and steel prices; and Figure 2d shows volatility in

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1 G. SCHWERT, WHY DOES STOCK MARKET VOLATILITY CHANGE OVER TIME? (University of Rochester Working Paper GPB 87-11, 1989).

†† All Figures are contained in an appendix to this paper.

crude oil prices.[2] No statistically reliable association exists among these series.

Another concern is the relation between macroeconomic variables and market volatility. Schwert has performed a careful statistical analysis of the relations between market volatility and a number of macroeconomic variables.[3] He finds: (1) stock market volatility is higher during recessions, especially during the Great Depression; (2) weak evidence that macroeconomic volatility—as measured by industrial production and business failures—can help predict stock volatility; (3) stronger evidence that financial asset volatility helps predict future security market volatility; and (4) financial leverage affects stock market volatility.

The relation between volatility and leverage is not surprising. If a firm has fifty percent debt in its capital structure and the value of its assets goes up by one percent, the value of the equity will rise by twice that as long as the riskiness of the debt has not changed. If the increase in asset value reduces the risk of the debt and increases its value, then the change in equity value from a change in the value of the firm's assets will be reduced, but the general positive relation will hold. Schwert finds that time series variation in financial leverage does increase stock market volatility, but that the explanatory power provided by this variable is small.

Finally, there seems to be a relation between trading activity and stock volatility. Such a relation is consistent with the proposition that sophisticated traders infer information from other traders' actions.[4]

II

CAUSES—EVIDENCE FROM THE OCTOBER 1987 CRASH

Studying data over a long period of time, as Schwert did, provides one way to understand volatility; looking at a shorter period in much greater detail provides another. Because of its extreme volatility, many researchers have focused on the October 1987 market crash as a way to understand volatility from a complementary perspective. For instance, it has been widely suggested that the operation of the financial futures markets in Chicago increased volatility in the stock market.[5] The allegations usually focus on the role that programmed trading, portfolio insurance and triple witching hours

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2 Interestingly, oil price volatility has been relatively stable compared to fluctuations in iron and steel prices.

3 G. SCHWERT, *supra* note 1.

4 *See* Black, *Noise*, 41 J. FIN. 529 (1986).

5 This has been forcefully stated in the New York Stock Exchange report on the October crash.

had in contributing to the market crash. Figure 3 shows monthly volatility from 1984 to 1988: the little spikes that periodically appear are triple witching hours—those times when the expiration of futures contracts and options contracts coincide. No significant correlation exists between triple witching hours and stock market volatility.

Additionally, the relation between market volatility and changes in futures trading volume must be considered. Figure 4 shows average trading volume on the S&P 500 index futures contract. Here, volume is measured as just the number of longs or the number of shorts—although in one sense the aggregate amount of trading is always zero, for every long there must be a short. Statistical analysis of the data in Figure 4 indicates that changes in volatility are not associated with changes in futures trading volume.

Next, the relation between market volatility and the futures index must be examined. Blume, MacKinlay and Terker[6] have carefully documented what happened to prices in New York and Chicago during the October 1987 crash. The S&P 500 fell twenty percent on October 19th. However, not all stocks were being traded that day. IBM, which represents eight percent of the S&P index, did not open until 10:45 a.m. Only ninety percent of the stocks were being traded as of 11:00 a.m. In addition, the tape was running between 15 and thirty minutes late. Basically this meant that anyone trading on the published S&P index was using outdated information. The evidence suggests that the traders in Chicago were not fooled by the misleading index—they appear to have made their trades based on what they thought the index would have been if quotes from New York were timely. Consequently, I believe the futures index was a more accurate reflection of market conditions than the reported S&P index.

Roll[7] has studied different markets around the world and documented substantial variation in the rules governing the various markets. By comparing what happened in London, Tokyo, Sydney, Hong Kong, Singapore, Paris, and other world markets he has determined how the presence or absence of certain rules affected each market during the crash.[8] Roll tried to analyze how the various in-

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6 M. BLUME, A. MACKINLAY & B. TERKER, ORDER IMBALANCES AND STOCK PRICE MOVEMENTS ON OCTOBER 19 AND 20 (University of Pennsylvania Working Paper, 1988).

