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Stock Market Volatility and Corporate Investment

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Abstract

Despite concerns are often voiced on the so called "excess volatility" of the stock market, little is known about the implications of market volatility for the real economy. This paper examines whether the stock market volatility affects real fixed investment. The empirical evidence obtained from the US data shows that market volatility has independent effects on investment over and above that of stock returns. Volatility and its changes are negatively related to investment growth. To the extent volatility depresses fixed capital formation and hence future income growth, the results suggest the desirability of reducing stock market volatility.

JEL Classification Numbers
E22, G13, G28

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Contents

Summary

A huge amount of work in macroeconomics and finance has been devoted to examining the "excess volatility" of stock market prices relative to fundamentals. Few studies, however, have explored the implications of stock market volatility for the real sector of the economy, such as its likely impact on corporate investment.

While standard asset pricing models and the q theory of investment imply a strong relationship between investment and stock market prices, they do not allow a link between stock market volatility and real investment. There are several possible channels, however, for stock market volatility to affect the investment decisions of firms. First, if the stock market price is "too volatile" and substantially deviates from fundamentals, as is frequently claimed, investors may be less willing to hold equities, which tends to raise the cost of capital and depress investment. Second, if the stock market undervalues a firm's capital, then the firm's dominant strategy will be to buy existing plant and equipment instead of installing new capital. Then, a lot of mergers and acquisitions, but little new investment, will take place. Third, high volatility may reduce the role of the stock market as a forecasting mechanism and induce firms to systematically ignore volatile short-run changes in stock prices in making long-term investment decisions, so that the stock market becomes only a sideshow for the real economy. Furthermore, stock market volatility may affect investment through its effects on timing, because fixed-investment projects are usually irreversible.

The paper examines the empirical relations between stock market volatility and real investment. Using U.S. data, it finds a strong relationship between the stock market and investment, contradicting the "irrelevant hypothesis." In other words, stock market volatility has not induced firms to ignore the stock market completely in making real investment decisions. The most notable finding in the paper is that there exists a strong negative association between stock market volatility and real investment. This result is robust to sample splitting and formal testing as well as to the use of additional control variables such as the q variable and changes in stock prices. While the evidence of a negative correlation highlights the desirability of reducing stock market volatility, it does not necessarily, in the absence of an established causal link, provide unambiguous support for policy proposals aimed at reducing stock market volatility.

I. Introduction

The past decade saw an explosion of literature on testing the stock market efficiency. In his seminal paper, Shiller (1981) argues that the stock market price exhibits "excess volatility" relative to fundamentals, which is believed to be inconsistent with the market efficiency hypothesis. Subsequent studies have been largely devoted to either validating the "excess volatility" claim or investigating the sources of market volatility. Surprisingly, few have ever attempted to explore the implications of stock market volatility for the real sector of the economy, such as its likely impact on firms' investment decisions.

According to Tobin's q theory, capital investment depends on the ratio of the market's valuation of capital to the cost of acquiring new capital--the q ratio. The growth of investment then relates to the changes in q. Since the change in stock market prices is the most important source of variation in q, stock prices should then have strong effects on capital investment. This association has been well documented by Fama (1981, 1990), Fischer and Merton (1984), Barro (1990), and Cochrane (1991). However, the empirical literature on investment has largely ignored the "second moment effect", that is, how the stock market volatility, in addition to stock returns, may affect real investment. The goal of this paper is to investigate the relation between stock market volatility and the economy's fixed capital investment.

This paper is organized as follows. Section II reviews the theoretical arguments why the stock market volatility, not just mean stock returns, might have strong effects on firms' real investment decisions. Section III presents evidence for the empirical relation between stock market volatility and aggregate investment. Section IV briefly discusses the implications of our finding. The last section concludes the article.

II. The Stock Market and Investment

The view that the stock market price plays an important role in determining firms' real investment in new plants and equipment can be traced back to Keynes (1936), who observed that "the daily revaluations of the Stock Exchange, though they are primarily made to facilitate transfer of old investments between one individual and another, inevitably exert a decisive influence on the rate of current investment. For there is no sense in building up a new enterprise at a cost greater than that at which a similar existing enterprise can be purchased; whilst there is an inducement to spend on a new project what may seem an extravagant sum, if it can be floated off on the Stock Exchange at an immediate profit". The essence of Keynes' arbitrage argument is captured by Tobin's q theory of investment, which states that the rate of investment is determined by the ratio of the market valuation of firm's capital stock to its replacement cost--the q ratio.

The standard asset pricing theories (Merton (1973a), Rubinstein (1976), Lucas (1978), Breeden (1979), and Brock (1982)) imply that the stock market valuation of a firm's common share is determined by investors' rational forecast of fundamentals such as corporate dividends, earnings, and profits, therefore also suggest a strong association between the stock market price and firms' new investment.

Empirical results (see von Furstenberg (1977), Clark (1979), and Summers (1981), among others) indicate that q has explanatory power for investment, consistent with both Tobin's q theory and equilibrium asset pricing models. However, q is not a sufficient statistic for investment, and other variables, such as production and corporate profits, also have predictive power over and above that of q. Moreover, it appears that changes in stock market prices outperform the standard q-variable as a predictor of investment, as noted by Barro (1990).

Blanchard, Rhee and Summers (1993), on the other hand, express skepticism regarding the role of the stock market valuation in firms' investment decisions when there exist large deviations between the market valuation and the managers' own assessment of fundamentals. They found that, given managers' own forecast of fundamentals, the market valuation does not matter much for the determination of investment.

