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STOCK VOLATILITY DURING THE RECENT FINANCIAL CRISIS

G. William Schwert

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ABSTRACT

This paper uses monthly returns from 1802-2010, daily returns from 1885-2010, and intraday returns from 1982-2010 in the United States to show how stock volatility has changed over time. It also uses various measures of volatility implied by option prices to infer what the market was expecting to happen in the months following the financial crisis in late 2008. This episode was associated with historically high levels of stock market volatility, particularly among financial sector stocks, but the market did not expect volatility to remain high for long and it did not. This is in sharp contrast to the prolonged periods of high volatility during the Great Depression. Similar analysis of stock volatility in the United Kingdom and Japan reinforces the notion that the volatility seen in the 2008 crisis was relatively short-lived. While there is a link between stock volatility and real economic activity, such as unemployment rates, it can be misleading.

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"We are in the worst financial crisis since the Great Depression, and a lot of you I think are worried about your jobs, your pensions, your retirement accounts," Democratic presidential candidate Barack Obama as he opened a debate with Republican rival John McCain, October 7, 2008 (Reuters).

1. Introduction

This quote has been repeated often by President Obama since that debate, and many commentators have called the recent recession the "Great Recession," to reflect the size and significance of the economic slowdown. Yet, at the time of the Obama-McCain debate, the September 2008 unemployment rate was only 6.2 percent (up from 4.7 percent a year earlier). Moreover, the National Bureau of Economic Research (NBER) did not announce that a recession had started in January 2008 until December 1, 2008.

So what caused candidate Obama to relate the financial crisis of 2008 to the Great Depression? An obvious answer is that the volatility of stock prices, particularly among financial sector stocks, had spiked so high in the days before that debate that the entire country was noticing and worrying about the condition of US financial markets. The implied volatility of the Standard & Poor's 500 portfolio, which is calculated from the prices of put and call options traded on the Chicago Board Options Exchange (CBOE) and is referred to as the VIX index, closed at an annual standard deviation of return of 68.01 percent on October 8, compared with just 24.72 percent on September 8, 2008. The large swings in stock prices were the lead stories for most news organizations, usually followed by speculation about the future economic conditions in the whole economy. Indeed, concerns about systemic risk, the absence of liquidity, and the stability of the financial system led to a variety of unusual measures to restore confidence in the stock and credit markets.

My goal in this paper is to review the behavior of financial volatility during the 2008 financial crisis, to put it into historical context, to show how markets did not expect the high volatility to persist for long, and to show that market expectations were accurate, since volatility returned to more normal levels relatively quickly. Finally, I discuss the connections between stock volatility and the real economy.

2. What Is Volatility?

2.1 Large Percentage Changes in Prices

Table 1 shows the 35 largest increases and decreases in the Dow Jones Industrial Average (DJIA) during its history, from 1885-2010 (34,663 days). On September 29, 2008, the DJIA fell from 11,143 to 10,365, over 777 points. This was the largest one day drop in market stock prices since Dow Jones began computing index numbers in 1885. Less than a month later, on October 13, 2008, the DJIA rose over 936 points in one day. Not surprisingly, the popular press was focused on these all-time records.

The academic finance profession widely agrees that volatility should be measured in percentage changes in prices, or rates of return. If you invest $1,000 today in a portfolio of common stocks, the rate of return tells you the proportional change in the value of your investment after the period. A ten percent rate of return would mean an increase in value of $100 whether the DJIA was at 100, 1,000, or 10,000.

By focusing on the absolute level of the DJIA, the press and the public exaggerate the severity of recent volatility. For example, the Dow Jones index reached above 778 for the first time on January 22, 1964, so it would have been impossible for the index to drop 777 points before that date. Table 2 shows the 35 largest percentage increases and decreases in the DJIA from 1885-2010.

The DJIA fell by only 38 and 31 points on October 28 and 29, 1929, yet these second and third largest daily percentage drops in the history of the New York Stock Exchange, and the October 15, 2008 drop represented only the tenth largest one day percentage drop in the history of the DJIA.

In the past I have suggested (only partly in jest) that the problem of volatility could be solved if Dow Jones (the publisher of the *Wall Street Journal*) would simply do what the Bureau of Labor Statistics does periodically with the Consumer Price Index: rescale the index equal to 100 in some recent period. Then absolute changes in the price index would approximate percentage changes, so the press and the public would not be fooled when the level of the index is higher than it has been in the past.

In Table 1 I highlight October 19, 1987 because it is the only day among these 70 largest increases and decreases that happened before 1997. In contrast, in Table 2 I highlight the 11 days since 2001 that are among the 70 largest percentage increases or decrease in the DJIA. Several patterns are clear from these tables. First, there are many reversals, when large drops in stock prices have been followed by large increases in stock prices. For example, the 1929 stock market crash represents two of the largest percentage drops in stock prices, -12.3 and -10.2 percent on October 28 and 29. The market rebounded on October 30 with the third largest one day percentage gain in the sample, 12.5 percent. This is characteristic of an increase in stock market volatility; that is, an increased chance of large stock returns of either sign. Most of the largest returns occurred during the Great Depression from 1929-1939. This is a simple way to show there were high levels of stock market volatility.

2.2 Standard Deviations of Returns

The most commonly used measure of stock return volatility is the standard deviation. This

statistic measures the dispersion of returns. Financial economists find the standard deviation to be useful because it summarizes the probability of seeing extreme values of returns. When the standard deviation is large, the chance of a large positive or negative return is large.

The tables and figures below show the historical behavior of stock volatility through several different lenses of a microscope. At the most distant setting, we can see volatility based on monthly returns all the way back to 1802 in the United States. If we want to look more closely at intra-month movements in stock prices, we can use daily returns that are available since 1885. Finally, if we want to be able to focus on intra-day movements in stock prices, we can use 15-minute returns that are available since 1982. Each of these perspectives gives insights into the recent episodes of high volatility, yet the overall picture that emerges is quite consistent: the 2008 financial crisis was relatively short-lived.

Figure 1 shows a plot of the standard deviation of monthly returns to an index of United States stocks from 1802-2010.[2] Each year the 12 monthly returns are used to calculate the standard deviation, so there is one point per year in the plot. This plot shows that stock return standard deviations are about 13 percent per year. Since the US stock market started to include railroad and industrial corporations, around 1834, the volatility of returns to this aggregate stock portfolio has been remarkably stable, with the exception of the Great Depression, from 1929-1939, when the standard deviation was around 30 percent per year. This longer-term perspective on stock market volatility makes it clear that the last couple of years have not been that unusual.

Figure 2 shows a plot of the standard deviation of monthly returns to an index of New York

[2] The data from 1802-1925 are from Schwert (1990). The data from 1926-2009 are from the Center for Research in Security Prices (CRSP), representing a value-weighted portfolio of stocks from the New York and American Stock Exchanges, from NASDAQ, and from ARCA. For 2010, I use the Standard & Poor's (S&P) 500 portfolio.

Stock Exchange-listed stocks from 1885-2010.[3] Each month the daily returns are used to calculate the standard deviation for the month. Since returns are not highly correlated through time, the standard deviation of monthly returns is about equal to the standard deviation of daily returns times the square root of the number of trading days in the month. This transformation is used in figure 2.

There are over 1,500 standard deviation estimates in figure 2, each based on about 21 trading days per month. In contrast, figure 1 contains 209 standard deviation estimates each based on 12 months per year. Thus, figure 2 contains much more information about volatility. It is also clear that months like October 1929, October 1987, and October 2010 show up more clearly in figure 2 because volatility was very high for brief periods of time. Otherwise, the results in figures 1 and 2 reinforce each other. The typical level of the monthly standard deviation is about 4 percent. The standard deviation estimates are over 8 percent from September 2008 through May 2009. To put this in perspective, though, there were 10 months between April 2000 and October 2002 that also had standard deviations above 8 percent.

For recent years, it is possible to measure volatility using prices measured within the day. Figure 3 shows a plot of the standard deviation of daily returns to the Standard & Poor's 500 index from February 1983 – July 2010 based on returns measured every 15 minutes within the day.[4] Thus, there are about 26 intraday returns used to calculate each daily standard deviation. To measure the daily standard deviation, I multiply the 15 minute standard deviation by the square root

[3] The data from 1802-1962 are from Schwert (1990). The data from 1962-2009 are from the Center for Research in Security Prices (CRSP), representing a value-weighted portfolio of stocks from the New York and American Stock Exchanges, from NASDAQ, and from ARCA. For 2010, I use the Standard & Poor's (S&P) 500 portfolio.

[4] The choice of a 15-minute interval for estimating the standard deviation is driven by the autocorrelation of shorter-interval intraday returns to the S&P index caused by non-synchronous trading of the stocks within the index. Returns to the futures contract, which does not have not have this problem, are not substantially autocorrelated even at one minute intervals.

of 26 (a similar procedure to the one used in figures 1 and 2). The typical level of the daily standard deviation is about 0.7 percent (which corresponds to about 3.2 percent per month if there are 21 trading days per month). The period from September 29, 2008 through the end of 2008 had 29 days where the daily standard deviation was larger than 3 percent, which is a large portion of the 45 such days over the entire 1983 – 2010 period.

Figure 3 also shows a plot of the standard deviation of daily returns to the near-term futures contract on the Standard & Poor's 500 index from April 1982 – July 2010 based on returns measured every 15 minutes within the day. The futures contract returns are more volatile than the underlying index, especially on days of extreme volatility. For example, on October 20, 1987, which is the largest in the sample, the daily standard deviation estimate is 8.7 percent for the index and 24.1 percent for the futures contract. This difference has become less pronounced since around 1990, as the rise in the trading volume of individual stocks has likely solved most of the "stale prices" problem inherent in the index.