7 Roll, *The International Crash of October 1987*, in BLACK MONDAY AND THE FUTURE OF FINANCIAL MARKETS 35 (R. Kamphuis, R. Kormendi & J. Watson ed. 1989).

8 First, Roll notes that all major markets declined substantially during the month of October. Of the 23 countries that he examined, 19 had declines of greater than twenty percent. The United States had the fifth smallest decline when measured in local currency units, but since the dollar also declined during this period its decline was eleventh smallest when restated to a common currency. Roll also determined that the

stitutional market characteristics are related to the extent of the market crash. Several of those are associated with larger price declines—the existence of a continuous auction process and automated quotations. Others lessened the impact of the crash—the presence of specialists and the existence of computer-directed trading. Still others were statistically unrelated to the extent of the decline—forward trading, options and futures trading, transactions taxes, off-exchange trading, price limits, and margin requirements. Roll finds no evidence to support the notion that program trading and portfolio insurance adversely affected the United States market during the crash.

III
CONSEQUENCES OF STOCK VOLATILITY

Let us now turn to the second question: Why do we care about volatility? I think there are at least four reasons: (1) an expected increase in volatility will increase the expected risk premium and thereby affect a firm's cost of capital;[9] (2) greater volatility in firm value increases the compensating differential required to retain corporate managers;[10] (3) the value of incentive compensation tools like stock options is reduced as aggregate market volatility increases;[11] and (4) what I consider to be the biggest problem, increased volatility gives people in Washington an excuse to "fix" the markets.

Politicians have faced a strong challenge to proposals for active intervention in security markets over the past twenty years from the proponents of the efficient markets hypothesis. The idea started with Cowles[12] who noted the inability of professionals to forecast stock price changes; and statisticians like Working,[13] Kendall[14] and Osborne[15] who suggested that stock prices and commodity prices

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United States market was not the first to decline: non-Japanese Asian markets began the decline, followed by European markets, then North American markets, and finally Japanese markets.

9 French, Schwert & Stambaugh, *Expected Stock Returns and Volatility*, 19 J. FIN. ECON. 3 (1987).

10 Smith & Stulz, *The Determinants of Firm's Hedging Policies*, 20 J. FIN. QUANTITATIVE ANALYSIS 391 (1985).

11 Smith & Watts, *Incentive and Tax Effects of U.S. Executive Compensation Plans*, 7 AUSTRALIAN J. MGMT. 139 (1982).

12 Cowles, *Can Stock Market Forecasters Forecast?*, 1 ECONOMETRICA 309 (1933).

13 Working, *A Random Difference Series for Use in the Analysis of Time Series*, 29 J. AM. STAT. ASSOC. 11 (1934).

14 Kendall, *The Analysis of Economic Time Series, Part 1: Prices*, 96 J. ROYAL STAT. SOC. 11-25 (1953).

15 Osborne, *Periodic Structure in the Brownian Motion of Stock Prices*, 10 OPERATIONS RESEARCH 345 (1962); Osborne, *Brownian Motion in the Stock Market*, 7 OPERATIONS RESEARCH 145 (1959).

behave like a random walk—that is, stock price changes behave as if they were independent random drawings. This was followed by Samuelson[16] and Mandelbrot[17] who provide the modern theoretical rationale for the efficient markets hypothesis. They argue that in a competitive securities market, price changes must reflect new information. Since, by definition, new information cannot be deduced from previous information, new information must be independent over time. This hypothesis is probably the most extensively tested proposition in the social sciences, and the evidence is amazingly consistent with its predictions.[18]

Yet the October 1987 crash caused many to argue that the efficient markets hypothesis must be incorrect. I believe that this argument represents flawed logic for at least three reasons: (1) The efficient markets hypothesis does not imply that volatility is constant. While the academic community has yet to provide a convincing explanation of the causes of the October crash, that should not be evidence against the efficient markets hypothesis. Logically, ignorance in the academic community cannot be evidence either for or against a particular hypothesis. What has been requested in this case differs fundamentally from what the academic community has heretofore supplied. Typically, in testing the efficient markets hypothesis, academics have examined an event which should be associated with a change in cash flows or risk and documented a concomitant stock price change. Here, academics are being asked to look at a stock price change and explain what caused it. Collectively, we have little experience in answering this question. (2) A large stock price change does not require a single large piece of information. If underlying events are correlated, then relatively small current events can produce large stock price reactions. (3) In certain cases, it is questionable to focus on abnormally large observations. For example, if I have a theory that explains the observations around the mean but does not explain extreme outliers, it can still be a useful model. At the bottom line, it takes a theory to beat a theory.

