INFORMATION MEMORANDUM

November 28, 1988

TO: The Commission

FROM: The Office of Economic Analysis

SUBJECT: Margin Requirements and Stock Market Volatility

PERSONS TO CONTACT : Jeff Davis (272-2850)

I. INTRODUCTION

A recent article published by the Federal Reserve Bank of New York [Gikas A. Hardouvelis, "Margin Requirements and Stock Market Volatility," FRBNY Quarterly Review (Summer 1988), pp. 80-89] finds a significant inverse relationship between the level of margin requirements and volatility of the stock market. The article concludes that "the results...support the contention that increases in margin requirements reduce market volatility."

We have reviewed the study and believe that its methodology is flawed and its conclusion is unwarranted. In particular, we find that the use of moving averages to create overlapping annual observations exaggerates the statistical significance of the findings. An alternative setup (suggested by the author) that uses non-overlapping observations fails to yield statistical significance for the claimed relationship between the margin level and volatility. Also, the results reported in the study are far too sensitive to the estimation period to be considered reliable. That is, the statistically significant findings reported in the article do not survive testing over alternative estimation periods. Instead, the reported relationship appears to draw its significance almost entirely from the inclusion of data from the 1930s. This means that the relationship between the margin level and volatility (as posited in the study's model) is either unstable or non-existent.

II. DESCRIPTION OF THE STUDY

Discussion of theory is held to a minimum in the article. Essentially, the article asserts that margin requirements reduce volatility by restricting destabilizing speculation. It then notes some disagreement among economists over the issue of whether speculation can be destabilizing and concludes that the issue can only be resolved empirically.

After a brief discussion of the factors that may influence the Fed to change the margin requirement, the study proceeds to develop a model to explain stock market volatility. The measure of volatility used in the model is the standard deviation of the monthly rate of return on a portfolio of stocks, including dividends and adjusted for inflation. Two separate portfolios are used. One consists of the stocks in the Standard & Poor's Composite Index, and the other is made up of the ninth and tenth deciles of NYSE stocks ranked by capitalized values.

The variables included in the model to explain volatility are (1) the volatility measure lagged 12 months, (2) the standard deviation of the monthly percentage change in the industrial production index, (3) the standard deviation of the monthly rate of return on corporate bonds, (4) a measure of stock price trend, and (5) the official margin level. 1/ A simpler model, using only the official margin level as an explanatory variable is also reported. All of the variables in the model, including the dependent variable, are calculated over moving twelve-month periods. The volatility measure for October 1935, for example, is the standard deviation of monthly stock returns calculated over the period from November 1934 through October 1935, and the margin level for October 1935 is the average margin level over the same 12 months.

The parameters of the model are estimated over two sample periods : December 1931-December 1987 and October 1935-December 1987. We do not repeat the parameter estimates; it is sufficient for our purposes to note the findings with respect to the average margin level. For both estimation periods, both portfolios of stocks, and both the one-variable and the multiple-variable models the study finds statistically significant negative coefficients for the margin variable.

III. CRITIQUE

We confine our critique of the study to two key points that we think are most telling. First, the use of moving averages to create observations raises questions about the significance of the statistics generated by the model. Second, the instability of the parameter estimates for the model over time cast doubt on the validity of the findings.

1/ The study also reports findings for a slightly different specification of the model. The only difference is that the measure of volatility is the standard deviation of the nominal monthly rate of return of stocks minus the one-month T-bill rate at the end of the previous month. The author refers to this measure as "volatility of monthly excess nominal stock returns." In fact, it is nearly identical to his other measure of volatility, as demonstrated by the nearly identical regression results. All of our comments apply equally to either specification of the model.

The Moving Average Process

As noted above in the description of the study, the author created monthly observations for his variables by calculating either an average or a standard deviation over the twelve months ending with the observation month. The observation for December 1958, for example, is made up of averages (or standard deviations) of the monthly data for January 1958 through December 1958. The next observation, for January 1959, is created by deleting the data for January 1958, substituting the data for January 1959, and recalculating the averages. The data for January 1959 would be included in each of the subsequent observations until January 1960. Thus, each month's data is used twelve times instead of just once. The result is a series of overlapping annual observations.

Since the observations are really annual, the process described above essentially creates twelve times the number of independent observations available. This exaggerates the power of any statistical tests performed on the data. The author, in fact, acknowledges that "the use of overlapping data provides more statistical power but also creates some technical difficulties." 2/ In a footnote he explains how he overcomes these "technical difficulties" and notes that "An alternative setup would be a nonoverlapping annual sample with both stock return volatility and the average margin calculated from January to December." 3/

Perhaps the best way to illustrate the effect of using the overlapping observations is to try the alternative setup suggested by the author and compare the results with those reported in the article. The resulting coefficients, shown in Table 1, are very similar to the results reported in the study, but the statistical significance of these coefficients is very different. 4/ The only variable that remains statistically significant for both portfolios is the standard deviation of the percentage change in the Industrial Production Index. For neither portfolio is the coefficient for the margin level statistically significant.