So far the focus of attention has been on the relation between mean stock market returns and investment growth. By contrast, the current study is interested in the question whether the stock market exerts a "second moment" effect on investment, or alternatively, whether managers will take the market volatility into account when they make investment decisions. While we have learnt a great deal about the validity of the market efficiency hypothesis from Shiller-type variance bound exercises, it seems that the broader macroeconomic implications can not been completely grasped without going a step further to examine the effect of "excess volatility" on the real economy.

The most important function of the stock market is to raise equity capital for corporations. If stock prices rationally reflect fundamental values, the stock market can then serve as a forecasting mechanism for firms and investors to guide the process of capital allocation. If, however, stock prices substantially deviate from fundamentals, as, for example, when they are largely driven by fads and noise trading (Shiller (1984), Summers (1986)), or if the stock market price is too volatile, then investors may be less willing to hold equities, which tends to raise the cost of capital and depress investment. Similarly, if the stock market undervalues the firm's capital, then the firm will find it a dominant strategy to buy existing plants and equipment instead of building up new capital. One will then see a lot of mergers and acquisitions taking place but little new investment.

A second possible effect of "excess volatility" is to make stock market valuation irrelevant to firms' real investment decisions. As Bosworth (1975) argues, "as long as management is concerned about long-run market value and believes that this value reflects 'fundamentals', it would not scrap investment plans in response to the highly volatile short-run changes in stock prices." If firms systematically ignore the changes in stock prices in making their investment decisions, we should then expect to see a very weak relation between stock price changes and investment. In other words, high volatility will make the stock market only a sideshow for aggregate investment.

A third channel for the stock market volatility to affect investment is through its effects on the timing of investment. Since fixed investment projects are usually irreversible, risk factors regarding the costs and benefits of the projects and the more general macroeconomic uncertainty will play an important role in determining investment. If the firm cares about its total market value, and has the option as to when to actually launch the risky investment project, then the volatility of the project's market value affects the optimal timing of investment. With greater volatility the firm can often increase its total market value by delaying the capital investment project. 1/ In the aggregate we may then see less investment at any point in time because of greater market volatility.

Consider a firm facing the decision whether to invest in a new project. Let us assume that the project entails a fixed amount of initial capital expenditure, i_0. The stock market valuation of the project, V(t), is uncertain, with a total expected rate of return $\mu > 0$, 2/ and a proportional dividend payout to the firm, $D(V_t) = \delta V_t$, where $0 < \delta < \mu$. For simplicity, assume that V_t follows an exponential Brownian motion process with constant drift and diffusion parameters:

$$dV_t = (\mu V_t - D(V_t))dt + \sigma V_t dB_t \qquad (1)$$

Since the investment is irreversible, and its market value is random, the firm wishes to time the undertaking of the project so that to realize maximum possible value of its investment. We can think of the firm's problem as an optimal stopping problem. Indeed it is analogous to the familiar problem in finance about when to exercise a perpetual, dividend-paying American options contract, where the underlying asset is the project

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1/ Brennan and Schwartz (1985), McDonald and Siegel (1986), and Pindyck (1988) applied the methodology of options pricing to project valuation and capital investment decisions. Their work demonstrated that the option of waiting (i.e., the option of delaying a project) is more valuable to the firm the greater the underlying uncertainty so that optimal investment rules differ from the "net present value (NPV)" rule usually applied in the simple certainty case.

2/ The rate of return, μ, is determined by the capital market equilibrium conditions. For example, it can be given by the classical Sharp-Lintner CAPM model.

with value V_t, and the exercise price is the sunk cost, i_0. 1/ Let W(V) denote the value of the option--that is, the value of waiting to invest by the firm. It is straightforward to obtain the optimal exercise (investment) policy:

$$\frac{\partial W(V^*)}{\partial V} = 1 \tag{2}$$

where $V^* = V^* (r, \delta, \sigma, i_0)$ is the critical value at which it is optimal for the firm to pay the sunk cost i_0 and undertake the investment project. Upon launching the investment project, the profit the firm obtains is $V^* - i_0$, which is equal to the terminal value of the option of waiting, $W(V^*)$, as stated in the boundary condition equation (A3). The value-maximizing firm desires to acquire the largest terminal value possible when it exercises the option, that is, when the firm pays the sunk cost, i_0, and becomes the owner of the capital stock of the new project, which has a market value V^* upon exercising. The optimal exercise policy stated by equation (2), therefore, is just the first-order condition for maximizing the option's terminal value $W(V^*) = V^* - i_0$ (i.e., the boundary condition equation (A3)). This first-order condition, called the high-contact condition in finance, 2/ is stated as the third boundary condition in Appendix I (equation (A4)). Note that the option of waiting is more valuable the greater the volatility of the project value. With higher σ^2 the firm wishes to delay the project until a higher critical value V^* is reached. Because of this optimal inertia caused by increased volatility, the actual amount of investment by the firm could be reduced.

The message from the example above pertains to an individual firm's investment decisions. Whether the market volatility, by inducing optimal waiting, decreases equilibrium investment at an aggregate level, is an empirical matter. There may be other forces at work so that the simple option of waiting to invest is no longer so valuable. If the project has strategic value to the firm, for instance, it may be optimal for the firm to launch the investment immediately or it may lose the investment opportunity to its competitors.