IV
PROPOSALS TO "FIX" THE SECURITY MARKETS

Finally, I would like to talk about some of the proposals to "fix"

16 Samuelson, *Proof That Properly Anticipated Prices Fluctuate Randomly*, 6 INDUS. MGMT REV. 41-49 (1965).

17 Mandelbrot, *Forecasts of Future Prices, Unbiased Markets, and Martingale Models*, 39 J. BUS. 242 (1966).

18 *See* E. FAMA, FOUNDATIONS OF FINANCE (1976) for a review of much of the evidence.

the security markets. One proposal is to create a single agency with regulatory authority over all interrelated financial markets to facilitate market coordination. However, I believe that this is a proposal to create a governmental regulatory monopoly. Now, if someone proposed granting IBM a monopoly in computers, the outrage would be widespread. Yet if a monopoly is bad in the private sector why is it a good thing in the public sector? Proponents argue that a single agency would facilitate the coordination of markets. However, in the mid-1970s, the SEC regulated both options trading and stock trading on the Philadelphia exchange. Because of their concern about market manipulation, they required that a wall be built on the trading floor to separate the option and stock trading. I do not see how the creation of one master agency will get regulators to focus on coordinating markets at all.

This proposal also assumes that regulatory agencies have the ability to recoguize ill-functioning markets and to implement corrective policies on a timely basis. The Federal Reserve has argued that it employs its authority to set margin requirements to stop "unwarranted speculation" when there is an upswing in the market. When the market returns to normal, the Fed generally claims that its actions were successful in correcting the problem. But basic financial theory tells us that abnormal returns will be bid away regardless of any restraints imposed on the market. Schwert[19] examines the effect on market volatility of the Fed's changes in margin requirements and finds that increases in the margin requirement are associated with prior increases in volatility, but that increases in margin have no predictive ability with respect to future changes in volatility. Therefore the evidence suggests the Fed can accurately look back and document what has happened, but they have no apparent ability to affect future volatility. Such evidence makes me question any other government agency's ability to do better.

The second proposal is the establishment of "circuit breakers" in the market. Some argue that since prior limits already exist in the futures markets, this would merely be taking a good idea from one market and applying it in a new area. However, I believe that we must be very careful to distinguish between price limits voluntarily adopted by an exchange and those externally imposed by a regulatory agency. The NYSE has strong incentives to choose a set of operating rules which maximize its value. Thus I must conclude that if there were a way to increase the attractiveness of the exchange to traders by imposing price limits they would already have been im-

19 G. SCHWERT, *supra* note 1.

plemented; if it did not, it would risk losing trades to competing exchanges offering more efficient rules.

Brennan[20] argues that price limits in futures markets serve as a partial substitute for posting margins. To understand his argument, consider the Brazilian coffee freeze of a few years ago and its impact on futures markets. Traders became aware of the freeze in their morning papers and knew that spot and futures prices were going to go up. On the first day of trading, prices rose until the price limit was reached. If I had written coffee futures I might have owed $2000 for the day. On the second day the same thing happened: the price limit was reached and I would owe another $2000. The same thing might happen on the third and fourth days until the new market-clearing price was reached, so that overall I would have owed $8000. Now if I knew in advance that I was going to lose $8000, I might simply default on the transaction on the first day. But price limits restrict the information about equilibrium coffee prices, thus I do not know what the final market-clearing price is to be. Therefore, Brennan argues, I would be less likely to default on the contract. Brennan's argument implies that this mechanism will not work in markets where investors can calculate forward prices and determine for themselves the new equilibrium price. Thus, price limits are not typically applied to interest rate futures, where future prices can be inferred from bond prices. If Brennan's explanation for the use of price limits is correct, then imposing them on stock markets will simply reduce the liquidity of the market. And even though the limits might be set so that they are imposed infrequently, they have their greatest impact at precisely those times when participants want to trade the most.