A previous study (by R. R. Officer) of the relationship between margins and volatility employed a moving average process

---

2/ P. 84.

3/ Footnote 18, p. 84.

4/ The estimation period used is October 1935-December 1987. The study also used December 1931-December 1987, but we think it is inappropriate to use observations prior to the imposition of official margin requirements and assume a zero level of margins.

TABLE 1

REGRESSION RESULTS USING NONOVERLAPPING SAMPLE
1935-1987

Dependent Variable = Standard Deviation of Returns
(t-statistics in parentheses)

Independent Variables	S&P Composite	Small Stocks
Constant	0.042 **	0.049
	(2.16)	(1.34)
Average Margin	-0.025	-0.034
	(1.32)	(1.05)
Lagged Standard Deviation of Return	0.241	0.496 ***
	(1.59)	(3.43)
Standard Deviation of % Change in Ind. Prod. Index	0.783 ***	1.054 **
	(3.19)	(2.41)
Standard Deviation of Corp. Bond Returns	0.323 *	0.304
	(1.83)	(1.08)
Price Trend	-0.009	-0.013
	(0.77)	(0.65)
Adjusted R-squared	0.292	0.513

* Statistically significant at the 10% level.
** Statistically significant at the 5% level.
*** Statistically significant at the 1% level.

to create the variables used in his model. 5/ Officer's study, however, did not use all of the observations in his regression analysis; he used only the ones for the one-year period following a change in the margin level (or, in a separate specification of the model, the one-year period preceding the change). His model, therefore, used only 20 observations. Besides the change in the margin requirement, his model also included the change in the standard deviation of industrial production. Only the latter variable was found to be statistically significant in explaining volatility. Based on the fact that Officer reported a negative coefficient for his margin variable, Hardouvelis simply states that Officer "found a negative association " between margins and volatility. 6/ He fails to note that the association was not statistically significant, and, more importantly, he ignores Officer's conclusion that "the change in the 1-year standard deviation of the market for the year before a change in the margin requirement shows a closer relationship with the change in the margin requirement than for the same regression but for the year following the change in the margin requirement." 7/ In fact, Officer's findings of statistical insignificance for the hypothesized relationship between volatility and margin requirements are consistent with the results reported in Table 1.

Instability of the Parameter Estimates

A model which claims to capture a relationship between two variables should yield reasonably consistent results when its parameters are estimated over different periods of time. This is particularly important when one of the variables is controlled by policy makers for the purpose of affecting the other variable. If the results are not consistent, then the relationship found in one period cannot be relied upon to hold in any other period, and the policy maker cannot predict the effects of his actions to change the policy variable. If the reasons for the different results are well understood, then the model can be modified to account for the differences over time. If the reasons are not understood, then the model is of little use to the policy maker and may, in fact, mislead him, producing results opposite of what he seeks and expects.

5/ R. R. Officer, "The Variability of the Market Factor of the New York Stock Exchange," 46 Journal of Business 434 (July 1973).

6/ P. 83.

7/ Officer, pp. 438-439 (emphasis in original). It should be noted that in neither of Officer's regressions is the coefficient for the change in the margin level statistically significant; so it cannot fairly be concluded, as Officer concludes, that the one relationship is stronger than the other.

Hardouvelis' study claims to have found a statistically significant negative relationship between margin levels and volatility. His estimation periods begin in 1931 and 1935; both include at least portions of the Great Depression and extreme volatility in the stock market that has not been repeated, even in 1987. His longer estimation period, which includes the 20 percentage point volatility of 1932 and 1933, produces considerably stronger results than his shorter period, which still includes the double digit volatility of 1938 and 1939. 8/ Moving from the longer period to the shorter period results in more than halving the margin level coefficient for the S&P portfolio and nearly halving that for the small stock portfolio. This, of course, is due to the fact that the 1932-1933 volatility enters the model with a zero level of margins.

There are a number of possible interpretations of the big difference in the margin level coefficient between the two estimation periods. The author appears to be satisfied that both are significantly negative. It is troubling, however, that the inclusion or exclusion of a few years, particularly at the beginning of the estimation period, could make such a big difference in the measured power of a policy variable. It raises questions about the results that might be produced if other estimation periods are used. With this in mind, we re-estimated the model for the S&P portfolio over three sub-periods.

We broke the October 1935-December 1987 period into two pieces : October 1935-December 1940 and January 1941-December 1987. This was done in order to illustrate the importance of the unusually high volatility in 1938-1939. Then, we used the period from February 1944 through January 1975, which includes all but the first two changes in the margin requirement. This period is particularly interesting because it excludes the Depression but brackets the years during which the Fed actively altered the margin requirement, presumably to effect policy. During this 31-year span the Fed changed the margin requirement 20 times. If the margin level has an effect on volatility, we would expect to observe that effect during this period. The results are shown in Table 2. 9/

8/ The average volatility is 5.0% over the longer period and 4.2% over the shorter period.