The burst of volatility during the fall 2008 financial crisis stands out in figure 3 more than it does in figures 1 and 2. Partly, this reflects the lack of intraday data before 1982, so the high volatility periods of 1929-39, and 1973-74 are not included in the picture. The intraday data do make the October 1987 crash volatility look more dramatic than the daily or monthly data in figures 1 and 2 show.

Figure 4 shows one more estimate of the volatility of the Standard & Poor's index: the implied volatility of the S&P index measured from put and call prices on "at-the-money" near-term options of the S&P index that are traded on the CBOE. The data from 1990-2010 are the implied volatilities of the S&P 500 index (VIX), while the data from 1986-89 are the implied volatilities of

the S&P 100 index (VXO).[5] The data from 1983-85 are from Day and Lewis (1988). These volatility estimates have an average horizon of about a month into the future, and they are expressed as annual standard deviations of returns. The average of these estimates is about 20 percent. The post-1987 crash period is the obvious extreme episode in this series, but the 2008 crisis has the second largest burst of volatility. The other periods of higher than average volatility for the S&P index occurred in 1990 and from 1998-2002.

These long historical series of stock return standard deviations help put recent events in perspective by showing that the general level of stock return volatility has not risen recently. The contrast between the volatility since September 2008 and the prior period from 2004-2008 is partly a reflection of the unusually low market volatility in the period prior to the financial crisis. Moreover, the spikes in volatility seen in late 2008 did have historical precedents. Compared to the Great Depression, though, when stock volatility rose and remained high for many years, it seems that stock volatility returned to more normal levels fairly quickly after the 2008 crisis.

2.3 Forecasting Volatility

Because the CBOE briefly reported information on volatility implied by longer-term options on the S&P index, we are able to see what the market expected to happen in the months following the 2008 crisis.[6] Figure 5 shows the structure of forward volatility rates implied by the VIX term structure on nine dates between July 2008 and June 2010. As with forward interest rates, the forward volatility between any two dates can be inferred from the two volatility estimates. For

[5] http://www.cboe.com/micro/vix/historical.aspx.

[6] I obtained a spreadsheet from the CBOE web site that contained the VIX term structure from the beginning of 1992 through June 2, 2010. After that time, the CBOE has decided to discontinue making these data available. They now have a web site that allows users to download VIX term structure estimates starting in November 24, 2010.

example, if you have the estimate of implied variance for the next year, σ_1^2, and for the next two years, σ_2^2, the forward volatility from the end of year one to the end of year 2 is just:

$$\sigma_{1\_2}^2 = [2\,\sigma_2^2 - \sigma_1^2] \quad (1)$$

What is clear from figure 5 is that the market's estimates of volatility up to three years into the future were not affected as much by the 2008 crisis as the shorter-term estimates three to six months into the future. In November 2008, the term structure of forward volatilities was sharply downward-sloping, decaying from over 65% per year at the one-month horizon to about 40% at the ten-month horizon. By April 2009, the entire term structure had shifted downward and become flatter, albeit at a level of around 35 percent, which was higher than the 25 percent level seen in July 2008. By April 2010, the term structure looked a lot like its June 2008 profile. Thus, even during the turbulent days in fall 2008, the market did not expect stock volatility to remain high for long periods, as it had during the Great Depression, and this forecast turned out to be roughly accurate.

Another way to look at market forecasts of volatility during the 2008 crisis is to examine the prices of futures contracts on the VIX index that have been traded on the CBOE Futures Exchange since March 2004. Figure 6 shows the futures price for the longest maturity contract from 2004-2010. Two things are notable in this graph: (1) the peak level of the futures price in mid-December 2008 never exceeds 45 percent, and (2) current levels of this futures price are similar to what was observed in mid-2007.

2.4 Summary of the Evidence

What do these plots of stock volatility tell us? They show that volatility measured using the standard deviation of rates of return has been relatively stable since the mid-19th century in the United States. The major exception is the Great Depression period from 1929-39. Moreover, they

show that the high levels of volatility following recent periods of market stress, such as 1987 and 2008, have been short-lived. These conclusions are not sensitive to whether volatility is measured from monthly returns, daily returns, or 15 minute returns. Finally, futures returns are more volatile than stock index returns in periods when there are big price movements. The next section of the paper studies the behavior of volatility in markets outside the United States, and the following section analyzes the volatility of different industry sectors to show the extent of the 2008 crisis in financial markets.

3. Volatility in Other Countries

3.1 Volatility of U.K. Stock Returns

Figure 7 shows a plot of the standard deviation of monthly returns to an index of United Kingdom stocks from 1802-2010.[7] Each year the 12 monthly returns are used to calculate the standard deviation, so there is one point per year in the plot. This plot shows that stock return standard deviations are about 13 percent per year. Some of the episodes of high volatility in the UK correspond to those in the US, although the magnitudes are not always equal. For example, the Great Depression was associated with much higher volatility in the US. Not surprisingly, the early part of World War II resulted in much higher volatility in the UK, because German bombs were falling on London, and the US did not enter the War until late 1941 (at which point volatility in the UK stock market seems to have lowered dramatically). Similarly, the first OPEC oil crisis in 1973-74 seems to have a much larger effect on UK stocks than on the US market. The pattern of volatility since 2000 seems quite similar between the UK and the US.

[7] These data are from Global Financial Data (GFD), https://www.globalfinancialdata.com. GFD has linked several series of historical stock prices to the FTSE All Shares index.

Figure 8 shows a plot of the standard deviation of monthly returns to the Financial Times All Shares Index (FTSE) from 1969-2010.[8] As with figure 2, each month the daily returns are used to calculate the standard deviation for the month. October 2008 stands out in figure 8, along with October 1987, as extreme spikes in volatility. Those months were surrounded by high volatility, at levels comparable with the 1973-75 OPEC period, and the 2002-2003 period. As in the US, volatility has returned to more normal levels since mid-2009.

3.2 Volatility of Japanese Stock Returns

Figure 9 shows a plot of the standard deviation of monthly returns to an index of Japanese stocks from 1915-2010.[9] This plot shows that stock return standard deviations are about 15 percent per year. Some of the episodes of high volatility in Japan correspond to those in the US and the UK, although the magnitudes are not always equal. For obvious reasons, the period when Japan was reconstructed following World War II was a period of extreme volatility in Japan. Also, the decade of the 1990s, when the Japanese economy was stagnant was a period of relatively high volatility. The increase in volatility associated with the 2008 financial crisis was similar to the behavior seen in the UK and the US.

Figure 10 shows a plot of the standard deviation of monthly returns to the Topix Index from 1951-2010.[10] As with figures 2 and 8, October 2008 stands out in figure 10, along with October 1987, as extreme spikes in volatility. As in the US and the UK, volatility has returned to more normal levels since mid-2009.

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[8] These data are from Yahoo Finance, http://finance.yahoo.com/q?s=%5EFTAS&ql=0.

[9] These data are from Global Financial Data (GFD), https://www.globalfinancialdata.com. GFD has linked several series of historical stock prices to the Topix index.

[10] These data are from Global Financial Data (GFD), https://www.globalfinancialdata.com.

Thus, the financial crisis had similar effects in the major stock markets around the world. Most importantly, the periods of very high volatility in daily stock returns were short-lived.

4. Volatility in Sectors of the Market

4.1 Volatility of Technology Stocks

In addition to looking across countries, sometimes it is instructive to examine different industry sectors to understand the breadth and depth of changes in stock market volatility. For example, in Schwert (2002) I found that from 1999-2001 there was a large increase in the volatility of portfolios of technology stocks, many of which were traded on Nasdaq. Figure 11 shows a plot of the standard deviation of monthly returns to the Datastream US Technology Index from 1973-2010. While there is evidence that technology stocks became more volatile from September 2008 through March 2009, the peak level of volatility was lower than for the broad market indexes for the US, the UK, and Japan. The brief level of high volatility of technology returns was similar to what was seen frequently between 1998 and 2002, and it was of much shorter duration.

4.2 Volatility of Financial Stocks

In contrast, and not surprisingly, given what is known about the source of the problems that led to the credit crisis in 2008, the volatility of the returns to the Datastream US Financial Index are much higher between July 2008 and May 2009 than at any time between 1973 and 2010, except for the stock market crash of October 1987. Thus, the comparison of volatility in the technology and financial sectors in figures 11 and 12 highlights the substantial differences between the episodes of high volatility in the early 2000's and the 2008 credit crisis.

5. Stock Volatility as a Leading Indicator

The survey of the behavior of stock return volatility across different measurement intervals, different countries, and different industries shows that there was a large burst of volatility in mid-2008 that lasted for less than a year. While the magnitude and duration of the increase in volatility differed somewhat, the general pattern was quite consistent. Moreover, the relatively quick dissipation of the high levels of volatility was accurately anticipated by the financial markets, even at the time of the highest short-term volatility.

So how does stock volatility relate to real economic activity? Figure 13 shows the monthly unemployment rate in the U.S. along with the monthly volatility of stock returns (previously shown in Figure 2), from 1929 through 2010.[11] Several things are apparent from this graph. First, there is a clear positive association between the unemployment rate and stock volatility, although the unemployment rate lags spikes in volatility and generally remains at high levels longer than does volatility. During the Great Depression, the levels of volatility and the unemployment rate were strikingly similar, particularly from 1931-32 and 1937-38. Likewise, the first OPEC oil crisis in 1973-74 shows similar behavior of stock volatility and unemployment rates, with the latter lagging a bit. In contrast, the spikes in volatility that occurred in 1987 and from 2000-2002 were not associated with large changes in the unemployment rate.

