The History and Economics of Stock Market Crashes

Paul D. Kaplan, CFA
Vice President, Quantitative Research
Morningstar, Inc., Chicago

Thomas Idzorek, CFA
Chief Investment Officer
Ibbotson Associates, Chicago

Michele Gambera, CFA
Chief Economist
Ibbotson Associates, Chicago

Katsunari Yamaguchi
President
Ibbotson Associates Japan, Tokyo

James Xiong, CFA
Senior Research Consultant
Ibbotson Associates, Chicago

David M. Blanchett, CFA
MBA Candidate
University of Chicago Booth School of Business, Chicago

The phrase "irrational exuberance" is closely associated with Alan Greenspan, the former chairman of the U.S. Federal Reserve Board. As Shiller (2005) explains:

> [Greenspan] used [it] in a black-tie dinner speech entitled "The Challenge of Central Banking in a Democratic Society" before the American Enterprise Institute at the Washington Hilton Hotel [on] December 5, 1996. Fourteen pages into this long speech, which was televised live on C-SPAN, he posed a rhetorical question: "But how do we know when irrational exuberance has unduly escalated asset values, which then become subject to unexpected and prolonged contractions as they have in Japan over the past decade?" He added that, "We as central bankers need not be concerned if a collapsing financial asset bubble does not threaten to impair the real economy, its production, jobs, and price stability."
>
> Immediately after he said this, the Tokyo stock market, which was open as he gave this speech, fell sharply, closing down 3%. Hong Kong fell 3%. Then markets in Frankfurt and London fell 4%. The stock market in the US fell 2% at the open of trade.

Shiller goes on to explain:

> It appears that "irrational exuberance" are Greenspan's own words, and not a speech writer's. In his 2007 autobiography, *The Age of Turbulence: Adventures in a New World* Greenspan said "The concept of irrational exuberance came to me in the bathtub one morning as I was writing a speech." (p. 176)

Although it is unlikely that Greenspan's simple statement was intended to cause the reaction that it did, the term "irrational exuberance" has now become associated with any period when investors are in a heightened state of speculative fervor. Speculative fervors, or bubbles as they are more popularly known, may be easy to identify with the benefit of hindsight, but they are not nearly as easy to identify when they are occurring. Moreover, they are not by any means a new phenomenon. Even though the recent market crash beginning in 2007 is likely fresh on the mind of the reader, there have been many others, and far worse—for example, from August 1929 to May 1932, when the U.S. stock market fell 79 percent, and from December 1989 to March 2003, when the Japanese stock market fell nearly 72 percent. (These returns are *real total returns*; in other words, they include dividends and are adjusted for the effects of consumer price inflation or deflation.[1])

"Black Sunday," 14 September 2008

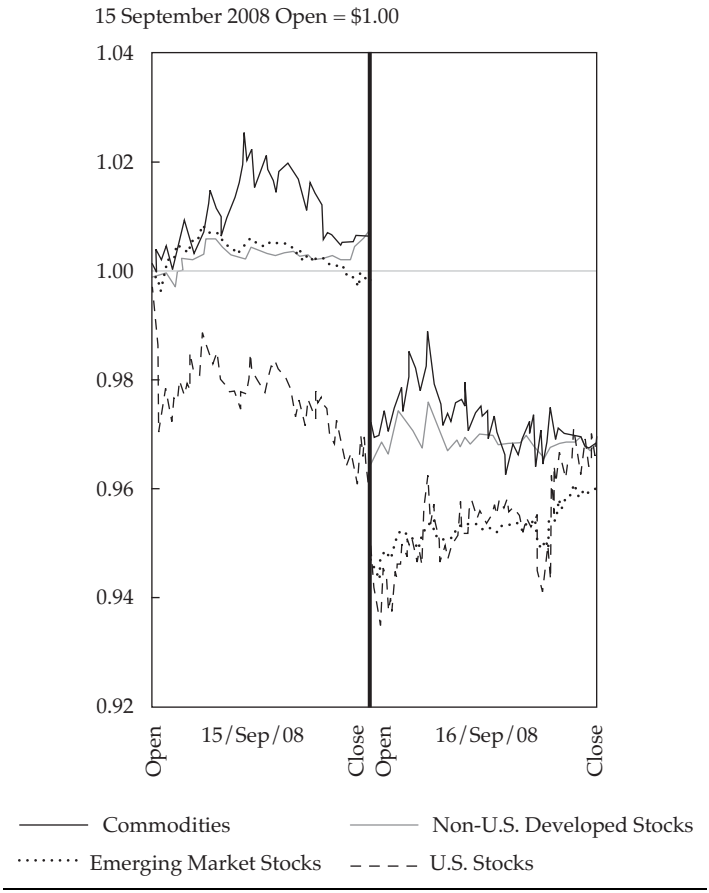
Much has been written about the 2008 crash, and certainly much more will be. At the time of this writing (mid-2009), the dust continues to settle. We will start with a brief version of what happened in the United States in 2008 and why.

Although markets had been in an orderly decline for the better part of a year, most observers agree that the catalyst that unleashed the full fury of 2008's global financial market meltdown occurred on Monday, 15 September 2008, when then-Secretary of the U.S. Treasury, Henry Paulson, announced that Lehman Brothers would be allowed to fail. Within minutes of this announcement, the various markets that were open tumbled and the credit markets began to freeze. The ensuing contagion resulted very quickly in a global financial crisis. **Figure 1** shows the intraday movement in various markets.

[1]We use real total returns, where possible, in this article because they represent the changes in purchasing power experienced by the investor. The use of nominal returns pretends that a dollar in 2009 is as valuable as a dollar in, say, 1900; it is not. The use of price-only returns (without dividends) omits one of the most important sources of return for investors, especially in past decades when dividend yields were higher than they are today.

Today's readers sometimes forget that the United States experienced a great deal of deflation during the Great Crash (1929–1932) period. Dividend yields were also high. Thus, the decline in real total return terms, just mentioned, was considerably less severe than the decline in the more familiar "nominal price-only" indices. Returns on nominal, price-only indices were as follows: The Dow Jones Industrial Average fell 89 percent on a top-day to bottom-day basis, and the S&P 90 (the precursor to the S&P 500 Index) fell 86 percent on a month-end (August 1929) to month-end (June 1932) basis.

Figure 1. Intraday Movement in Various Markets, 15 September–16 September 2008



Vulnerabilities in the Financial System. What factors led to the bubble that burst in the fall of 2008? The first critical ingredient at the heart of all bubbles is human nature. Greed and misaligned incentives were present throughout the system, which created this leverage-driven real estate bubble. (And rest assured, more bubbles are in our future.) In addition to raw greed, several financial innovations that were designed to reduce or transfer risk were, ironically, the means by which risk was greatly magnified.

The continued development of asset-backed securities, and more specifically the securitization of mortgages, contributed significantly to the crash. Twenty years ago, most mortgage providers owned and serviced the mortgage loans they made. Under this business model, the mortgage provider had a strong incentive to conduct due diligence on the loan applicant prior to lending the money. After all, if the applicant

was unable to pay the mortgage, it was the lender's problem. Additionally, when a borrower was in trouble, it was often possible for the borrower to make alternative arrangements with the lender. Over time, however, the mortgage business model changed. Mortgage providers began to sell off their mortgages to investment banks and other financial institutions that bundled the mortgages into mortgage-backed securities. This shift in the business model removed much of the incentive for mortgage providers to conduct due diligence on loan applicants and made it much more difficult for troubled borrowers to negotiate alternative arrangements.

The mortgage business model shift, in turn, fueled the development of a vast array of unconventional loans that would eventually be at the crux of the most "toxic" securities. (A toxic security, in current parlance, is one that has high risk or, especially, hidden risks.) The public was hungry for bigger and better homes that they could not truly afford; mortgage bankers and brokers craved the new business; investment bankers were eager to package and sell anything that the investing public would buy; and either the ratings agencies did not understand the true credit quality of these bundled mortgage-backed securities, or they were blinded by their conflicts of interest.