9/ Table 2 also shows our regression results for the entire October 1935-December 1987 period. Our coefficients are very slightly different from those reported by Hardouvelis, presumably due to small data errors in our database or his, or both. Our t-statistics, however, are much larger than his, because ours are not adjusted for the "technical difficulties" he describes in his footnote 18. We do not yet have the software to make the adjustment, but the nature of the adjustment is such that our t-statistics are overstated.

TABLE 2

REGRESSION RESULTS

Dependent Variable = S&P Composite Standard Deviation of Returns
(t-statistics in parentheses)

Independent Variables	Oct.1935-Dec.1987	Oct.1935-Dec.1940	Jan.1941-Dec.1987	Feb.1944-Jan.1975
Constant	0.050 (10.10)	0.384 (7.73)	0.045 (10.84)	0.038 (7.24)
Average Margin	-0.026 (5.38)	-1.024 (7.38)	-0.008 (1.89)	-0.002 (0.33)
Lagged Standard Deviation of Return	0.185 (4.94)	-0.448 (3.56)	0.045 (1.16)	0.007 (0.13)
Standard Deviation of % Change in Ind. Prod. Index	0.870 (13.94)	1.654 (6.64)	0.317 (5.32)	0.255 (4.50)
Standard Deviation of Corp. Bond Returns	0.267 (5.88)	-0.774 (1.53)	0.343 (9.49)	0.477 (6.07)
Price Trend	-0.013 (4.54)	0.131 (5.44)	-0.011 (4.49)	-0.008 (2.37)
Adjusted R-squared	0.399	0.763	0.209	0.194

Note : T-statistics shown above have not been corrected for conditional heteroskedasticity or the moving average process of the error term.

Comparing the first and second columns of Table 2, we see that the measured effect of margins on volatility is nearly four times greater from October 1935 through December 1940 than it is from October 1935 through December 1987. Even more striking is a comparison of the October 1935-December 1940 results with the results for January 1941-December 1987 (the third column of the table); the shorter period's coefficient for the margin variable is well over 100 times that for the longer period! 10/ These results very strongly indicate that, at best, the relationship between margins and volatility is itself extremely volatile.

Further evidence tending to cast doubt upon Hardouvelis' findings appears in the last column of Table 2, which contains the results for February 1944-January 1975. For this period of active adjustment of the margin level the coefficient associated with the margin level is statistically insignificant. 11/ This result, taken with the results in the other three columns of Table 2, suggests that Hardouvelis' findings are largely the product of the coincidence of the unusual volatility of the Depression and the low margin levels at the introduction of margin requirements.

IV. REVISED STUDY

On November 16, 1988, Gikas Hardouvelis presented a revised study at an OEA workshop. The revised study reported three changes in methodology. First, the set of explanatory variables in the model was changed. Second, the study added an alternative measure of volatility. And, third, some additional tests were performed.

With respect to first change, since we have not criticized the author's choice of explanatory variables, this change does not alter our criticisms. The method of generating observations (that is, the moving average process) remains the same, and, therefore, so does our criticism. Furthermore, the author acknowledged at the OEA workshop that when he tested his model over sub-periods of his sample period the margin variable failed to pass the standard significance tests. 12/

10/ Furthermore, it is clear that if we adjusted our t-statistics in the same manner as Hardouvelis, the coefficient for the margin level would not approach statistical significance for the period of January 1940-December 1987.

11/ Again, if adjusted to take into account the difficulties introduced by the moving average process, the t-statistic would be even smaller and less significant.

12/ The author's response to questions about the apparent instability of his model was that he could not exclude any of his sample period because he had only 22 "effective" observations, a

(continued...)

We haven't yet performed any of our own tests using the alternative measure of volatility in the revised study. But the author's admission that the use of sub-periods produced insignificant results means that our criticism applies to his model using either measure.

Finally, the additional tests included in the revised study are intended to supplement the model's results, but they tend to simply repeat the same errors. For example, one of his regressions purports to show that excess volatility is more prominent during periods of low margin requirements. 13/ However, he defines periods of low margin requirements to be periods when the margin requirement was less than 50 percent. The last time the margin requirement was below 50 percent was February 1945. Thus, what his regression finds is nothing more than that volatility was "more prominent" before 1945, which is the essence of our criticism. What the study needs is some evidence that the "relationship" between margin requirements and volatility is not produced entirely by the extraordinarily high volatility of the 1930s, which was produced largely by the same economic conditions that produced federally imposed margin requirements.

V. CONCLUSION

We do not conclude from our critique of Hardouvelis' study that margin requirements have no effect on volatility. All we conclude is that his work does not provide reliable evidence of such an effect.

12/(...continued)
reference to the 22 times the margin level has been changed. His concern seemed to be that the loss of any of these observations would greatly reduce the explanatory power of his model. However, his model does not use changes in the margin level; rather, it uses the level itself. Thus, he employs not 22 observations, but 627 observations. If he believes that the "effective" power of his model is defined by these 22 "effective" observations, then his statistical tests should not rely on over 600 degrees of freedom.

13/ P. 15.