The next section examines the empirical relation between the stock market volatility and aggregate investment. The central questions to be investigated are as follows: (i) does the stock market volatility make

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1/ Even if the value of the investment project is known with certainty, for example, when it is fixed at a constant level, V_0, but the fixed cost of investment, is stochastic, the whole analysis below will still go through. In this case, the project is formally analogous to a financial option with stochastic strike price.

2/ It is better known as the "smooth-pasting" condition in international economics, as, for example, in the recent literature on exchange rate target zones.

changes in the stock market price irrelevant to firms' investment decisions? and (ii) does the stock market volatility reduce corporate investment?

III. Evidence

1. Stock market volatility

We use the monthly excess returns of the value-weighted New York Stock Exchange (NYSE) composite portfolio to estimate stock market volatility for 1926-90. 1/ The risk-free rate used to construct the monthly excess returns is the one-month treasury bill yield from the Ibboston and Sinquefield database. There are 780 observations. Since numerous studies have shown that stock market volatility is time-varying, (see Poterba and Summers (1986), French, Schwert and Stambaugh (1987), among others), we use two closely related formulations to model the time-dependent conditional heteroskedasticity. The first formulation is a generalized autoregressive conditional heteroskedasticity (GARCH) model and the estimated GARCH(1, 1) parameters are (with t-statistics in parenthesis):

$$R_{mt} = \underset{(4.8415)}{0.0078} + \varepsilon_t, \qquad \varepsilon_t \mid \Omega_{t-1} \sim N(0, h_t) \tag{3}$$

$$h_t = \underset{(3.2463)}{0.8133 * 10^{-4}} + \underset{(6.0049)}{0.1212}\, \varepsilon^2_{t-1} + \underset{(44.1643)}{0.8544}\, h_{t-1} \tag{4}$$

Log of likelihood function = 1256.32

Note that the sum of estimated GARCH parameters in Equation (4) (that is, the coefficients of the past innovation and the past conditional variance, respectively) is close to 1, suggesting that the volatility process is an integrated GARCH process. We also fit an autoregressive conditional heteroskedasticity-in-mean (ARCH-M) model, which jointly estimates the conditional variance and the relation between expected risk premium and variance of the market portfolio. The estimated model (with t-statistics in parenthesis) is presented below :

$$R_{mt} = \underset{(4.0103)}{0.1532}\, h_t^{1/2} + \varepsilon_t, \qquad \varepsilon_t \mid \Omega_{t-1} \sim N(0, h_t) \tag{5}$$

$$h_t = \underset{(24.1734)}{0.0025} + \underset{(1.6134)}{0.0049}\, \varepsilon^2_{t-1} + \underset{(3.2318)}{0.0236}\, \varepsilon^2_{t-2} + \underset{(2.1645)}{0.0124}\, \varepsilon^2_{t-3} \tag{6}$$

log of likelihood function = 1151.35

1/ We also used returns on the Standard and Poor's Composite Stock Index to estimate market volatility and the resulting volatility estimates are closely comparable to those obtained from the returns on the value-weighted NYSE composite portfolio.

Figure 1 and Figure 2 plot the volatility (monthly standard deviation) estimates from the GARCH(1, 1) model and from the ARCH-M model, respectively. The corresponding summary statistics are given in Table 1. The mean value of the predicted conditional variance from the GARCH(1,1) model corresponds to a standard deviation of 19.7 percent per year, close to the estimate by Ibboston and Sinquefield. The volatility series predicted by GARCH(1,1) has larger mean and standard deviation than those predicted by ARCH-M model, and shows less severe skewness and kurtosis. However, the GARCH(1,1) volatility series has strong autocorrelation, which decays more slowly than the autocorrelation of the ARCH-M volatility. In any case, it turns out that the conclusions we draw about the relation between stock market volatility and investment are the same regardless of which series to be used. We therefore report only the set of results obtained by using volatility estimates from the GARCH(1,1) model.

2. <u>The relation between stock market returns and investment</u>

Investment, I_t, is the real fixed, nonresidential, private domestic investment, which corresponds more closely to the stock market than other types of investment spending such as residential housing and outlays on human capital. The annual series is from 1929 to 1992. The summary statistics for $\Delta \ln(I_t)$, the logarithmic difference of real investment, along those for stock returns and estimated stock market volatility, are given in Table 1. Panel a of Figure 3 plots the investment growth and the return on the value-weighted NYSE index. The visual impression indicates the presence of a strong relation between stock returns and investment growth, and this is confirmed by the basic regression results for investment equation, presented in Table 2. The first equation column regresses investment growth on the contemporary and lagged stock returns, while the second column uses as regressors the changes in q, which is taken from Blanchard et al. (1993). Although the coefficient of $\Delta\ln(S_t)$, the current stock returns, has a high p value (0.92), $\Delta\ln(S_{t-1})$ --the lagged stock returns--is highly significant, with a coefficient of 0.57. The Chow test shows that the investment equation column (1) based on stock returns exhibits sample stability. Stock returns also appear to have more explanatory power than the q variable, corroborating the previous evidence, see, for example, Barro (1990). The results are essentially the same if we replace total stock returns with capital gains return (i.e., excluding dividends) on the value-weighted NYSE stock portfolio.