The second financial innovation that contributed to the recent bubble and crash was the development and widespread use of credit default swaps. Credit default swaps (CDS) are a form of "insurance" on bonds.[2] Should a bond default, the issuer (seller) of the CDS promises to make the purchaser whole. These risk-hedging devices had the unintended consequence of linking the financial stability of numerous financial firms together, creating a new kind of systemic risk capable of bringing down the financial system. As indicated later, the financial system very nearly succumbed to this risk.

CDS-issuing companies, such as AIG, dramatically underestimated the probability of widespread defaults and/or multiple defaults occurring in a short period of time. In addition, various financial institutions often held, as assets, large positions in bonds and other debt assets issued by other financial institutions; it was a widespread practice to hedge the default risk on these positions using CDS. This practice created a potential domino effect. The nearly simultaneous bankruptcy of several firms could immediately impair the CDS issuer(s), in turn, impairing additional financial institutions down the line and thus leading to a vicious cycle capable of destroying the financial system.

[2]The word "insurance" is in quotes because the buyer need not have an insurable interest. Thus, the notional amount of the insurance can be an unlimited multiple of the face value of the bonds. So, a CDS is essentially a naked short position, not an insurance policy, although the trigger feature of a CDS causes it to closely resemble insurance. This point is addressed in Peter Wallison's article in this book.

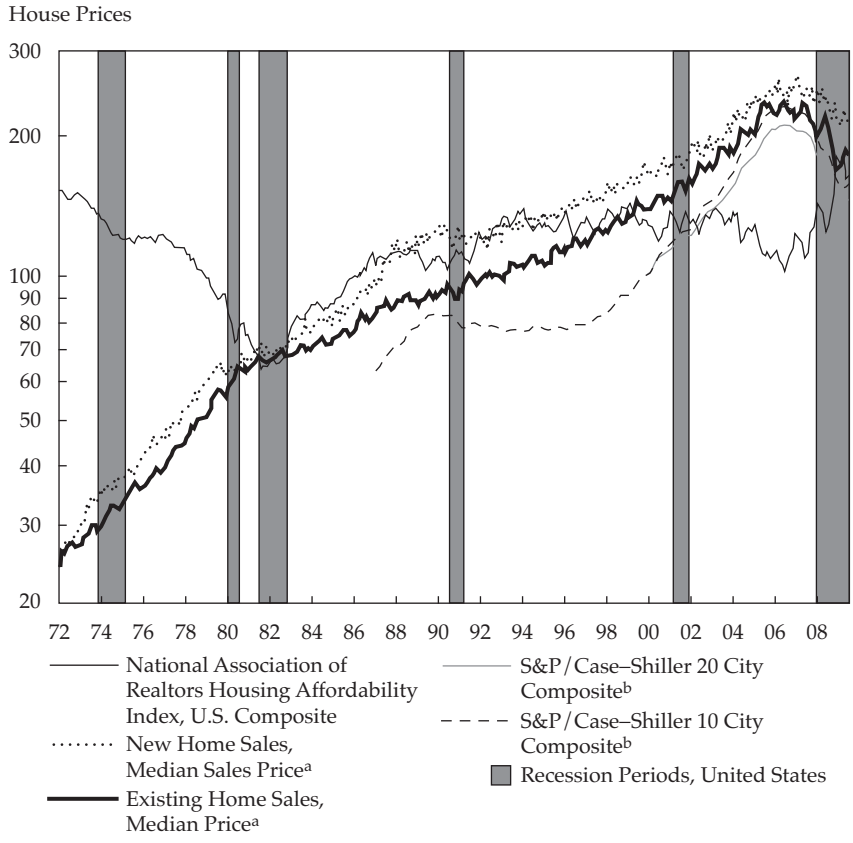
The environment prior to the crash could be described as one in which greed was rampant throughout the system; the lending system was out of control; ratings agencies completely failed at their job of giving accurate ratings to securities; and the risk-hedging system created a false sense of security, which inadvertently linked various players in the financial system together in an unhealthy way. We will resist the temptation to lambaste the market overseers that enabled these factors to exist in this form.

Deflation of the Real Estate Bubble and the Ensuing Financial Crisis. At the heart of the growing bubble was a leverage-driven residential real estate bubble that had started to deflate. **Figure 2** shows the S&P Case–Shiller Home Price Indices from January 1973 to June 2009, as well as several other house price metrics. As shown, house prices peaked around the beginning of 2006 and were clearly declining by the end of 2006. As real estate prices declined, the strain on the financial system increased, especially for firms with significant exposure to real estate–linked investments.

The first dramatic and highly visible sign of the pending meltdown began on 10 March 2008 as rumors of Bear Stearns' deteriorating financial health propagated through Wall Street. Bear Stearns had bet heavily on real estate, especially subprime mortgages. Falling real estate prices were quickly revealing the toxicity of many subprime mortgages. In addition to a large exposure to subprime mortgage-backed securities, Bear Stearns had sold billions of dollars of "insurance" on bonds in the form of CDS. The rumors became a self-fulfilling reality triggering a classic run on the bank. Within a week, Bear Stearns was on the brink of insolvency. After reviewing the web of interconnected CDS, Timothy Geithner, who was at the Federal Reserve Bank of New York at the time, and Ben Bernanke, the Federal Reserve chairman, deemed that allowing Bear Stearns to fail would cause multiple other financial institutions to fail. Bernanke arranged for JPMorgan Chase to acquire Bear Stearns at a bargain price and provided JPMorgan with a $30 billion guarantee to protect JPMorgan from further losses on Bear Stearns' toxic assets.

The Fed's move may have prevented the financial crisis from erupting in March 2008, but as time revealed, it had unintended consequences. Throughout mid-2008, house prices continued to fall, as Figure 2 shows. Falling house prices meant that ever larger numbers of homeowners owed more on their mortgages than their homes were now worth, removing a key incentive to pay their mortgages. The value of mortgage-related securities continued to drop. It was clear that the two largest home mortgage lenders—Fannie Mae and Freddie Mac—were in deep trouble. Fannie Mae and Freddie Mac were quintessential examples of financial institutions that had grown so large, and so interconnected with other institutions, that they were deemed too big to fail. Almost all Wall Street firms had significant exposure to debt issued by Fannie and Freddie. On 7 September 2008, the government ended months of speculation by nationalizing Fannie and Freddie.

Figure 2. U.S. House Price Measures, January 1973–June 2009



[a]Thousands of U.S. dollars.
[b]2000: 1=100.

Source: Based on data from FactSet.

The Treasury and the Fed were in the midst of a firefight to prevent the financial crisis from worsening—a fight that they would eventually lose. A crisis of confidence had already begun. The ensuing two weeks would see multiple stunning and unprecedented events—the failure of Lehman Brothers, sending the global financial system into crisis; the freezing of the credit markets; the nationalization of AIG; a comprehensive congressional bailout bill; the purchase of Merrill Lynch by Bank of America; and the eventual disappearance of "Wall Street" (the community of independently owned and operated investment banks).

Like Bear Stearns was in March, Lehman Brothers was now the victim of a bank run. This time, however, the Treasury and the Fed were unable to arrange a shotgun marriage for Lehman Brothers, largely because of their unwillingness to offer a potential suitor the same toxic-asset guarantees provided to JPMorgan six months earlier. Paulson's 15 September announcement that Lehman Brothers would be allowed to fail immediately sent the financial system into crisis. Markets around the world were in a free fall, and the credit markets froze. The crisis of confidence reached the first of several peaks. If Lehman could fail, anyone could fail. Concern over counterparty risk brought lending to a halt.