Finally, and most important for understanding public reaction to the 2008 financial crisis, the jump in stock volatility in late 2008 was much larger than the subsequent increase in the unemployment rate. Statements that the 2008 recession was the "worst since the Great Depression," which were frequently repeated by public officials and the news media, were somewhat inaccurate or disingenuous. For example, the unemployment rate was never higher after

[11] The unemployment data are from Global Financial Data (GFD), https://www.globalfinancialdata.com.

September 2008 than it was between September 1982 and June 1983. While stock volatility was briefly at levels similar to those seen during the Great Depression in late 2008, the unemployment rate was never half as high as it was during the periods of high stock volatility during the Great Depression.

Of course, the reason why stock volatility can color public perceptions of economic conditions is that is so easily visible in real time. The availability of financial information, including direct measures of volatility expectations in the form of the VIX index, provides the news media and politicians with ammunition for stories of imminent economic disaster. Most measures of real activity, such as the unemployment rate, are only available with a substantial lag because of normal measurement processes.

6. Summary and Conclusions

The financial crisis in late 2008 was a major disruption to the financial sector. There has been much discussion about the causes and consequences that led to the failure or near failure of many large financial institutions, and there have been many proposals to assure that a similar credit crisis will be less likely to happen in the future.

One of the most visible indicators of the crisis that captured the attention of the general public was the extremely high level of stock return volatility. This uncertainty prompted much speculation and discussion about the likely real economic consequences of the credit crisis. This paper has shown that the spike in stock volatility occurred in many countries. Volatility was highest among stocks in the financial sector, but it was also high market-wide.

From the contingent claims markets there is direct evidence that market participants did not expect the high levels of volatility to persist for long periods. It turns out that these expectations

were realized, because stock volatility returned to much more normal levels within months. Thus, the comparisons with the Great Depression that have occurred frequently over the last few years are exaggerated or misguided.

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Table 1

The Thirty-five Largest Daily Increases and Decreases in the Dow Jones Industrial Index, 1885-2010 (T=34,683)

		DJIA	Chg	Ret		DJIA	Chg	Ret
1	20080929	10365.45	-777.68	-6.98%	20081013	9387.61	936.42	11.08%
2	20081015	8577.91	-733.08	-7.87%	20081028	9065.12	889.35	10.88%
3	20010917	8920.70	-684.81	-7.13%	20081113	8835.25	552.59	6.67%
4	20081201	8149.09	-679.95	-7.70%	20000316	10630.59	499.18	4.93%
5	20081009	8579.19	-678.91	-7.33%	20090323	7775.86	497.48	6.84%
6	20000414	10305.77	-617.78	-5.66%	20081121	8046.42	494.13	6.54%
7	19971027	7161.15	-554.26	-7.18%	20020724	8191.29	488.95	6.35%
8	20081022	8519.21	-526.00	-5.82%	20080930	10850.66	485.21	4.68%
9	19980831	7539.07	-512.61	-6.37%	20020729	8711.88	447.49	5.41%
10	20081007	9447.11	-508.39	-5.11%	20080318	12392.66	420.41	3.51%
11	**19871019**	**1738.74**	**-508.00**	**-22.61%**	20080311	12156.81	416.66	3.55%
12	20080915	10917.51	-504.48	-4.42%	20081020	9265.43	413.21	4.67%
13	20081105	9139.27	-486.01	-5.05%	20080918	11019.69	410.03	3.86%
14	20080917	10609.66	-449.36	-4.06%	20100510	10785.14	404.71	3.90%
15	20081120	7552.29	-444.99	-5.56%	20010405	9918.05	402.63	4.23%
16	20081106	8695.79	-443.48	-4.85%	20081016	8979.26	401.35	4.68%
17	20010312	10208.25	-436.37	-4.10%	20010418	10615.83	399.10	3.91%
18	20081119	7997.28	-427.47	-5.07%	20081124	8443.39	396.97	4.93%
19	20070227	12216.24	-416.02	-3.29%	20080401	12654.36	391.47	3.19%
20	20081112	8282.66	-411.30	-4.73%	19980908	8020.78	380.48	4.98%
21	20080606	12209.81	-394.64	-3.13%	20090310	6926.49	379.44	5.80%
22	20020719	8019.26	-390.23	-4.64%	20021015	8255.68	378.28	4.80%
23	20070809	13270.68	-387.18	-2.83%	20080919	11388.44	368.75	3.35%
24	20010920	8376.21	-382.92	-4.37%	20010924	8603.86	368.05	4.47%
25	20090210	7888.88	-381.99	-4.62%	20081216	8924.14	359.61	4.20%
26	20001012	10034.58	-379.21	-3.64%	20021001	7938.79	346.86	4.57%
27	20100520	10068.01	-376.36	-3.60%	20010516	11215.92	342.95	3.15%
28	20000307	9796.03	-374.47	-3.68%	20001205	10898.72	338.62	3.21%
29	20080922	11015.69	-372.75	-3.27%	19971028	7498.32	337.17	4.71%
30	20080205	12265.13	-370.03	-2.93%	20070918	13739.39	335.97	2.51%
31	20081006	9955.50	-369.88	-3.58%	20080805	11615.77	331.62	2.94%
32	20071019	13522.02	-366.94	-2.64%	20071128	13289.45	331.01	2.55%
33	20071101	13567.87	-362.14	-2.60%	19981015	8299.36	330.58	4.15%
34	20071107	13300.02	-360.92	-2.64%	20020705	9379.50	324.53	3.58%
35	20000104	10997.92	-359.60	-3.17%	20000315	10131.41	320.18	3.26%

Table 2

The Thirty-five Largest Daily Percent Increases and Decreases in the Dow Jones Industrial Index, 1885-2009 (T=34,683)

		DJIA	Chg	Ret		DJIA	Chg	Ret
1	19871019	1738.74	-508.00	-22.61%	19330315	62.10	8.26	15.34%
2	19291028	260.64	-38.33	-12.82%	19311006	99.34	12.86	14.87%
3	19291029	230.07	-30.57	-11.73%	19291030	258.47	28.40	12.34%
4	19291106	232.13	-25.55	-9.92%	19320921	75.16	7.67	11.36%
5	18991218	42.69	-4.08	-8.72%	**20081013**	**9387.61**	**936.42**	**11.08%**
6	18951220	28.77	-2.68	-8.51%	**20081028**	**9065.12**	**889.35**	**10.88%**
7	19320812	63.11	-5.79	-8.40%	19871021	2027.85	186.84	10.15%
8	19070314	55.84	-5.05	-8.29%	19320803	58.22	5.06	9.52%
9	19871026	1793.93	-156.83	-8.04%	19320211	78.60	6.80	9.47%
10	**20081015**	**8577.91**	**-733.08**	**-7.87%**	19291114	217.28	18.59	9.36%
11	19330721	88.71	-7.55	-7.84%	19311218	80.69	6.90	9.35%
12	19371018	125.73	-10.57	-7.75%	19320213	85.82	7.22	9.19%
13	**20081201**	**8149.09**	**-679.95**	**-7.70%**	19320506	59.01	4.91	9.08%
14	18930726	24.76	-1.98	-7.39%	19330419	68.31	5.66	9.03%
15	**20081009**	**8579.19**	**-678.91**	**-7.33%**	19311008	105.79	8.47	8.70%
16	19170201	88.52	-6.91	-7.24%	19320610	48.94	3.62	7.99%
17	19971027	7161.15	-554.26	-7.18%	19390905	148.12	10.03	7.26%
18	19321005	66.07	-5.09	-7.15%	19310603	130.37	8.67	7.12%
19	**20010917**	**8920.70**	**-684.81**	**-7.13%**	19320106	76.31	5.07	7.12%
20	19310924	107.79	-8.20	-7.07%	**20090323**	**7775.86**	**497.48**	**6.84%**
21	19330720	96.26	-7.32	-7.07%	19321014	63.84	4.08	6.83%
22	**20080929**	**10365.45**	**-777.68**	**-6.98%**	19070315	59.58	3.74	6.69%
23	19140730	52.32	-3.88	-6.91%	**20081113**	**8835.25**	**552.59**	**6.67%**
24	19891013	2569.26	-190.58	-6.91%	19310620	138.96	8.65	6.64%
25	19880108	1911.31	-140.58	-6.85%	19330724	94.28	5.86	6.63%
26	19291111	220.39	-16.14	-6.82%	18930727	26.40	1.64	6.63%
27	19400514	128.27	-9.36	-6.80%	**20081121**	**8046.42**	**494.13**	**6.54%**
28	19311005	86.48	-6.29	-6.78%	18930802	27.85	1.71	6.54%
29	19400521	114.13	-8.30	-6.78%	19330619	95.99	5.76	6.38%
30	19340726	85.51	-6.06	-6.62%	19010510	52.50	3.14	6.37%
31	19550926	455.56	-31.89	-6.54%	**20020724**	**8191.29**	**488.95**	**6.35%**
32	19980831	7539.07	-512.61	-6.37%	19320806	66.56	3.96	6.33%
33	19291023	305.85	-20.66	-6.33%	19321110	65.54	3.87	6.28%
34	19320531	44.74	-2.96	-6.21%	19320113	84.36	4.97	6.26%
35	19330921	97.56	-6.43	-6.18%	19330429	77.66	4.56	6.24%