These simple facts contradict the "irrelevant hypothesis". Apparently, the excess stock market volatility has not induced firms to completely ignore the stock market in making real investment decisions. The finding of a strong relation between the stock market price and investment, does not necessarily imply that stock prices rationally reflect fundamental values. The point is that, even if managers know for sure that stock price movements are not in the right direction relative to changes in fundamentals, managers can do better by modifying their investment plans according to the "incorrect" stock price changes, as emphasized by Fischer and Merton (1984). For instance, if the manager has inside information about the future value of their new investment project and correctly estimate the rate of return

Figure 1. Stock Market Volatility Estimated From GARCH Model (1926-90)

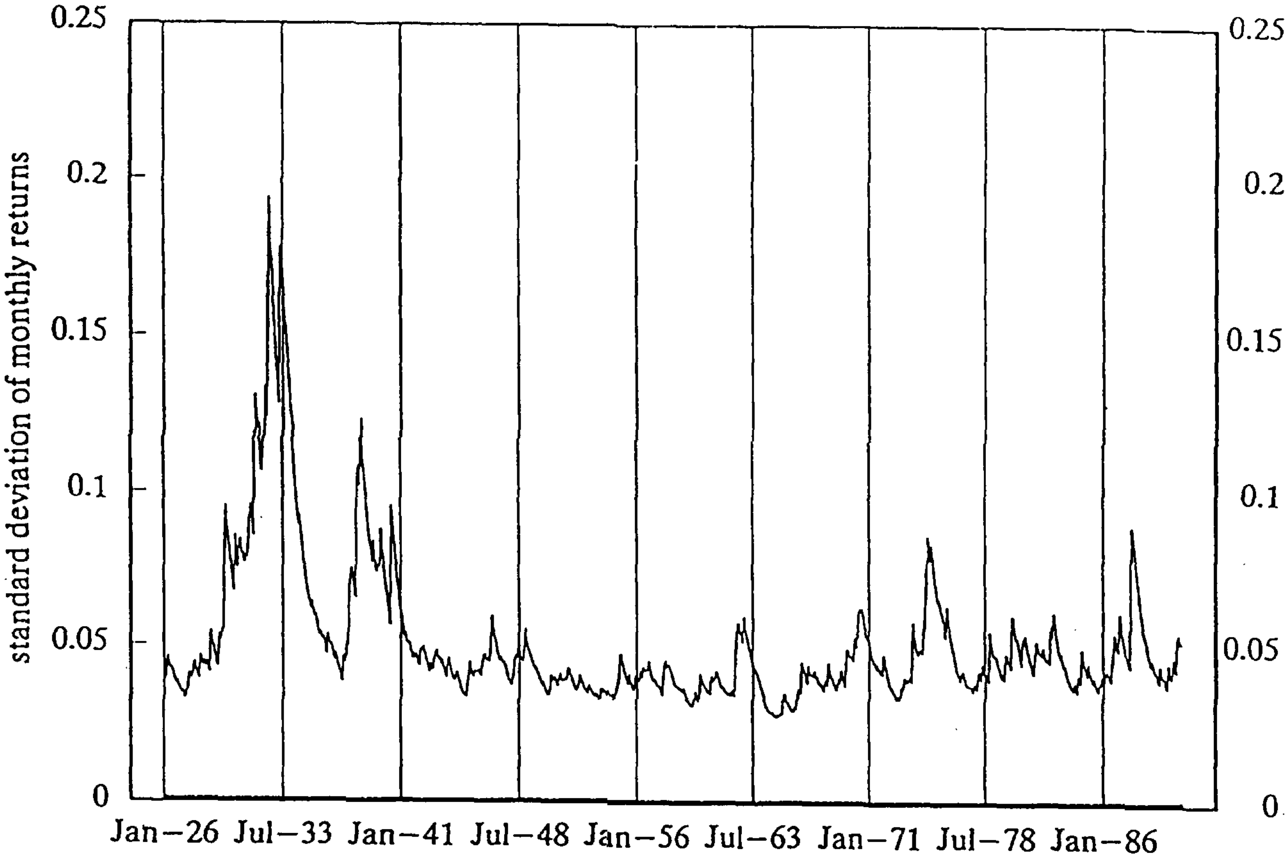


Figure 2. Stock Market Volatility Estimated From ARCH-M Model (1926-90)