The announcement of Lehman's bankruptcy immediately put AIG into trouble. The day following the Lehman announcement, the U.S. government announced it would nationalize AIG. Like Bear Stearns, but on a far larger scale, AIG had issued billions of dollars of CDS—or what we have described as "insurance" on bonds—that promised to make bondholders whole in what was hitherto perceived as the highly unlikely event of a bond default. Those unlikely bond defaults were under way. AIG did not have the reserves to cover its CDS, and with the credit markets freezing, it would be impossible to borrow the required money.

The next day, Wednesday, 17 September, Bernanke and Paulson abandoned their piecemeal approach to dealing with the crisis and developed a comprehensive plan to present to congressional leaders the following day. On Thursday, Paulson sent a three-page bill to Congress asking for a $700 billion bailout of the financial system. On Friday, Goldman Sachs and Morgan Stanley—the last two independent investment banks, following the earlier demise of Bear Stearns and Lehman Brothers—converted themselves into bank holding companies, thus submitting to the oversight of the Fed and obtaining access to the Fed's discount window.

On 29 September, the U.S. House of Representatives rejected the bill, sending the markets into another free fall. The Dow Jones Industrial Average experienced its single largest point loss, losing 777 points or 6.98 percent. The following day, Asian and European markets followed suit.

After witnessing the market sell-off following the rejection of the Paulson–Bernanke bailout plan, Congress pushed through a slightly revised bill a few days later. The key revision enabled the government not only to purchase toxic assets but also to make direct capital injections into troubled companies. On 12 October, Paulson and Bernanke called an emergency meeting of CEOs from nine of the nation's largest banks, in which they basically forced the banks to accept direct capital injections, or Troubled Asset Relief Program (TARP) money as it has become known.

The market crisis continued throughout the rest of 2008 and into early 2009. All of these events deepened the severity of the recession that officially began in December 2007 and that has not ended as of this writing (mid-2009).[3] The equity and credit markets have, however, rebounded strongly, suggesting that markets are expecting a much-improved economic situation in the future.

Bubbles and Crashes Globally

With hindsight gained from more than a century of capital market history, both in the United States and in other markets, one can see that stock market crashes are a regular occurrence globally. To place the market meltdown of 2008–2009 in historical perspective, we examine the long-term record of stock market total return indices[4] for the United States, the United Kingdom, and Japan.[5]

We also examine the record of the regional stock market indices (stated in U.S. dollars) for Asia ex-Japan, Europe, and Latin America from 1988 to the present and compare them with the indices for Japan and the United States over that same period to see which of the more-recent crashes were regional and which were global in nature.

Data. Because the data came from a variety of sources, we needed to make these data comparable both between markets and across time. Therefore, we adjusted each market index by its domestic consumer price index. As a result, we present *real total return* indices; these contrast with the nominal, price-only indices, such as the S&P 500 Index, that are most commonly used.

We gathered index returns and inflation rates for the various markets covered by this study from the sources shown in **Table 1**. Note that some of the data from the earlier periods are at an annual frequency, whereas the more recent data are at a monthly frequency. Hence, when discussing some of the early part of the historical record, we present important dates in terms of year-ends and switch to month-end dates when discussing the more recent periods.[6]

[3]The National Bureau of Economic Research, or NBER, is charged with the responsibility of "officially" defining recessions after the fact. It historically has used a rule that a recession consists of two consecutive quarters with negative real GDP growth, meaning that the current recession started in July 2008. But NBER has recently adopted a more complex definition of a recession, according to which the current recession started in late 2007.

[4]Total return indices include reinvestment of dividends.

[5]Given the emphasis on the United States that prevails in the other sections of this article and throughout this book, we dedicate more space here to the United Kingdom and Japan than we do to the United States.

[6]For the United States, we interpolated monthly nominal total returns for 1876–1925 using monthly price returns on the Dow Jones averages and annual price and total returns from Ibbotson, Goetzmann, and Peng (2000). See Appendix B for a description of the methodology.

Table 1. Data Sources

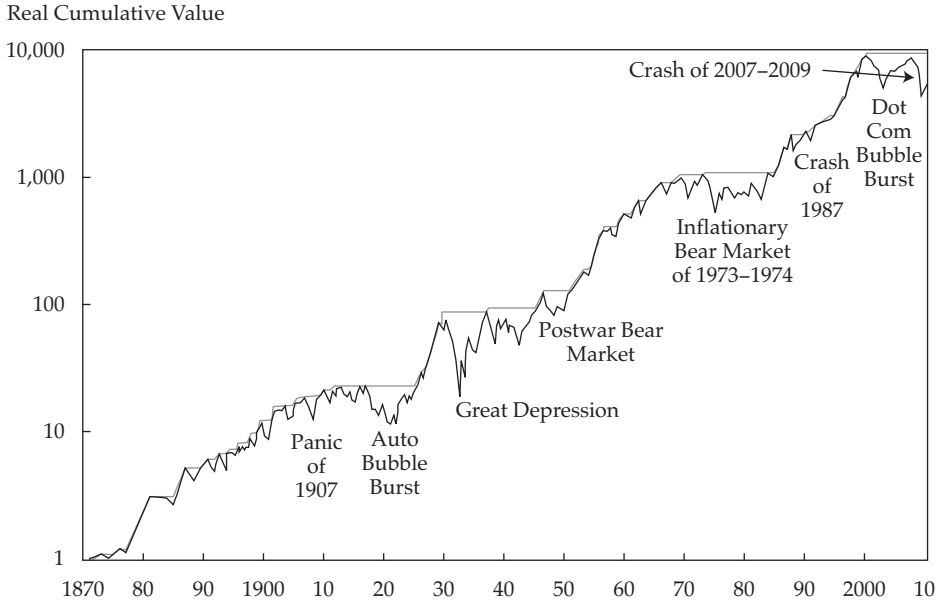
Market/Data	Period	Frequency	Source
United States			
Nominal total return	1871–1925	Annual	Ibbotson, Goetzmann, and Peng (2000)
Nominal price return	1886–1925	Annual	Ibbotson, Goetzmann, and Peng (2000)
	Jan 1886–Dec 1925	Monthly*	Dow Jones (as reported in Pierce 1982)
Inflation rate	1871–1925	Monthly, Annual**	Shiller (2009)
Real total return	Jan 1926–Jun 2009	Monthly	Morningstar (2009)***
United Kingdom			
Real total return	1900–1969	Annual	Dimson, Marsh, and Staunton (2002)***
Nominal total return	Jan 1970–Jun 2009	Monthly	MSCI Gross Return U.K. Index***
Inflation rate	Jan 1970–Jun 2009	Monthly	International Monetary Fund***
USD total return	Jan 1988–Jun 2009	Monthly	MSCI U.K. Index in U.S. dollars***
Japan			
Real total return	Jan 1952–Jun 2009	Monthly	Inflation-Adjusted TOPIX***
Inflation rate	Jan 1970–Jun 2009	Monthly	International Monetary Fund***
USD total return	Jan 1988–Jun 2009	Monthly	TOPIX in U.S. dollars***
Asia ex-Japan, Europe, Latin America			
USD total return	Jan 1988–May 2009	Monthly	MSCI All Country (AC) Asia ex-Japan Index***
			MSCI All Country Europe Index***
			MSCI Emerging Markets Latin America Index***

*Converted from daily data.
**Converted from monthly data.
***As reported in Morningstar® EnCorr®.

Appendix A contains the methodology used to blend multiple data sources (with various frequencies) into the country-specific real total return indices used in the figures and the discussion.

U.S. Record. **Figure 3** shows the real total return index and the peak values of the U.S. stock market over the period January 1871 through June 2009, a period of just more than 138 years. This plot shows that an investment in a hypothetical index fund of the U.S. stock market held over this period (with all dividends reinvested and no taxes, fees, or other costs) would have grown nearly 5,000-fold in real purchasing power. Nonetheless, a number of significant sharp and/or long declines occurred along the way. The periods where there are gaps between the peak and the index are the times—called "drawdowns"—when the market in question fell below its own immediate past peak and later recovered.