Fig. 1 -- Annualized Standard Deviations of U.S. Stock Returns from Monthly Returns in the Year, 1802-2010

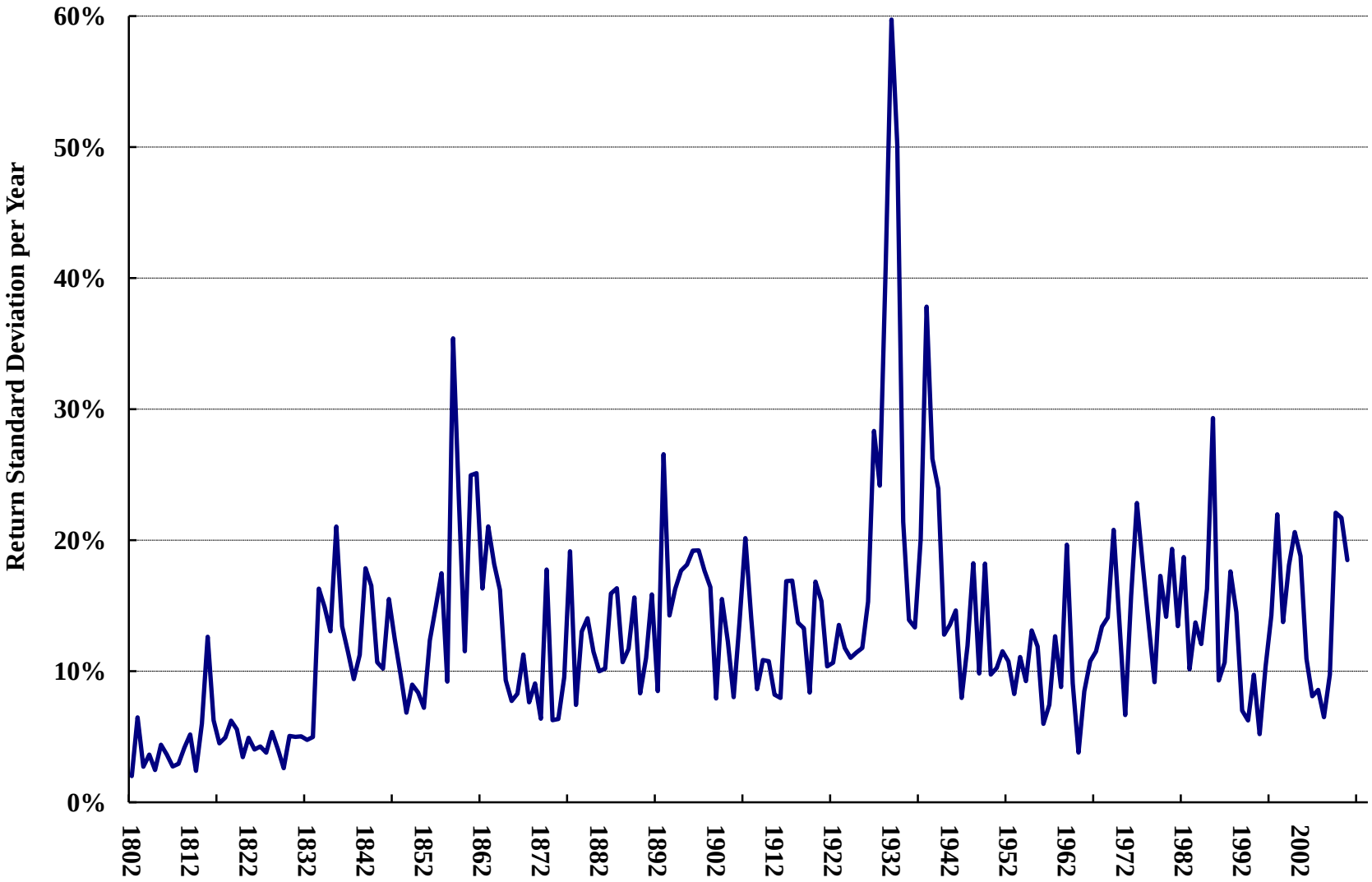

Fig. 2 -- Standard Deviation of Monthly Stock Returns from Daily Returns in the Month, 1885-2010

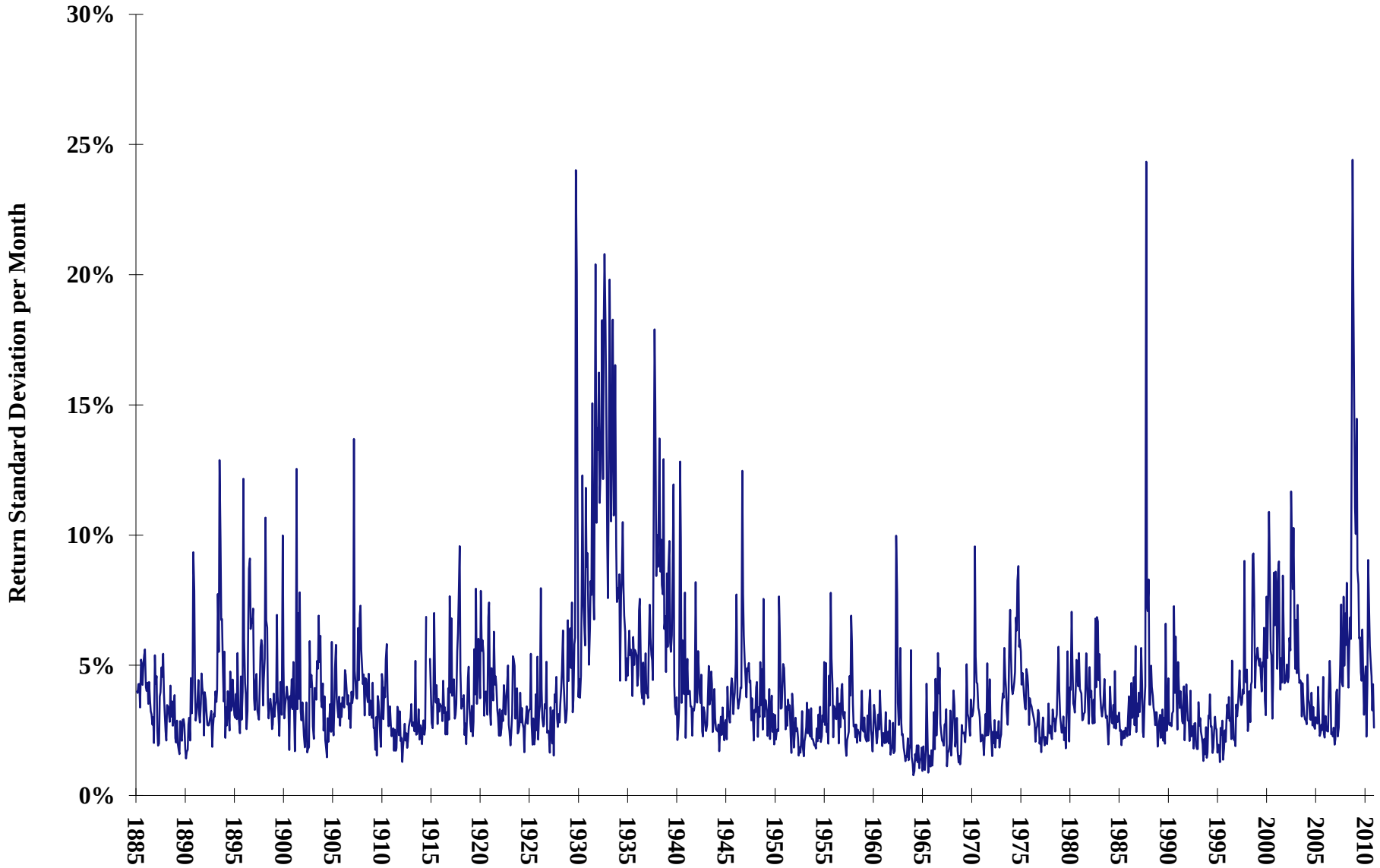

Fig. 3 -- Volatility of the S&P 500 and S&P Futures, Based on Intraday 15-minute Returns, 1982-2010