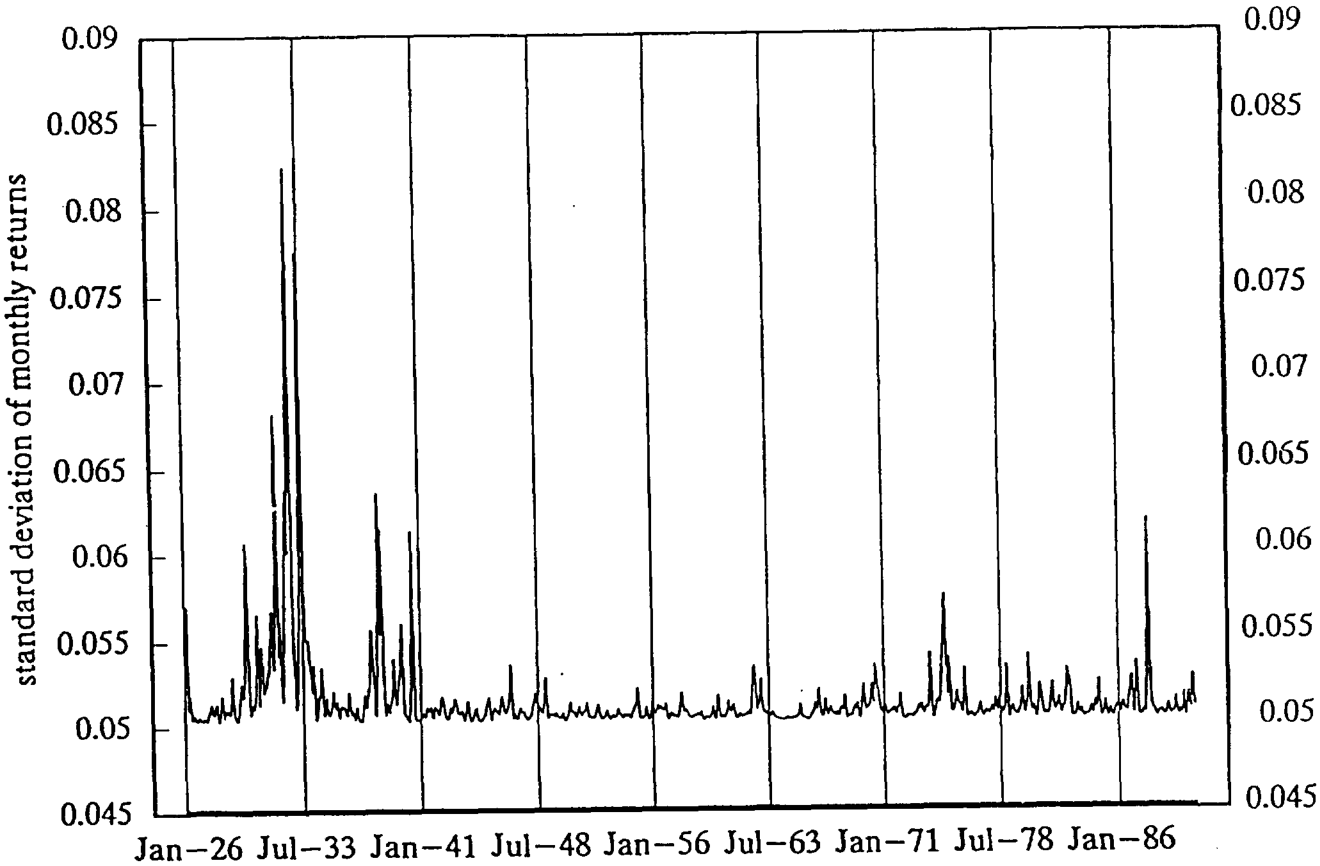
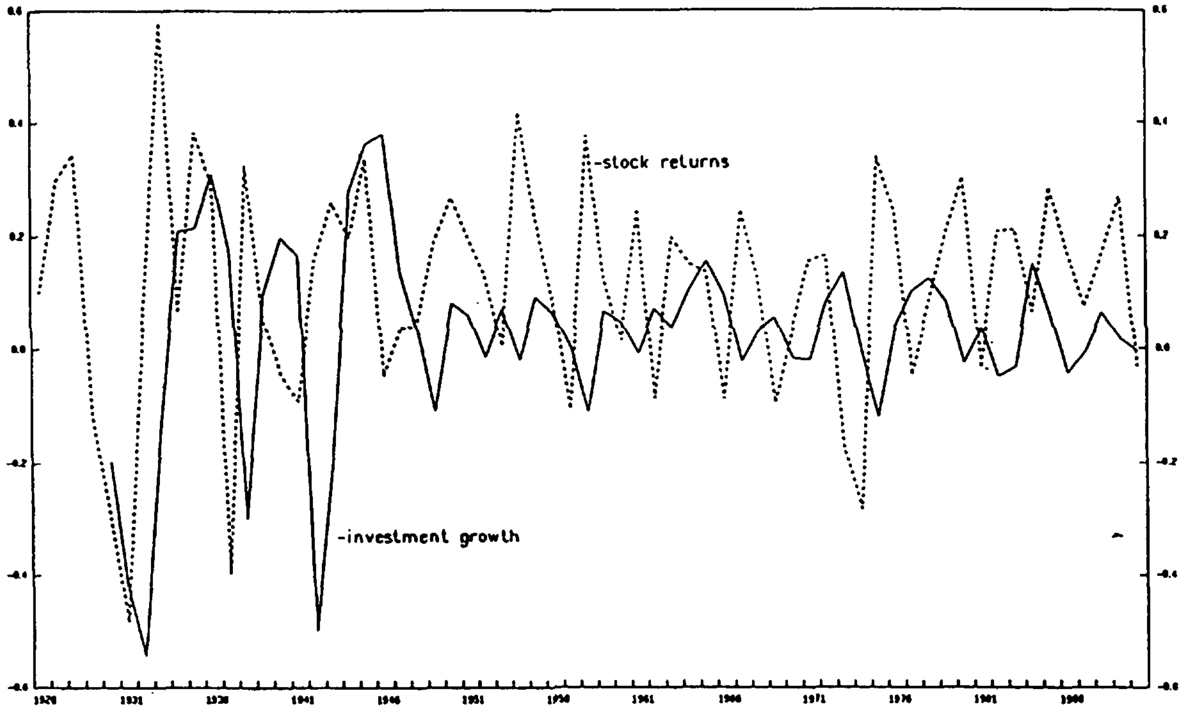


Figure 3. The Stock Market and Investment (1926-90)