In sum, given our current state of knowledge of the causes of stock market volatility, I believe that the case for active intervention in the marketplace is weak. In my opinion, most of the proposed changes in the operation of the market have the potential to do as much harm as good. Given the competition we face in world capital markets, I would hope that we do not regulatorily saddle United States markets with an onerous regulatory burden simply to provide the appearance of doing something.

20 Brennan, *A Theory of Price Limits in Futures Markets*, 16 J. FIN. ECON. 213 (1986).

APPENDIX

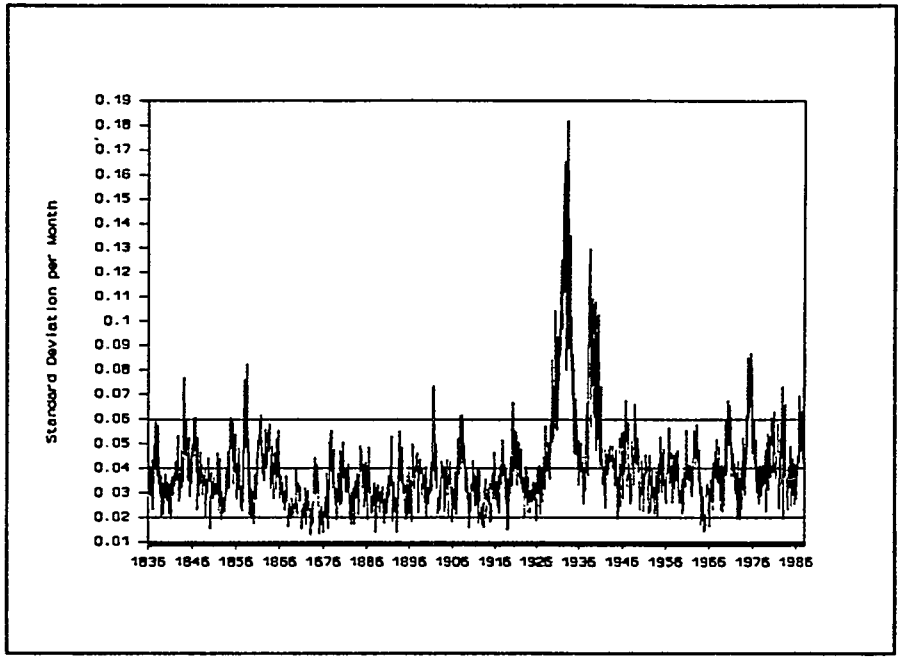


Fig. 1: Standard deviations of monthly stock returns, 1836-1987 from Schwert 1988.

Fig. 2a

Variability of 90 day US treasury bill yield
(Vertical axis: Proportionate scale)

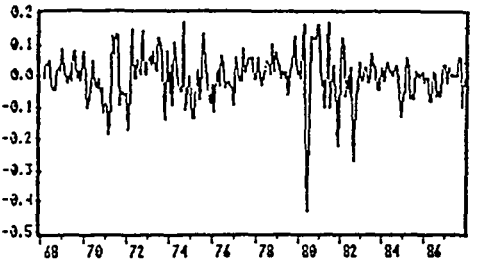


Fig. 2b

Variability of weighted-average value of
US $ in terms of foreign currencies
(Vertical axis: Proportionate scale)

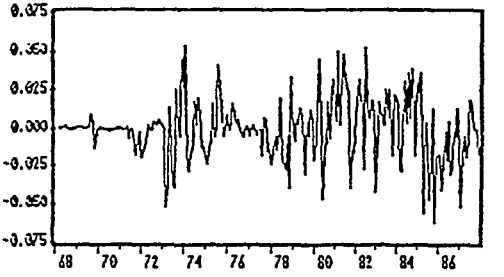


Fig. 2c

Variability of iron and steel prices
(Vertical axis: Proportionate scale)

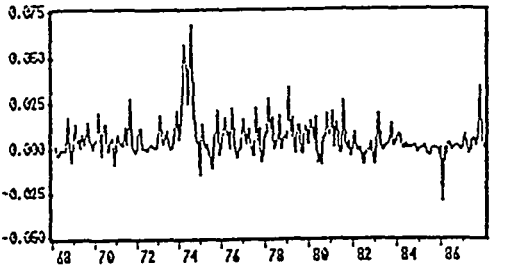
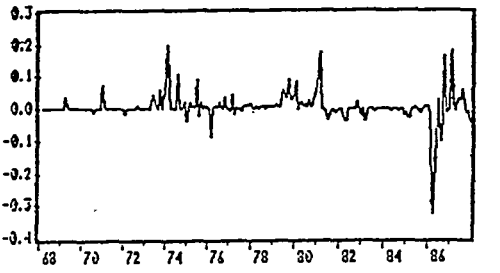