Figure 3. Real Total Return Index and Peak Values of the U.S. Stock Market, 1871–2009



In **Table 2**, we list the major drawdown and recovery periods ("major" designating those periods with greater than 20 percent declines). We also identify some noteworthy events during the respective periods.

U.K. Record. The long-term equity returns for the United Kingdom bear a striking resemblance to those of the United States, highlighting how connected the two economies have been. The largest shock to the U.K. stock market over the past 109 years occurred shortly after the collapse of the Bretton Woods system and during the oil crisis that began 17 October 1973, when members of the Organization of Arab Petroleum Exporting Countries (OAPEC) proclaimed an oil embargo against select industrial governments of the world to pressure Israel during the fourth Arab–Israeli War.[7] The reduced supply of oil led to an increase in price, which, when combined with strikes by coal miners and railroad workers, led to an energy crisis during the winter of 1973–1974. Although the embargo was officially lifted in March 1974, the U.K. stock market did not regain the peak reached in April 1972 until January 1984, roughly 12 years later.

[7]The now better-known OPEC (Organization of Petroleum Exporting Countries) is a separate, overlapping organization.

Table 2. Largest Declines in U.S. Stock Market History, January 1871–June 2009 (real total return terms)

Peak	Trough	Decline	Recovery	Event(s)
Aug 1929	May 1932	79.00%	Nov 1936	Crash of 1929; first part of Great Depression
Aug 2000	Feb 2009	54.00	TBD	Dot-com bubble burst (2000–2002); crash of 2007–2009
Dec 1972	Sep 1974	51.86	Dec 1984	Inflationary bear market; Vietnam; Watergate
Jun 1911	Dec 1920	50.96	Dec 1924	World War I; postwar auto bubble burst
Feb 1937	Mar 1938	49.93	Feb 1945	Second part of Great Depression; World War II
May 1946	Feb 1948	37.18	Oct 1950	Postwar bear market
Nov 1968	Jun 1970	35.46	Nov 1972	Start of inflationary bear market
Jan 1906	Oct 1907	34.22	Aug 1908	Panic of 1907
Apr 1899	Jun 1900	30.41	Mar 1901	Cornering of Northern Pacific stock
Aug 1987	Nov 1987	30.16	Jul 1989	"Black Monday," 19 Oct 1987
Oct 1892	Jul 1893	27.32	Mar 1894	Silver agitation
Dec 1961	Jun 1962	22.80	Apr 1963	Height of the Cold War; Cuban Missile Crisis
Nov 1886	Mar 1888	22.04	May 1889	Depression; railroad strikes
Apr 1903	Sep 1903	21.67	Nov 1904	Rich man's panic
Aug 1897	Mar 1898	21.13	Aug 1898	Outbreak of Boer War
Sep 1909	Jul 1910	20.55	Feb 1911	Enforcement of the Sherman Antitrust Act
May 1890	Jul 1891	20.11	Feb 1892	Baring crisis

The 74 percent drawdown in the real total return index of U.K. stocks in the 1970s is much worse than that same market's decline in the Great Depression, despite the much more severe damage to the real economy in the earlier episode. Thus, markets do not always track real economic events exactly or even somewhat closely, as shown in **Figure 4** and **Table 3**.

Japanese Record. The Japanese economy experienced a strong recovery following World War II and had relatively consistent growth through the 1980s, with the stock market peaking in December 1989. The compound annual real total return of the Tokyo Stock Price Index (TOPIX) from January 1952 to December 1989 was 13.4 percent.[8] The market then declined for much of the subsequent two decades—with stock prices falling 71.9 percent from the 1989 peak, in real terms, by March 2009. **Figure 5** and **Table 4** include information on the major declines in the Japanese stock market during the past six decades.

It is important to distinguish between market declines caused by business cycles and those caused by sudden unexpected crashes in Japan as well as in other markets. For example, the decline that began in December 1972 was triggered by currency

[8]The Tokyo Stock Exchange (TSE) is divided into three markets: the first section, second section, and Mothers (venture capital market). The first section includes the largest, most successful companies. The TOPIX tracks all domestic companies of the TSE's first section (see www.tse.or.jp/english/faq/list/general/g_b.html).

instability and rising interest rates following the first oil crisis. The 1961–65 decline was caused, at first, by a tightening of monetary policy and deteriorating corporate earnings, culminating in a financial market crisis that led to a bailout of Yamaichi Securities in 1965. Those are bear markets—continuous declines caused by changes in fundamentals but without a big one-day or several-day "crash."

Figure 4. U.K. Stock Market History, 1900–2009

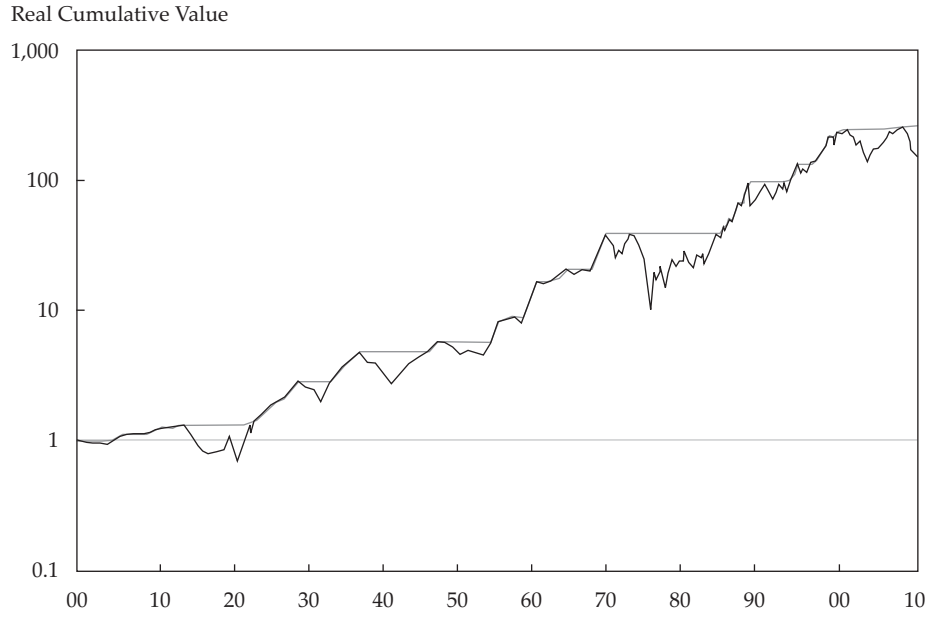


Table 3. Largest Declines in U.K. Stock Market History, 1900–2009
(real total return terms)

Peak	Trough	Decline	Recovery	Event(s)
Apr 1972	Nov 1974	73.81%	Jan 1984	Oil shock
1913	1920	45.85	1922	World War I
Dec 1999	Jan 2003	44.91	Apr 2007	Information technology bubble and collapse
1936	1940	43.71	1946	Second part of Great Depression; World War II
Oct 2007	Feb 2009	40.99	TBD	Crash of 2007–2009; global financial crisis
1968	May 1970	35.80	Apr 1972	Speculation in currencies; Bretton Woods
Sep 1987	Nov 1987	34.07	Nov 1992	"Black Monday," 19 Oct 1987
1928	1931	30.57	1933	First part of Great Depression
1946	1952	21.30	1954	Post–World War II correction