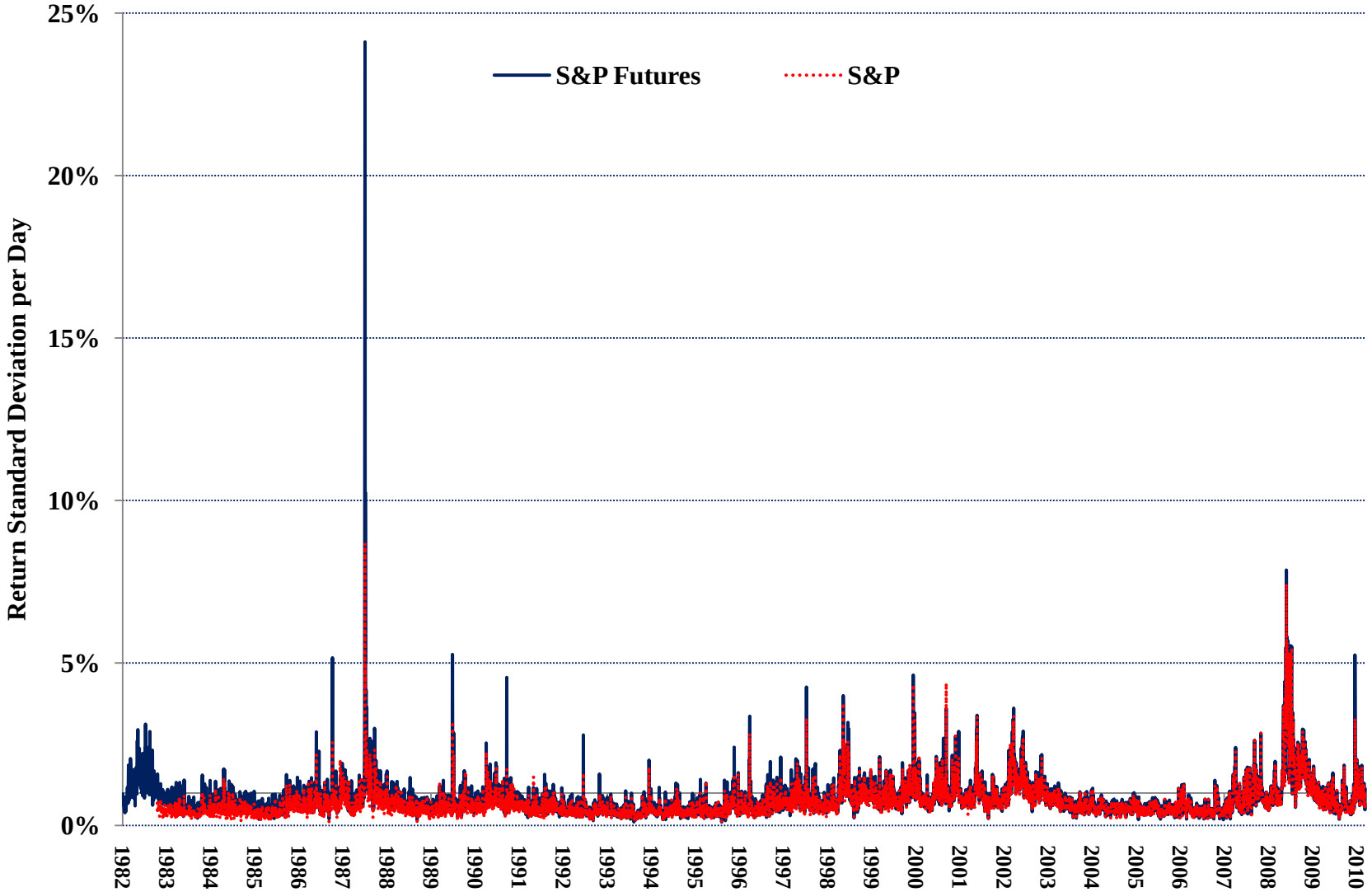

Fig. 4 -- Annual Standard Deviation of Returns to the S&P Index Implied by CBOE Put and Call Prices, 1983-2010

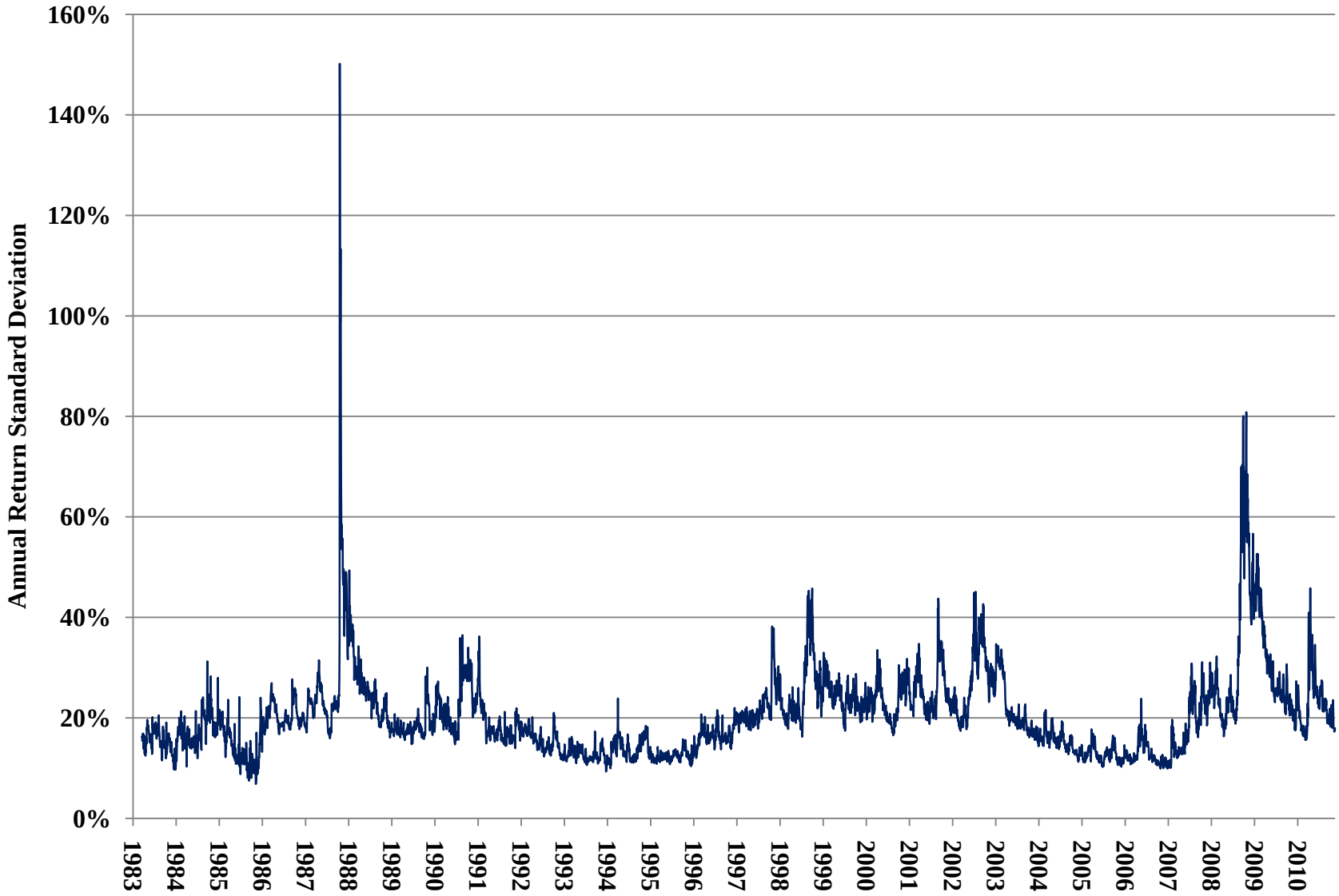

Fig. 5 -- Forward Structure of S&P Volatility Implied by Longer-term CBOE Put and Call Option Prices, 2008-2010

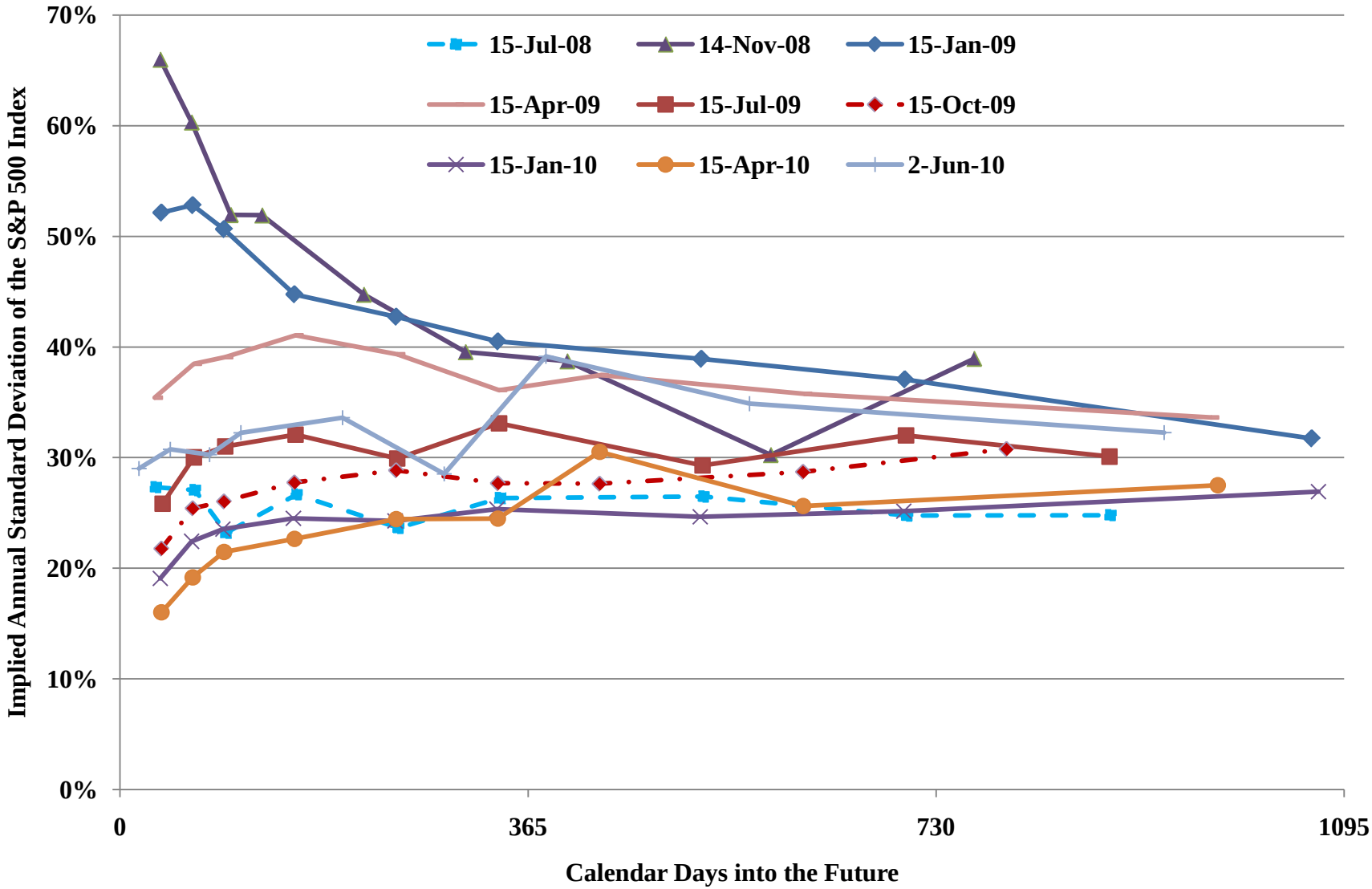

Fig. 6 --Longest Maturity S&P Volatility Futures Value, March 2004 - December 2010 (average maturity = 0.81 year)