Panel a. Stock Returns and Investment



Panel b. Market Volatility Changes and Investment

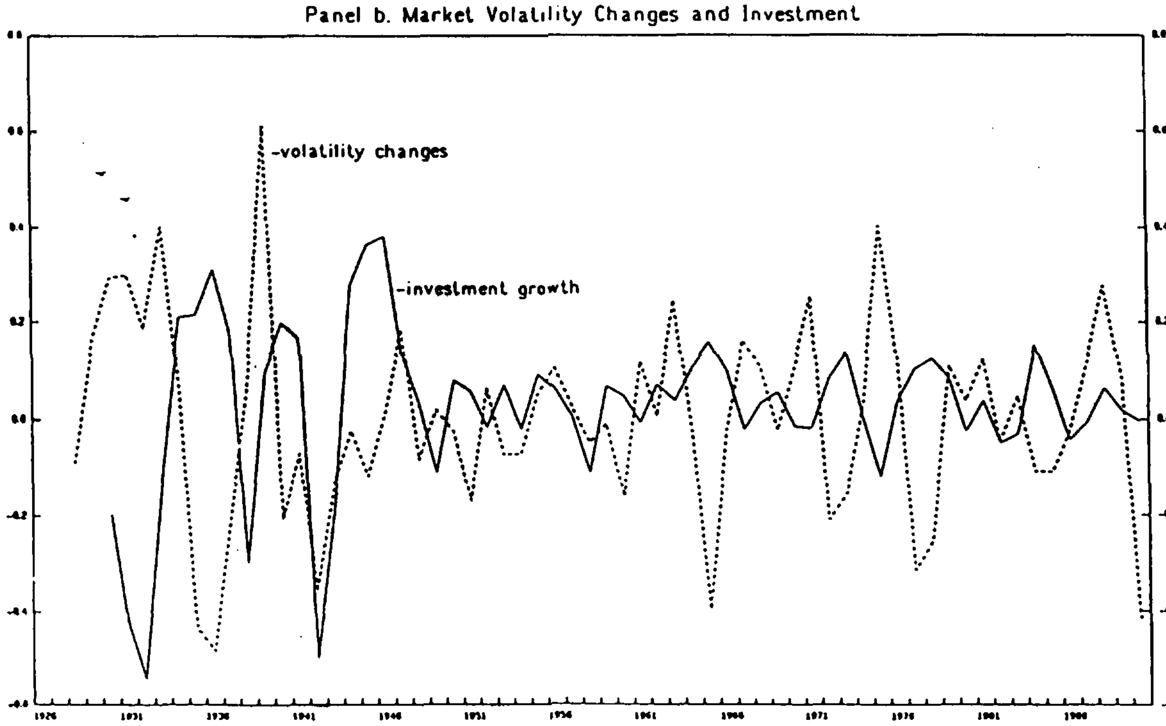


Table 1. Summary Statistics of Investment Growth, Stock Market Returns and Volatility

Sample period	1930-90 $\Delta \ln (I_t)$	Jan. 1926 Dec. 1990 $\Delta \ln (S_t)$	Jan. 1926 Dec. 1990 h^a_t	Jan. 1926 Dec. 1990 h^b_t
Mean	0.02749	0.00935	0.00323	0.00266
Standard deviation	0.17102	0.05659	0.00419	0.00032
Minimum	-0.54218	-0.29001	0.00077	0.00253
Maximum	0.38096	0.38275	0.03757	0.00678
Skewness	-1.15842	0.27943	4.41329	7.35570
Kurtosis	2.98823	7.88772	23.15208	70.80359
$\rho(1)$	0.429	0.109	0.963	0.728
$\rho(2)$	-0.150	-0.0171	0.920	0.417
$\rho(3)$	-0.314	-0.127	0.884	0.327
$\rho(4)$	-0.151	0.0143	0.845	0.248
$\rho(5)$	-0.0353	0.0774	0.814	0.183
$\rho(6)$	-0.0156	-0.0283	0.795	0.197
$\rho(7)$	-0.0256	0.0049	0.785	0.297
$\rho(8)$	-0.146	0.0416	0.782	0.445
$\rho(9)$	-0.0204	0.0820	0.765	0.478
$\rho(10)$	0.261	0.0084	0.735	0.427
$\rho(11)$	0.281	-0.0260	0.703	0.386
$\rho(12)$	0.0414	-0.0026	0.659	0.299

1/ $\Delta \ln(I_t)$ is the first difference of the log of the real private fixed investment, I_t, $\Delta \ln (S_t)$ is the value-weighted NYSE return, h^a_t is the variance of stock market return estimated from GARCH (1, 1) model, and h^b_t is the variance of stock market return estimated from ARCH-M model.

Table 2. Stock Market and Investment: Mean Effect

Forecasting variable	(1)		(2)	
	β	p value	β	p value
$\Delta \ln(S_t)$	-0.0089	0.919		
$\Delta \ln(S_{t-1})$	0.5691	0.000		
$\Delta \ln(q_t)$			0.2701	0.003
$\Delta \ln(q_{t-1})$			0.4229	0.000
R^2	0.411		0.388	
Chow test	2.4824	0.070	2.6625	0.057

1/ Dependent variable is $\Delta \ln(I_t)$. "β" gives OLS slope coefficients, "p value" gives probability values for two-sided tests of the slope coefficients and for other listed test statistics. Data sample is 1930-90.

from undertaking the project to be 15 percent; but a wave of unjustified pessimism of stock market participants has depressed the stock market price so that the expected stock market return becomes 20 percent; then instead of ignoring the irrational stock market and undertaking the capital project anyway, the rational manager should realize higher return by calling off the project and instead purchasing equity shares of his own firm or from other firms at the "irrationally" low market share prices. Furthermore, even if one accepts the view that fads, animal spirits, and social psychology can move stock prices, as argued by some economists (Shiller (1984), Summers (1986)), stock prices should still retain predictive power for real investment, for there are good reasons to believe that the same factors --fads, animal spirits, etc.,--that move stock prices also likely affect real capital investment.