Figure 5. Japanese Stock Market History, 1952–2009

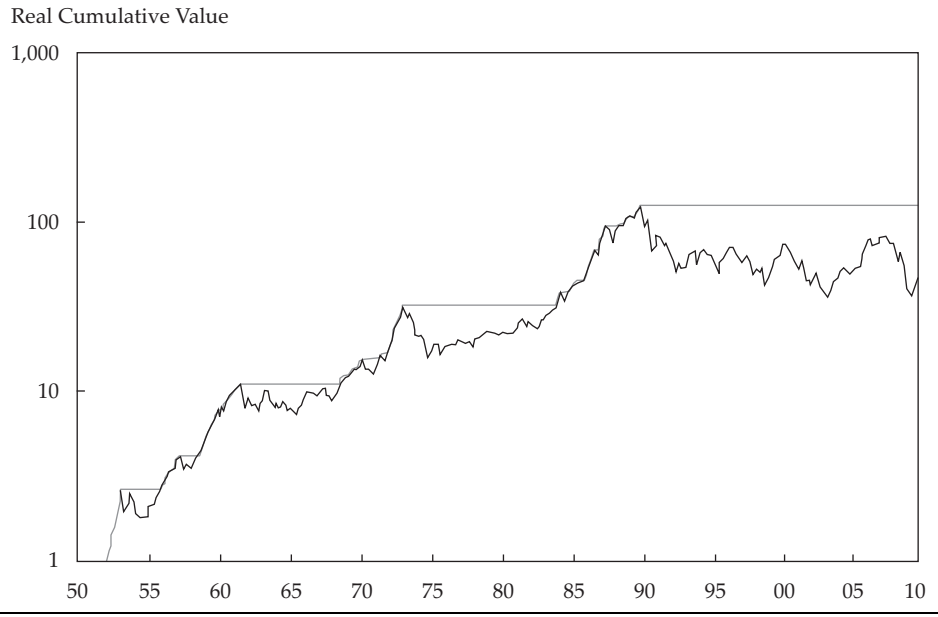


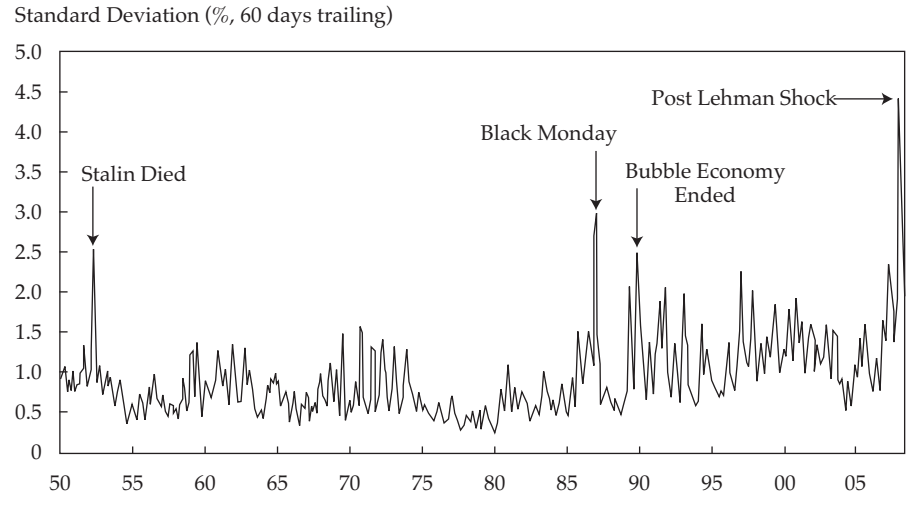
Table 4. Largest Post–World War II Declines in Japanese Stock Market History, January 1952–June 2009
(real total return terms)

Peak	Trough	Decline	Recovery	Event(s)
Dec 1989	Mar 2003	71.92%	TBD	Easy credit; real estate bubble
Dec 1972	Oct 1974	51.85	Dec 1983	Worldwide oil crisis
Jun 1961	Jun 1965	34.47	Aug 1968	Yamaichi Securities bailout
Jun 1953	May 1954	31.98	Dec 1955	Stalin shock
May 1970	Dec 1970	21.33	Jun 1972	Bretton Woods
Aug 1987	Dec 1987	19.79	Mar 1988	"Black Monday," 19 Oct 1987

When a large stock market crash occurs, market volatility (by definition) jumps up to an abnormal level. **Figure 6** shows the trailing 60-day volatility of the TOPIX over the past 60 years from December 1950 to March 2009.

Such abnormal spikes in daily volatility can usually be linked to specific events. The most recent crash after the Lehman shock in September 2008 led to a 4.3 percent daily standard deviation by the end of 2008, the highest average during these 60 years of Japan's history. The second highest level of trailing volatility occurred during the "Black Monday" episode in 1987. Until the 1980s, there was no significant jump in volatility except during the "Stalin shock" in 1953, when Joseph Stalin, prime minister of the Union of Soviet Socialist Republics and the general secretary of the Communist Party, died on 5 March of that year.

Figure 6. Daily Volatility of Japanese Stock Market, December 1950–March 2009



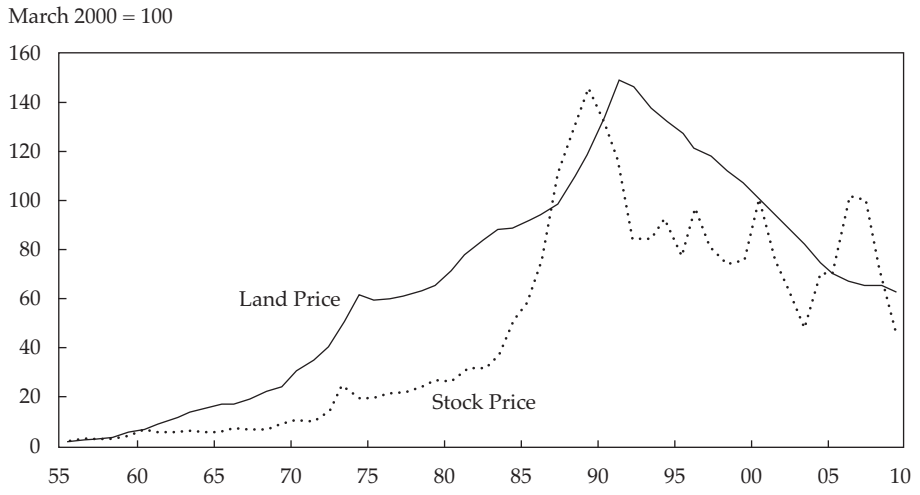
Although two of those crashes—"Black Monday" in 1987 and the Lehman shock in 2008—were global events, the long 1990–2009 downtrend in the Japanese stock market and the Stalin shock in 1953 were specific to Japan. These latter two events are described in more detail in the following sections.

■ *One big wave in five decades*. Over the past five decades, comprising essentially all of post–World War II Japanese history, there was basically one huge market event: a bull market or bubble that peaked around 1990 and the subsequent bear market or crash that extends through the present. A peculiar feature of this long wave is that land prices and stock prices increased together for the first 35 years and declined together in the following two decades. **Figure 7** shows a Japanese land price index and stock price index from 1955 to 2009.

Post–World War II industrial and commercial development in Japan were concentrated in a few large cities and their suburban areas—primarily the Tokyo metropolitan area, Nagoya, and Osaka. In the 1950s and 1960s, therefore, young workers began moving from rural areas to these urban areas for greater job opportunities and consequently began changing their careers from agriculture to manufacturing and commerce. Because of this massive demographic shift, the residential housing boom was sustained well into the 1970s. Because land is a scarce resource in Japan, land prices in urban areas continued to climb at a much faster pace than stock prices did in the 1960s and 1970s.