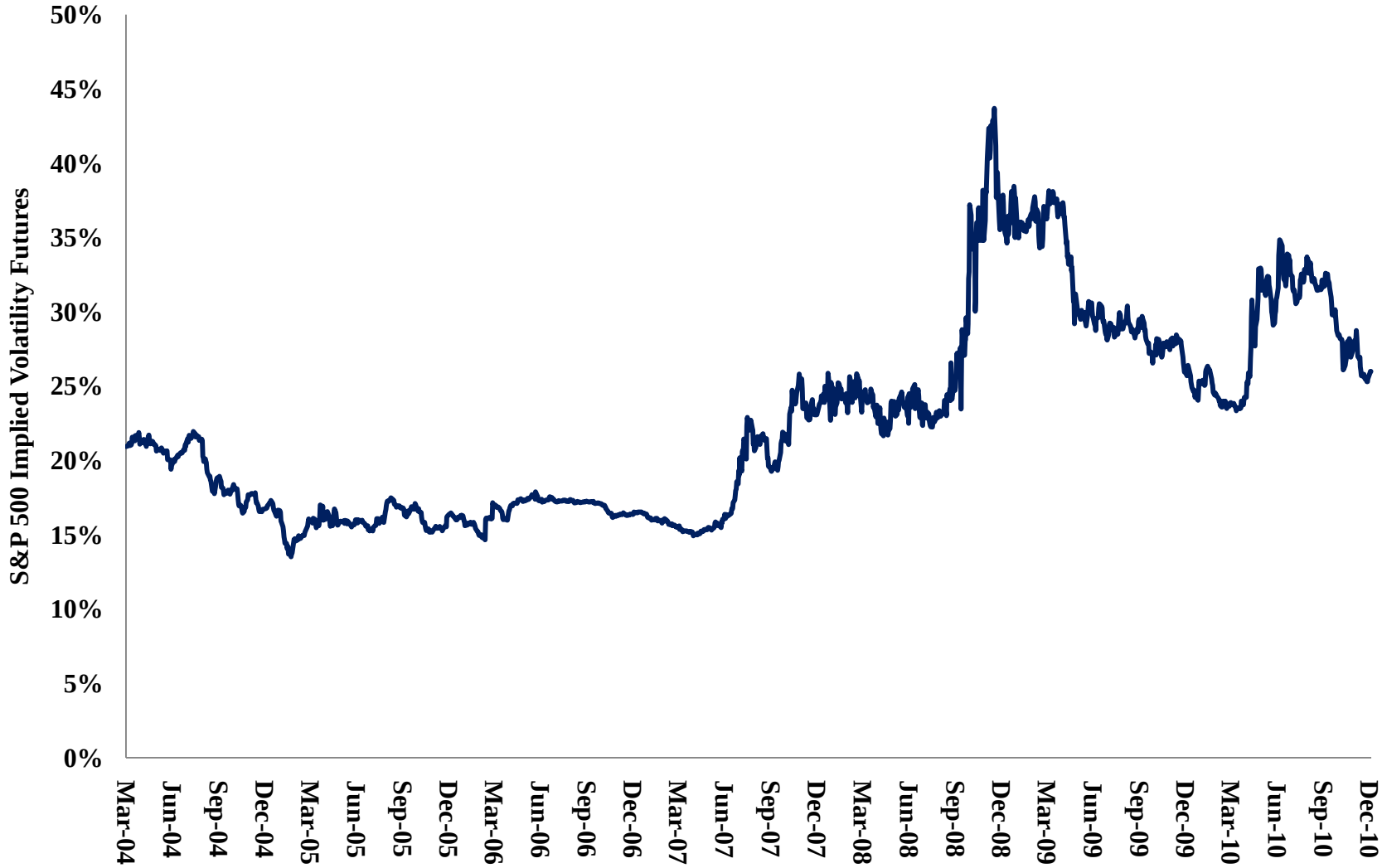

Fig. 7 -- Annualized Standard Deviations of U.K. Stock Returns from Monthly Returns in the Year, 1802-2010

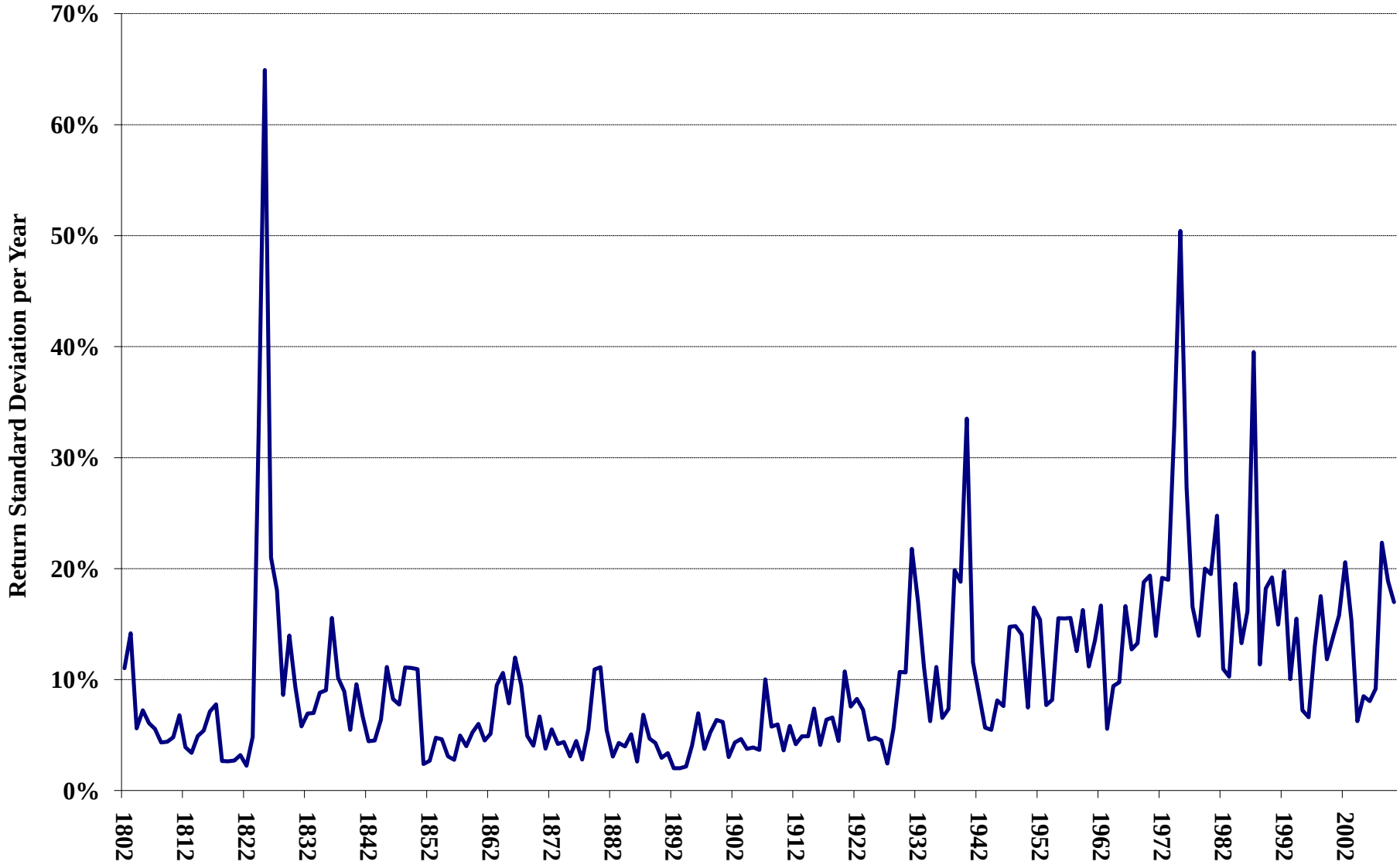

Fig. 8 --Standard Deviation of Monthly FTSE Stock Returns from Daily Returns in the Month, 1969-2010