3. <u>The stock market and investment: The "second moment" effect</u>

We now turn to the question whether the stock market volatility, in addition to mean stock returns, can affect real investment. Standard theories of investment are either completely silent on this issue or unable to offer unambiguous answer to it.

Table 3 looks at the relation between volatility and investment growth over the period from the era of the Great Depression up to 1990. Equation (1) regresses investment growth on two volatility measures, the contemporary and lagged variances of stock returns. It turned out that both volatility variables, especially the lagged variance, are significant with negative coefficients. They explain about 24 percent of the variation of investment growth. One possible factor that justifies the explanatory power of volatility is that it is merely a proxy for stock returns. The standard asset pricing models give a relation between excess market returns and market volatility (see Merton (1973a, 1980)). 1/ The volatility measures retain predictive power for investment, however, even after the stock return variables are explicitly included in the investment equation (column 2). Furthermore, the relation between stock volatility and investment appears stable over the sample period from 1926 to 1990, and controlling the stock returns by using the q-variable (column 3) gives similar results. The likelihood ratio tests indicate that investment equations that include only the stock return variable but omit volatility of stock returns are mis-specified.

The fact that stock market volatility enters investment equation significantly seems somewhat puzzling. Standard theories of investment, such as Tobin's q theory, do not allow this variable to play a role. As reviewed in Section II, however, several plausible channels for stock market volatility to affect investment can be listed. When stock market volatility is high, investors will be reluctant to hold corporate stocks

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1/ It is worth noting that the relation between expected market return and market volatility does not stand well empirically. See French et al. (1987) for evidence.

Table 3. Stock Market and Investment: Second Moment Effect

Forecasting variable	(1)		(2)		(3)	
	β	p value	β	p value	β	p value
h_t	-0.1159	0.057	-0.1233	0.032	-0.0706	0.186
h_{t-1}	-0.2209	0.001	-0.1089	0.029	-0.1084	0.051
$\Delta \ln(S_t)$			-0.1461	0.110		
$\Delta \ln(S_{t-1})$			0.3752	0.000		
$\Delta \ln(q_t)$					0.1885	0.041
$\Delta \ln(q_{t-1})$					0.3677	0.000
R^2	0.238		0.449		0.433	
Chow test	2.521	0.067	1.970	0.112	2.402	0.050
χ^2 (2)			12.788	0.000	11.251	0.004

1/ Dependent variable is $\Delta \ln(I_t)$. "β" gives OLS slope coefficients, "p value" gives probability values for two-sided tests of the slope coefficients and for other listed test statistics. $\chi^2(2)$ is the likelihood ratio test for the joint significance of volatility measures. Data sample is 1930-90.

since investors may not be compensated for all of the risk they bear. Indeed the empirical relation between market risk premium and volatility is tenuous at best, see the evidence provided by French et al. (1987). Lower investor demand for common stocks will in turn make it more costly for firms to make new investment financed by equity. It is often suggested that high volatility is a symptom of inefficiency of the stock market. When the stock maret prices do not rationally reflect fundamental values, there might be a tendency for the stock market to consistently undervalue firms' capital. It may be optimal for firms to purchase existing plants and equipment rather than to install new plants and equipment. Under such circumstances, one can observe the ownership of existing capital changing hands in the market for corporate control, but little new capital formation. Since much of fixed investment is irreversible, an analogy to financial options reveals that the option of waiting to invest (i.e., delaying an investment project) may be valuable if the market valuation is highly volatile. The evidence that stock market volatility is negatively associated with investment is consistent with firms' optimizing behavior in making irreversible investment decisions under uncertainty. In addition, if stock market prices change excessively in the short run, firms may find it difficult to make long-term investment plans based on the information provided by the stock market.

We also examine the empirical relation between stock market volatility and investment over a sub-sample period that excludes those years of the World War II. The results are shown in Table 4. The evidence for the negative association between stock market volatility and investment growth is stronger when the war years are excluded.

Table 5 presents regression results using postwar quarterly data. It is noteworthy that the explanatory power of current and lagged stock returns disappears but volatility remains highly significant. This suggests that the level of stock returns may be of only secondary importance as a determinant of aggregate investment, especially at high frequency; stock market volatility may be more important for high frequency investment changes.

There also exists close association between changes of stock market volatility and investment. Figure 2, panel b, indicates strong negative comovement of volatility changes and investment growth, where volatility changes are the yearly changes in standard deviation of stock returns. As can be seen from Table 6, the lagged volatility change is highly significant in the investment equation.

IV. Discussions

There exists a huge literature providing evidence for the presence of "excess volatility" in the stock market and its underlying causes. Though it has been noted that the stock market volatility is related to the volatility of macroeconomic variables such as inflation, money growth and industrial production, the large swings of the stock market volatility cannot been fully explained by macroeconomic fluctuations (Schwert (1989)).