Although the abnormally high economic growth rate of the post–World War II period had already ended by the early 1970s, the Japanese economy continued to grow, powered by foreign demand for Japanese industrial goods primarily in the

Figure 7. Japanese Stock and Land Price Indices, 1955–2009



Notes: Annual index value with March 2000 = 100. The stock price index is the TOPIX Price Return Index published by the Tokyo Stock Exchange. The land price index is the Urban Land Price Index (which includes land used for commercial, residential, and industrial purposes) published by the Japan Real Estate Institute. Both indices are in nominal terms and exclude income (dividend or rental) returns.

automobile and electronics industries. This export-driven growth, however, created trade conflicts with other countries, especially the United States. In September 1985, the Group of Five (G–5) finance ministers announced the Plaza Accord and intervened in currency markets to cause the Japanese yen, among other currencies, to appreciate against the U.S. dollar. The value of the yen more than doubled in dollar terms in three years, from ¥251 per dollar in December 1984 to ¥121 per dollar in December 1987.[9]

The sudden and substantial appreciation of the yen had an immediate depressing effect on exports, and the Japanese economy went into a recession. The Bank of Japan lowered the official discount rate four times in 1986, from 5 percent to 3 percent and then to 2.5 percent in early 1987. Along with monetary policy, fiscal policy encouraged domestic spending through a ¥5 trillion investment in public construction and through a ¥1 trillion tax cut in 1987. This ¥6 trillion stimulus represented 1.8 percent of GDP at that time.

[9]The yen is quoted "European style," that is, the number of non-U.S. currency units per U.S. dollar. Thus, for the 1984–87 period, the value of the dollar (quoted in Japanese yen) halved; the value of the yen (quoted in dollars) doubled. See DeRosa (2009, p. 61).

Monetary and fiscal easing, starting in 1986, fueled a speculative investment boom in real estate and stocks, not only in the domestic (Japanese) market but also overseas because of the strength of the yen. For example, Japanese banks and brokerage firms were massively buying U.S. government bonds. Most Japanese insurance companies set up investment vehicles in the Cayman Islands and other tax havens for foreign investment purposes. In October 1989, Mitsubishi Estate Co. purchased Rockefeller Center in New York City for ¥220 billion.

In domestic markets, speculative bubbles were growing in both real estate and stocks in the late 1980s, as shown in **Table 5**. Banks lent funds to industrial companies to invest in stocks and real estate, even though such investments were not the primary business of those companies. In urban areas, small houses and shops were bought by developers, often for the purpose of tearing them down and redeveloping them. Higher stock prices also made it attractive for companies to issue equity and convertible bonds, although the large amount of equity financing subsequently caused the return on equity of Japanese companies to deteriorate.

Table 5. Annual Returns of Japanese Stock and Land Price Indices, 1986–1991

Month-End	Stock Price Index	Land Price Index
Mar 1986	26.7%	2.8%
Mar 1987	47.8	5.4
Mar 1988	14.8	10.0
Mar 1989	15.0	7.6
Mar 1990	–9.8	14.1
Mar 1991	–11.5	10.4

Source: See note to Figure 7.

On the last day of December 1989, the Nikkei 225 Index hit its all-time high, to which it has yet to return: 38,915.87. The high prices of stocks reflected the fact that market participants believed in an ever brighter future for the Japanese economy. A survey of 50 economists and strategists in January 1990 showed that they were still bullish: The average of their forecasts for the December 1990 level of the Nikkei was 44,861, up 15 percent from the previous year-end. The actual result turned out to be a big drop. The Nikkei average declined by 39 percent in 1990, finishing the year at 23,848.71.

In the late 1980s, when the price-to-book ratio of the Japanese stock index was as high as 5:1 or 6:1, high land prices were used as a justification for the extraordinary valuation of stocks at that time. Why? Because many of the major industrial companies owned land they acquired many years earlier, sometimes before World

War II. Because land holdings were carried at their historical acquisition cost on many companies' balance sheets, these companies accumulated large "hidden" asset values when the land was valued at then-prevailing prices. Even though corporate earnings did not justify the high valuation, many investors believed that the value of land owned by them justified the high valuation. Some economists and analysts revived a valuation metric called the "*q* ratio" or "Tobin's *q*," proposed by the Nobel Prize–winning economist James Tobin and consisting of the market value of a corporation's stock plus debt divided by the replacement cost of the company's assets.[10] As long as land prices remained at high levels, the *q* ratio remained at a modest level, justifying "buy" recommendations—or at least justifying the continued holding of such stocks.

As the Bank of Japan became nervous about ever increasing asset prices, it started raising interest rates to stop the bubble from growing further. It had kept its official discount rate as low as 2.5 percent since February 1987, but it raised this interest rate three times starting in mid-1989, reaching 4.25 percent by year-end. It further raised the rate twice, getting up to 6 percent in 1990. Stock prices responded by tumbling quickly after their peak at the end of 1989.

Even after the stock market started its decline, the construction boom continued until land prices ultimately peaked two years later in 1991. Because the construction boom in the late 1980s was largely financed by bank lending, the declining value of real estate created a large debt overhang among the industrial corporations that owned the real estate, as well as bad loans held by Japanese banks. It took almost a decade to wipe out those bad loans and restore the balance sheets of industrial corporations and banks. By the end of the 1990s, the banking industry in Japan had gone through a massive restructuring. Many of the leading banks merged into the big three "megabank" groups: Mizuho Bank, Mitsubishi UFJ Financial Group, and Sumitomo Mitsui Banking Corporation. Other major banks and brokerage firms either went into bankruptcy or were bailed out by the government and foreign funds.

■ *Stalin crash in 1953*. After World War II ended in August 1945, the Japanese economy was struggling for recovery because of a lack of capital and excessive inflation. The Japanese economy was reported to be generating a GDP per capita of only $1,346 in "1990 dollars," two-thirds that of Mexico and only double that of impoverished India.[11] The Tokyo Stock Exchange (TSE) reopened on 16 May 1949, and the TOPIX ended up closing at 22.06, but because of the depressed economy, the index declined by more than 50 percent in one year to a low of 9.63 on 30 June 1950.

[10] See Tobin (1969).

[11] Maddison (2009). The units are "1990 International Geary–Khamis dollars," roughly equivalent to the value of a U.S. dollar in 1990.

The Korean War, which erupted on 25 June 1950, was the trigger event that turned around the economy and stock market. Suddenly, Japan became an important geopolitical nation for those nations fighting against the Communist bloc. Led by military demand, the first postwar economic boom started with strong momentum. By 1953, most economic indicators—such as industrial production, consumer spending, and GDP—had recovered to their pre–World War II levels. By 4 March 1953, the TOPIX had climbed to 35.42, almost quadrupling in less than three years.

On 4 March 1953, the Soviet Union announced that Stalin was seriously ill. He died the next day, 5 March, at the age of 74. Following his death, military- and defense-related stocks declined sharply, both in the United States and Tokyo, with the TOPIX declining 8.7 percent on 5 March alone. This was the biggest one-day decline for the TOPIX until "Black Monday" in October 1987.

As with many (but not all) crashes, the price level after the Stalin crash represented an extraordinary opportunity. Measured from their 1953 lows, Japanese stocks doubled (in real total return terms) by 1957 and doubled again by 1960. The postwar Japanese economic miracle had begun.

Global Perspectives on 1987 and 1929 Crashes and the Long Boom. Although the market crashes of 1987 and 1929 certainly originated in the United States, they were not confined to the United States. Their ripples were felt globally and were sometimes more severe in other markets.

■ *Crash of 1987*. Prior to the most recent market drop, the largest collapse experienced by the vast majority of investors took place on 19 October 1987, an event commonly referred to as "Black Monday." Although some investors may believe the drop was limited largely to the United States, it was, in fact, a worldwide phenomenon. For the month of October, 19 of 23 country markets declined by more than 20 percent and all posted negative returns. The U.S. market had the 5th smallest decline in local currency units among the 23 countries but had the 11th smallest decline when the returns for each country are restated in U.S. dollars, as shown in **Table 6**.