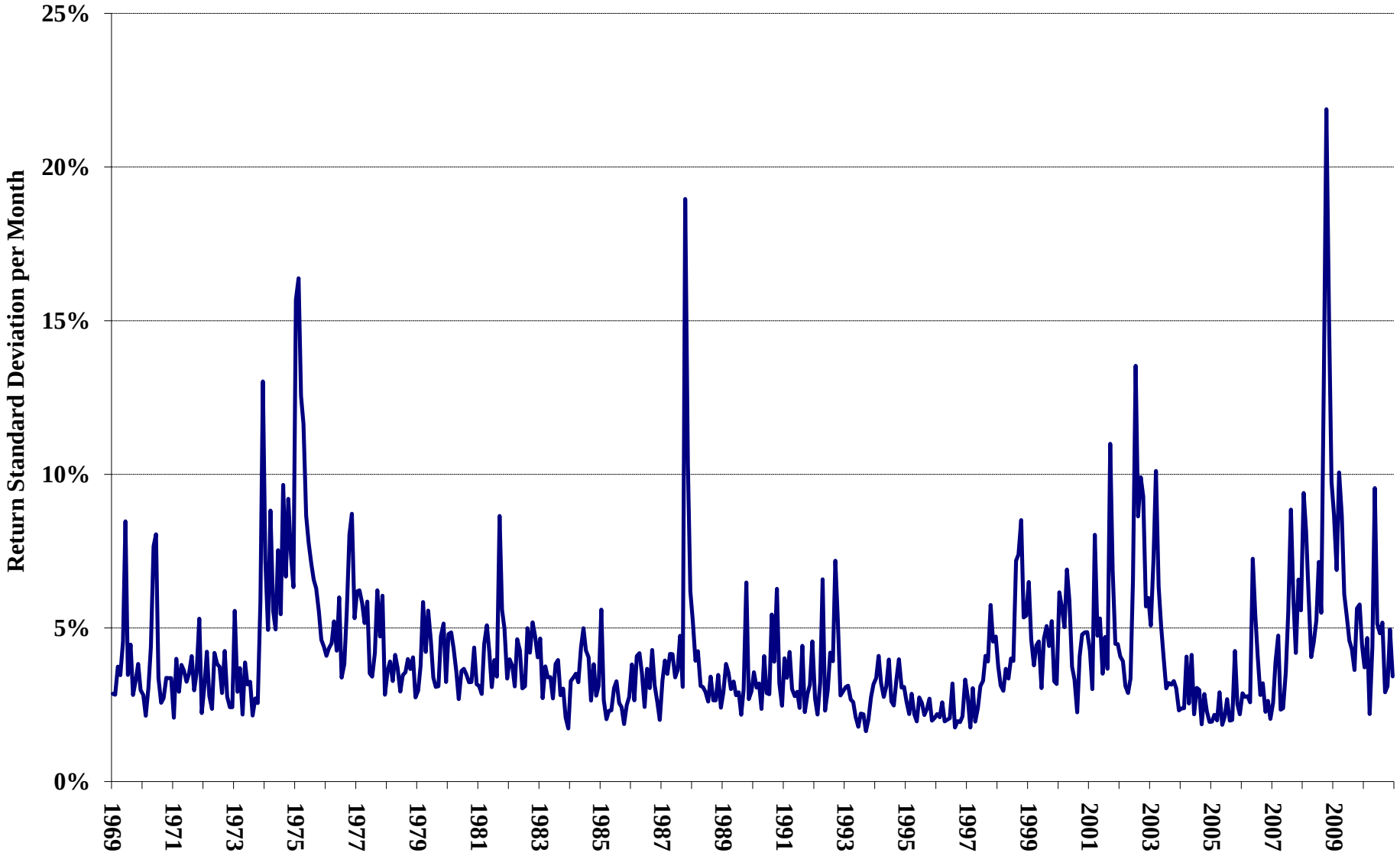

Fig. 9 -- Annualized Standard Deviations of Japanese Stock Returns from Monthly Returns in the Year, 1915-2010

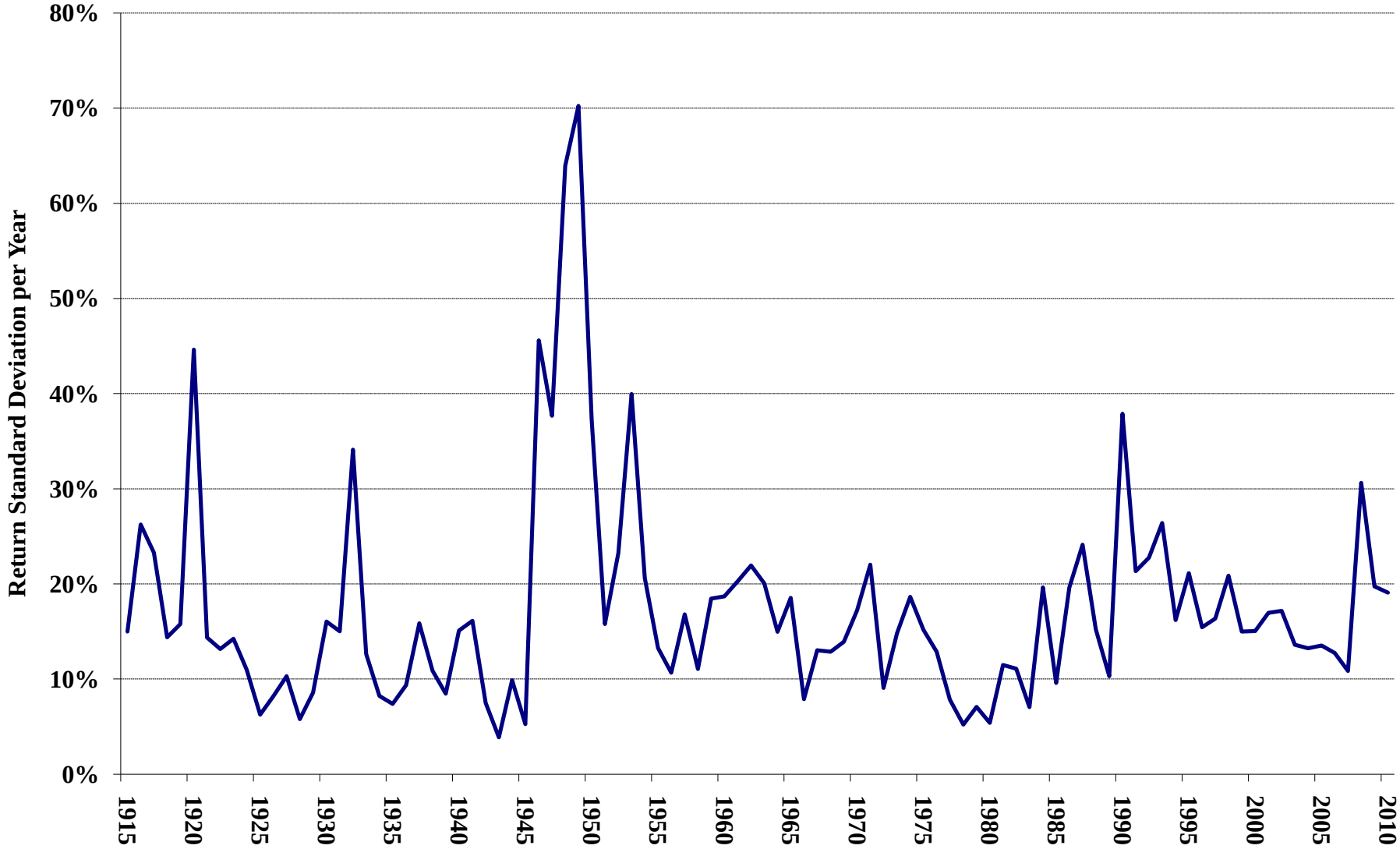

Fig. 10 --Standard Deviation of Monthly Topix Stock Returns from Daily Returns in the Month, 1951-2010