Fig. 2d

Variability of crude petroleum price
(Vertical axis: Proportionate scale)



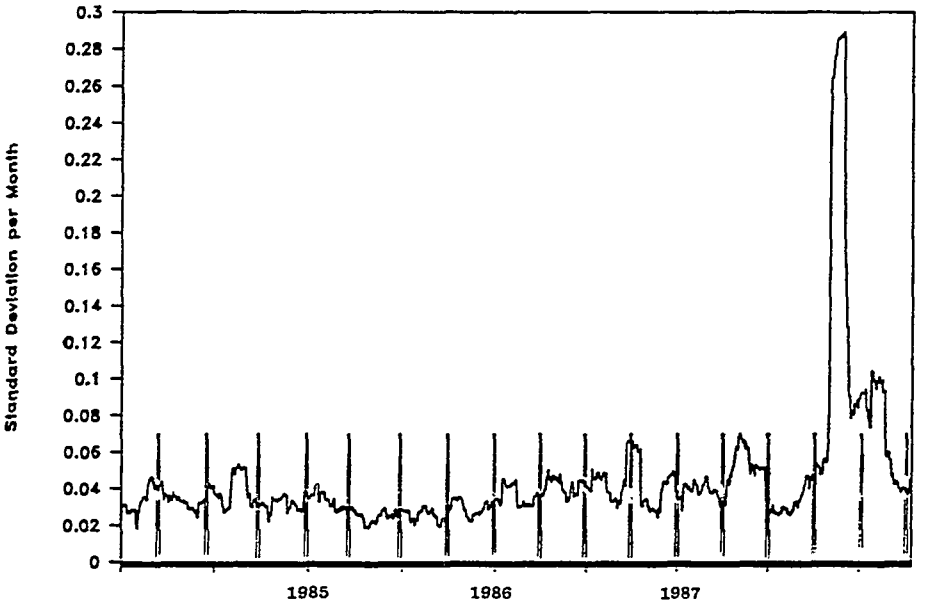


Fig. 3: Estimates of monthly S&P volatility based on last 20 daily returns from 1984 through 1987

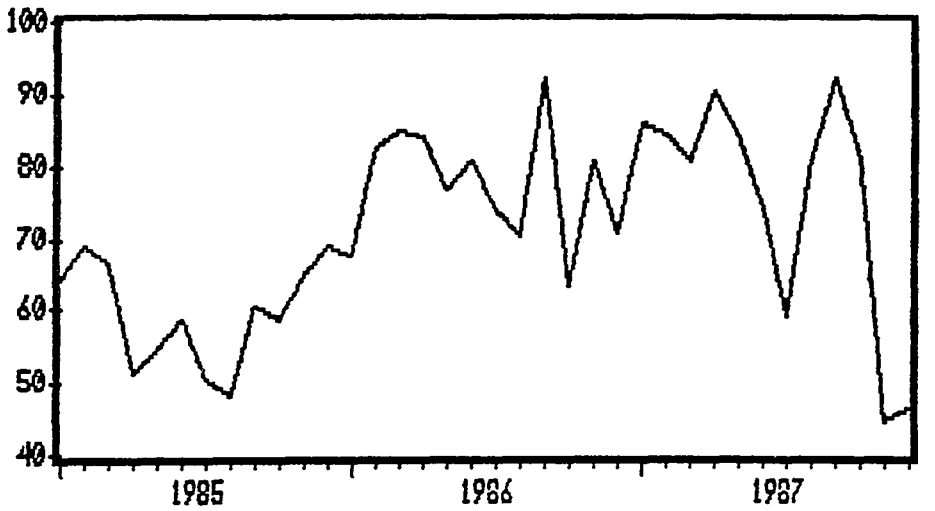


Fig 4: Average daily trading volume on S&P 500 Index futures contracts (in thousands)