Table 4. Stock Market Volatility and Investment: Excluding World War II Period

Forecasting variable	(1)		(2)		(3)	
	β	p value	β	p value	β	p value
h_t	-0.1212	0.013				
h_{t-1}	-0.1639	0.000	-0.1632	0.000	-0.0987	0.019
$\Delta \ln(S_t)$			0.0025	0.941		
$\Delta \ln(S_{t-1})$			0.4366	0.000		
$\Delta \ln(q_t)$					0.2304	0.002
$\Delta \ln(q_{t-1})$					0.3287	0.000
R^2	0.348		0.574		0.503	
χ^2 (1)			16.601	0.000	6.066	0.014

1/ Dependent variable is $\Delta \ln(I_t)$. "β" gives OLS slope coefficients, "p value" gives probability values for two-sided tests of the slope coefficients and for other listed test statistics. $\chi^2(1)$ is the likelihood ratio test for the significance of volatility measures. Data sample is 1930-90.

Table 5. Stock Market Volatility and Investment: Evidence From Quarterly Data

Forecasting variable	(1)		(2)		(3)	
	β	p value	β	p value	β	p value
h_t	-0.0465	0.003	-0.0371	0.024	-0.0415	0.011
h_{t-1}	-0.0537	0.001	-0.0554	0.001	-0.0572	0.000
$\Delta \ln(S_t)$			0.0398	0.192		
$\Delta \ln(S_{t-1})$			0.0383	0.161	0.0336	0.250
R^2	0.101		0.107		0.103	
Chow test	1.708	0.167	2.299	0.047	2.778	0.029
χ^2 (2)			18.660	0.000		

1/ Dependent variable is $\Delta \ln(I_t)$. "β" gives OLS slope coefficients, "p value" gives probability values for two-sided tests of the slope coefficients and for other listed test statistics. $\chi^2(2)$ is the likelihood ratio test for the joint significance of volatility measures. Data sample is 1947:Q3-92:Q4.

Table 6. Stock Market Volatility Changes and Investment

Forecasting variable	(1)		(2)		(3)	
	β	p value	β	p value	β	p value
$\Delta \ln(vol_t)$	-0.2997	0.004	-0.0872	0.377		
$\Delta \ln(vol_{t-1})$	-0.1811	0.048	-0.1149	0.037	-0.1243	0.037
$\Delta \ln(S_t)$			-0.0265	0.767		
$\Delta \ln(S_{t-1})$			0.4961	0.000	0.5368	0.000
R^2	0.189		0.422		0.434	
Q(12)	34.026	0.001	16.591	0.166	16.199	0.182
Chow test	1.768	0.164	2.754	0.028	2.122	0.091
χ^2			6.350	0.042	5.124	0.024

1/ Dependent variable is $\Delta \ln(I_t)$, and $\Delta \ln(vol_t)$ is the logarithmic difference of the standard deviation of stock returns. "β" gives OLS slope coefficients, "p value" gives probability values for two-sided tests of the slope coefficients and for other listed test statistics. Q(12) is Ljung-Box Q statistics for the residual autocorrelation of order 12, and χ^2 is the likelihood ratio test for the significance of volatility changes. Data sample is 1930-90.

On the other hand, more convincing evidence seems to suggest that stock market volatility is generated by trading activity per se (see French and Roll (1986), among others). This literature has cast doubts about the efficiency of the stock market and stimulated the debate about the role of public policy in stabilizing the stock market. After the Market Crash of October 1987, a number of proposals have been put forth to curb the excessive speculative trading that generates volatility. Summers and Summers (1990), for example, propose a transactions tax on short-term trading. Others advocate tightening margin requirement and introducing similar regulatory changes to reduce market volatility. Although extensive review on these proposals are beyond the scope of this paper, the evidence presented here that stock market volatility is negatively correlated with fixed capital formation, highlights the desirability of reducing volatility. However, in the absence of an established causal link here, it should be stressed that these results are insufficient to justify any proposed direct policy interventions.

V. Conclusion

This paper has presented robust evidence for the negative association between stock market volatility and fixed investment. Large swings of stock market prices are related to low growth in real fixed investment. The stock market volatility may have led to a reduction in the capital stock and hence long-run productivity and income growth in the United States. The results suggest that measures proposed for reducing the stock market volatility, such as a transactions tax on short-term trading, may have some merits and deserve further evaluation. A more stable stock market will better serve as the forecasting mechanism for the economy as well as fulfill its role in channelling savings into capital investment.

APPENDIX I

Optimal Investment Rule Under Uncertainty

Following Merton (1973b), the value of the option, W(V), satisfies the following linear partial differential equation:

$$\frac{1}{2}\sigma^2 V^2 W_{VV} + (r-\delta)VW_V - rW = 0 \tag{A1}$$

where r is the riskless interest rate, and W_V, W_{VV} denote the first and second partial derivatives with respect to V. In addition, W(V) must satisfy the following boundary conditions:

$$W(0) = 0 \tag{A2}$$

$$W(V^*) = V^* - i_0 \tag{A3}$$

$$W_V(V^*) = 1 \tag{A4}$$

The solution is

$$W(V) = \alpha V^{\beta} \tag{A5}$$

where,

$$\beta = \frac{1}{2} - \frac{(r-\delta)}{\sigma^2} + \sqrt{\left[\frac{(r-\delta)}{\sigma^2} - \frac{1}{2}\right]^2 + \frac{2r}{\sigma^2}} \tag{A6}$$

$$\alpha = \frac{V^* - i_0}{(V^*)^{\beta}} \tag{A7}$$

and

$$V^* = \frac{\beta i_0}{(\beta - 1)} = V^*(r, \delta, \sigma, i_0) \tag{A8}$$

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