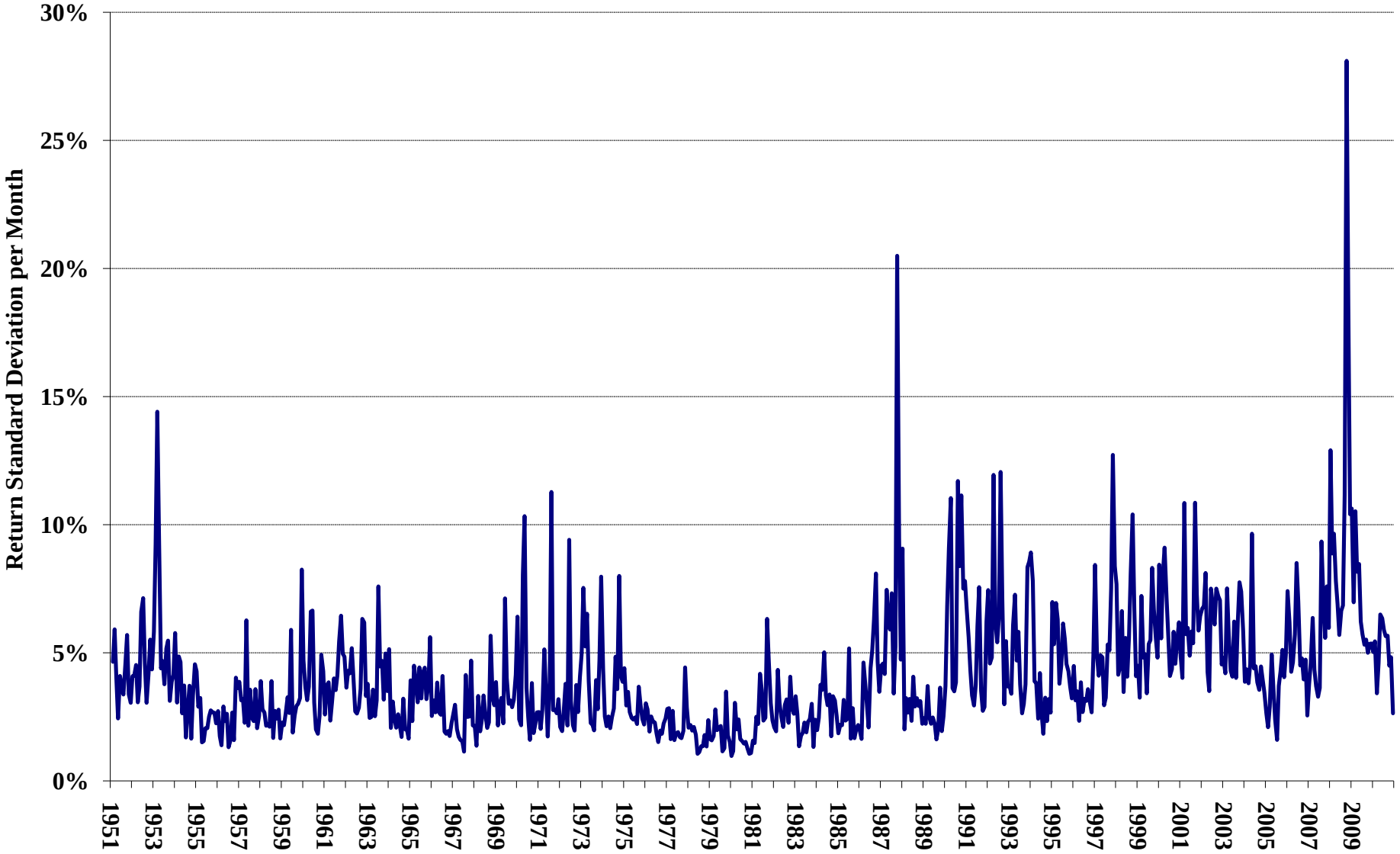

Fig. 11 --Standard Deviation of Monthly Datastream Technology Stock Returns from Daily Returns in the Month, 1973-2010

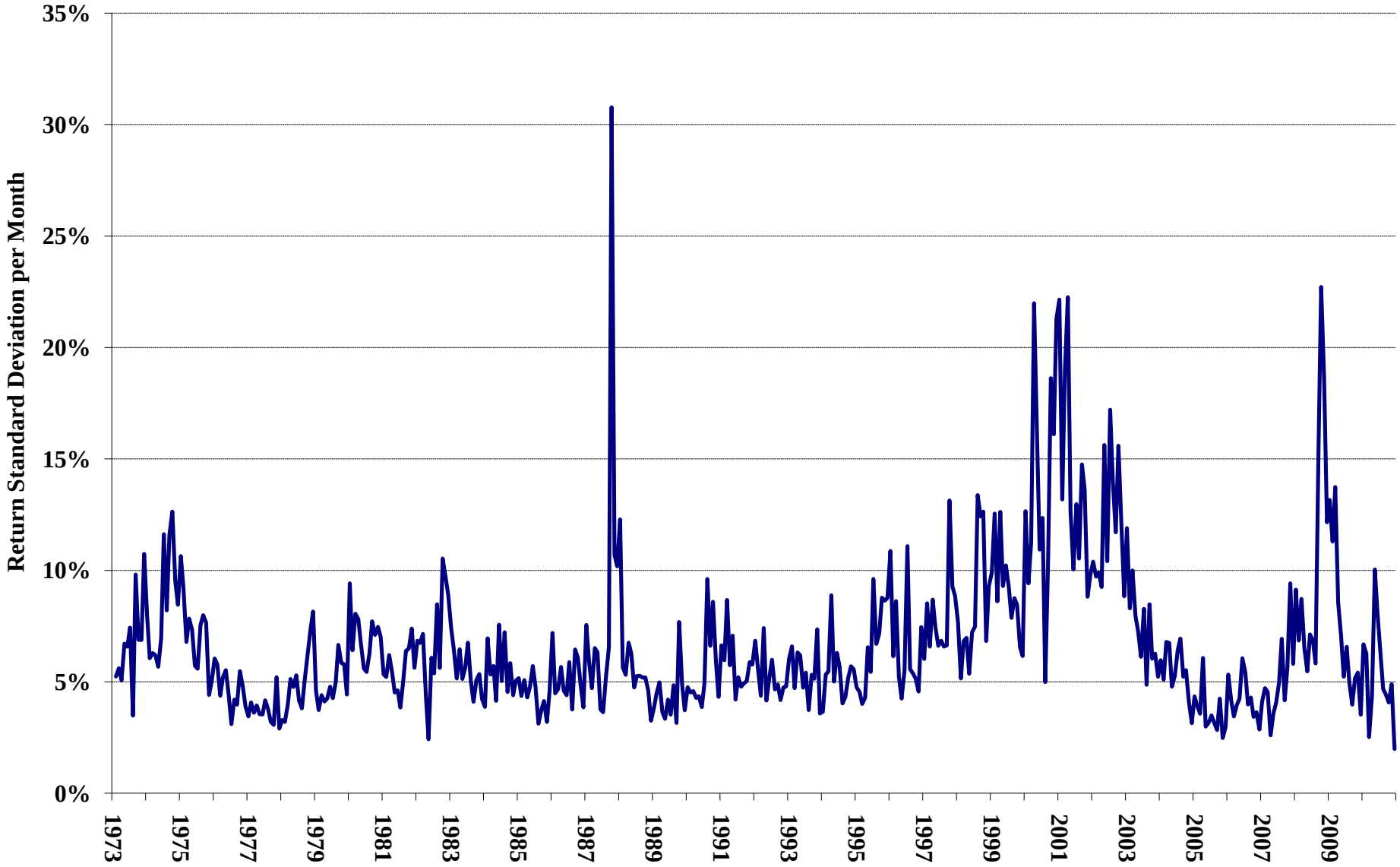

Fig. 12 --Standard Deviation of Monthly Datastream Financial Stock Returns from Daily Returns in the Month, 1973-2010

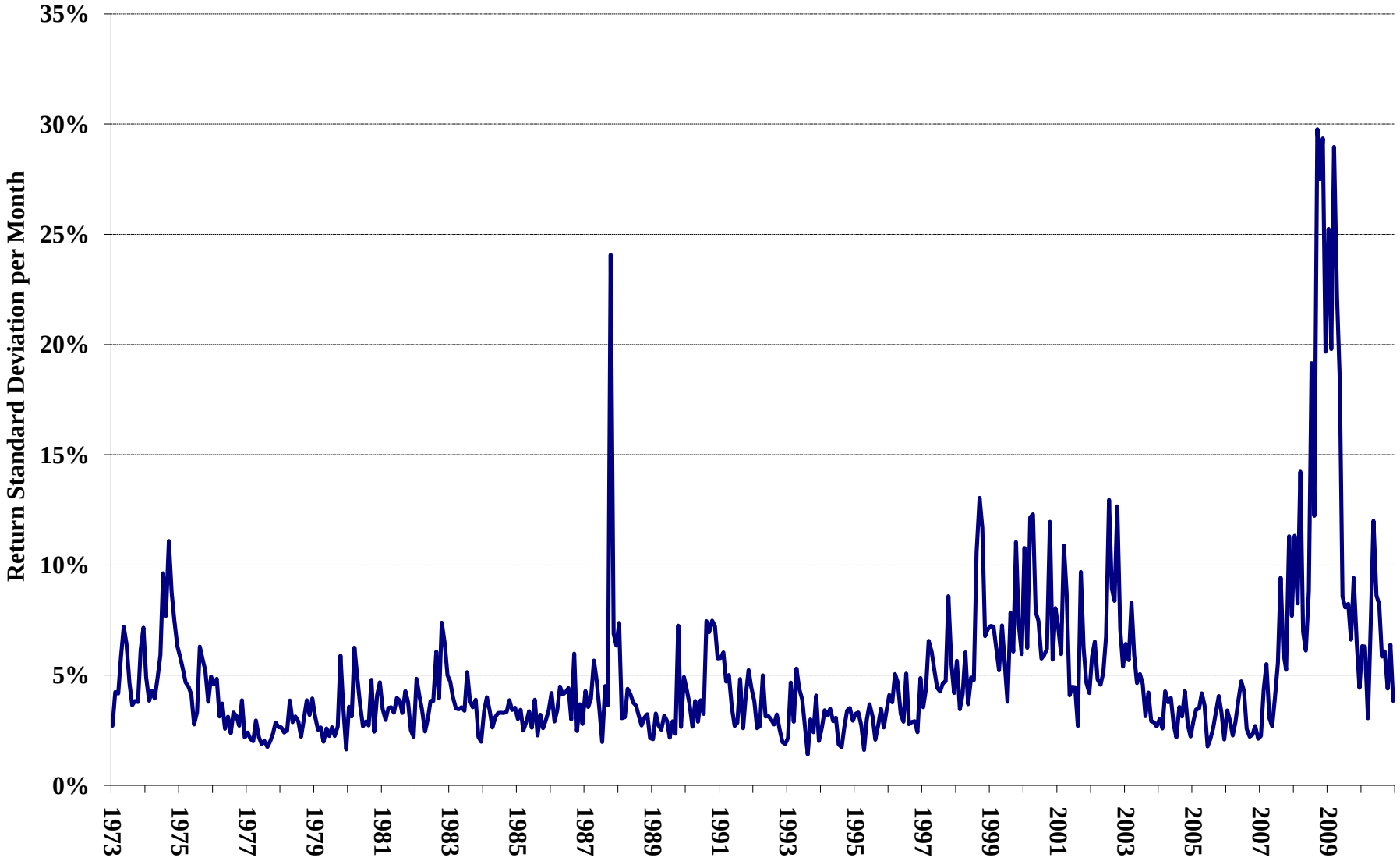

Fig. 13 -- Unemployment Rate and Standard Deviation of Monthly Stock Returns from Daily Returns in the Month, 1929-2010