The United States was also not the first market to decline sharply. The worst part of the collapse appeared to be in non-Japanese Asian markets on 19 October (their time), followed by European markets, then North American, and finally Japanese. Although markets were definitely connected in 1987, they had significantly lower correlations than they do today. In fact, from 1981 to 1987, October 1987 was the only month when all of the 23 markets moved in the same direction (down).

A variety of explanations have been proposed to understand the cause of the 1987 crash in the international stock market. In the United States, blame has been laid on the market's institutional structure and practices—such as computer-assisted trading, portfolio insurance, margin rules, and the absence of limitations of trading based on price movements (referred to as "circuit breakers"). Although these reasons

Table 6. October 1987 Stock Market Total Return

Rank	Market	Local Currency Units	Market	U.S. Dollar
1	Hong Kong	–45.8%	Hong Kong	–45.8%
2	Singapore	–42.2	Australia	–44.9
3	Australia	–41.8	Singapore	–41.6
4	Malaysia	–39.8	Malaysia	–39.3
5	Mexico	–35.0	Mexico	–37.6
6	Norway	–30.5	New Zealand	–36.0
7	New Zealand	–29.3	South Africa	–29.0
8	Ireland	–29.1	Norway	–28.2
9	Spain	–27.7	Ireland	–25.4
10	United Kingdom	–26.4	Spain	–23.1
11	Switzerland	–26.1	Canada	–22.9
12	South Africa	–23.9	United Kingdom	–22.1
13	Netherlands	–23.3	United States	–21.6
14	Belgium	–23.2	Switzerland	–20.8
15	France	–22.9	France	–19.5
16	Canada	–22.5	Belgium	–18.9
17	Germany	–22.3	Sweden	–18.6
18	Sweden	–21.8	Netherlands	–18.1
19	United States	–21.6	Germany	–17.1
20	Italy	–16.3	Italy	–12.9
21	Japan	–12.8	Japan	–7.7
22	Denmark	–12.5	Denmark	–7.3
23	Austria	–11.4	Austria	–5.8

Source: Based on data from Roll (1988).

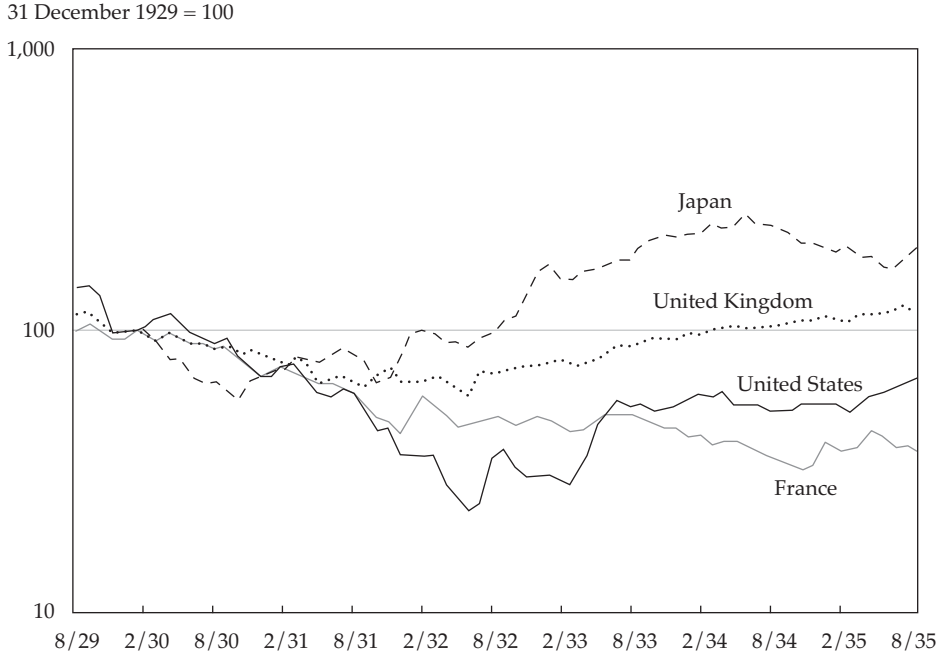
may hold for the U.S. market, they cannot possibly explain the similarities across all markets given how much market structures differ between countries. A more plausible explanation is that the fundamental values of stocks in one country were influenced by stock market price declines in other countries. Still, it is hard to believe that the fundamental value of the world's corporate equities could be 20 percent lower one day than it was the day before.

■ *Crash of 1929*. Going further back in time reveals a historical period with stock market declines that resemble (and in fact exceed) those of 2007–2009: the stock market crash of 1929 and the ensuing Great Depression.

In contrast to "Black Monday" in 1987, which was not followed by any sort of depression, the crash of 1929 ushered in a Great Depression that had a tremendous ongoing impact, not only on U.S. markets but also on international markets. The depression in the real economy lasted well into the early 1940s for some nations

and was the longest and most severe depression ever experienced by the industrialized Western world. **Figure 8** shows the cumulative price return of the stock markets of four countries—France, Japan, the United Kingdom, and the United States—in the periods before, during, and after the stock market crash.[12] Although the size of the market collapse varied considerably from country to country (Japan having by far the best performance in real total return terms), the returns across countries are highly correlated.

Figure 8. Real Stock Price Indices Excluding Dividends, 1929–1935



Source: Based on data from Kindleberger (1973).

[12]Because the returns in Figure 8 are real returns (adjusted for the domestic inflation rate in each country shown), they portray the changes in purchasing power experienced by a domestic investor, holding domestic stocks, and consuming in the domestic goods and services markets in each country. It is not necessary to adjust further for changes in exchange rates to describe this experience.

However, an international investor (say, a U.S. investor diversifying his or her risk by holding U.K., French, and Japanese stocks) does care about exchange rates. The sharp devaluation of the yen (from ¥2.00 per U.S. dollar in 1929 to ¥4.91 per dollar in 1934) would have substantially reduced returns to a U.S. investor in Japanese stocks over that period. (In 1935, the yen was revalued to ¥3.40 per dollar.) The British pound fell from $4.85 in 1929 to $3.34 in early 1933, depressing returns to U.S. investors in British stocks, but then rose to $5 by 1934. The French franc did not vary much between 1929 and 1933 but then rose from Fr25.59 to the dollar in 1933 to Fr15.31 in 1935 before falling sharply later in the decade. The source of the exchange rate data is Bidwell (1970).

Before the crash, the U.S. market was consistently reaching new all-time highs, with the Dow Jones Industrial Average increasing from a low of 191 in early 1928 to a high of 300 in December 1928 and a peak of 381 on 3 September 1929, roughly doubling over the less-than-two-year period. The expansion of production outside Europe during World War I, as well as the complications and reparations of war, also likely played a key role in causing the Great Depression.

The United States emerged from World War I as a major creditor and financier for the rebuilding effort in postwar Europe. Even before the crash, U.S. banks had started calling back previous loans in Europe. Yet the European credit structure depended extensively on U.S. loans, and given the excessive international speculation—not only in the capital markets but also in foreign direct investment—once financing was withdrawn, the entire system began to unravel. The Great Depression had the greatest effect on the nations that were most indebted to the United States, such as Germany and the United Kingdom. By early 1932, unemployment had reached 6 million in Germany, roughly 25 percent of the workforce.

To counter reduced demand and in an effort to protect domestic production, the majority of countries increased tariffs or raised existing ones. These measures dramatically reduced the volume of international trade. The United States introduced the Smoot–Hawley Tariff Act (officially known as the United States Tariff Act of 1930), raising tariffs to record levels on more than 20,000 imported goods. The ensuing retaliatory tariffs by U.S. trading partners reduced U.S. exports and imports by more than half (U.S. imports decreased from $4.4 billion in 1929 to $1.5 billion in 1933, a 66 percent nominal decline) and greatly contributed to the severity of the Great Depression.

Countries dependent on exporting primary products, such as food, had already started feeling the effects of the Great Depression in the late 1920s. More-efficient farming methods and technological changes meant the supply of agricultural products was increasing faster than demand, causing prices to fall. This trend was good for consumers but bad for producers, so the net effect is unclear.

Liquidity also became a concern during the Great Depression. When the stock market crashed, U.S. banks, which had depended heavily on their stock investments, began calling some of their loans. Unfortunately for the banks, as the economy worsened, repayment became more difficult. By 1933, 11,000 of the 25,000 banks in the United States had failed, dramatically affecting consumer confidence and leading to a reduction in spending that aggravated the continuing downward spiral.

A very strong recovery in 1935–1936 propelled some markets to fresh highs. Interestingly, the 1937 peak of the U.S. real total return index (not shown in Figure 8 but visible on a small scale in Figure 3) was higher than the 1929 peak. However, a second depression followed; the two depressions (and interposed recovery) combined to form what is now usually regarded, in retrospect, as a single Great Depression.

■ *Drawdowns during the Long Boom (1982–2007).* Stock markets around the world have experienced a number of large drawdowns over the past 20 years. Although Japan's drawdown, beginning in December 1989 and covered earlier in this article, is perhaps the most well known, other markets experienced similar, although more temporary, drawdowns.

By definition, an economic expansion is the period between recessions—that is, a period of continued growth without a recession. Most of the period from January 1988 to June 2009 was just that for many countries and stock markets: a period of continued growth. This period, which began for many countries in the early 1980s, is often characterized as the "Long Boom," during which many world economies grew at a relatively fast clip, with their respective stock markets following suit. Drawdowns of more than 50 percent, however, have actually occurred relatively frequently, even during the Long Boom. Generally, they have occurred in emerging market nations.

Apart from the crash of 2007–2009, both the Asia ex-Japan and Latin American stock markets have experienced market declines (in some cases experienced as crashes) of more than 50 percent. **Figure 9** and **Table 7** include information on drawdowns around the world in various markets from January 1988 to June 2009. Unfortunately, we do not have data covering emerging markets in the first years of the Long Boom, 1982–1987.

Figure 9. Drawdowns around the World, January 1988–June 2009
(U.S. dollars)

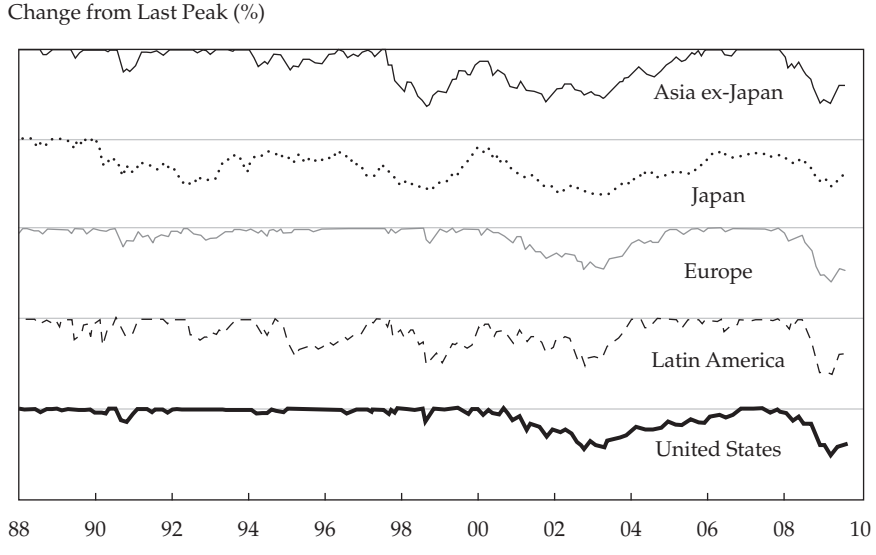


Table 7. Worst Drawdowns around the World, January 1988–June 2009
(in U.S. dollars)

Peak	Trough	Decline	Recovery
Asia ex-Japan			
Dec 1993	Aug 1998	64.55%	Dec 2005
Oct 2007	Feb 2009	61.50	TBD
Jul 1990	Sep 1990	27.30	Dec 1991
Apr 1989	Jun 1989	11.25	Sep 1989
Jul 1988	Aug 1988	8.30	Dec 1988
Apr 2006	Jun 2006	7.78	Oct 2006
Oct 1992	Dec 1992	6.46	Feb 1993
Jun 1992	Aug 1992	5.77	Oct 1992
Mar 1990	Apr 1990	4.08	May 1990
May 1993	Jun 1993	2.61	Aug 1993
Japan			
Dec 1989	Mar 2003	62.81%	TBD
Feb 1989	Jun 1989	11.38	Sep 1989
Apr 1988	Aug 1988	11.00	Nov 1988
Sep 1989	Oct 1989	2.68	Nov 1989
Europe			
Oct 2007	Feb 2009	59.78%	TBD
Mar 2000	Sep 2002	45.73	Dec 2004
Jul 1990	Sep 1990	20.49	May 1992
Jul 1998	Sep 1998	16.50	Apr 1999
May 1992	Nov 1992	13.62	Aug 1993
Jan 1994	Jun 1994	7.41	Aug 1994
Dec 1999	Jan 2000	7.00	Mar 2000
Apr 1988	Aug 1988	6.91	Oct 1988
Sep 1989	Oct 1989	6.50	Dec 1989
Jul 1997	Aug 1997	5.62	Sep 1997
Latin America			
May 2008	Feb 2009	61.12%	TBD
Jul 1997	Aug 1998	51.34	Dec 2003
Sep 1994	Mar 1995	42.23	Apr 1997
Feb 1990	Mar 1990	30.80	Jul 1990
May 1989	Jun 1989	25.00	Feb 1990
May 1992	Sep 1992	24.85	Aug 1993
Jul 1990	Oct 1990	20.22	Feb 1991
Jan 1994	Jun 1994	17.12	Aug 1994
Apr 2006	May 2006	13.89	Oct 2006
Mar 2004	May 2004	11.08	Sep 2004

(continued)

Table 7. Worst Drawdowns around the World, January 1988–June 2009
(in U.S. dollars) (continued)

Peak	Trough	Decline	Recovery
United States			
Oct 2007	Feb 2009	50.95%	TBD
Aug 2000	Sep 2002	44.73	Oct 2006
Jun 1998	Aug 1998	15.37	Nov 1998
May 1990	Oct 1990	14.70	Feb 1991
Jan 1994	Mar 1994	6.93	Aug 1994
Dec 1999	Feb 2000	6.82	Mar 2000
Dec 1989	Jan 1990	6.71	May 1990
Jun 1999	Sep 1999	6.24	Nov 1999
Jul 1997	Aug 1997	5.56	Nov 1997
Mar 2000	May 2000	5.00	Aug 2000

Stock returns in individual emerging markets have been even more volatile than in these broad regional aggregations. For example, the Russian stock market declined by about 80 percent during that country's government debt default crisis in 1998. Several individual country markets in Asia declined by a similar amount around that time. Readers wanting more detail on emerging equity market returns, volatility, booms, and crashes should refer to Speidell (forthcoming).

Why Do Crashes Occur?

Financial crises and bank failures have occurred throughout history. As an example, Calomiris (2008) mentions a bank panic in ancient Rome in AD 33. But in economies where subsistence farming and barter were widespread, banking crises affected only a small part of the population. For instance, although the topic is a series of banking failures in Europe in the 1300s, Homer and Sylla (2005) suggest that the major drag on economic growth came from recurring plague epidemics and not from the defaults of the kings of England and France, which caused bank failures during the Hundred Years' War (1337–1453).

In today's world, banks and insurance companies affect a large part of the economy. As a result, the health of the financial sector is a key factor in the economic cycle. At the same time, economic theory has devoted increasing attention to the causes of financial crises.

Economic Thought and Financial Crises. Adam Smith stated that the existence of many small banks is a guarantee for the public because, among other things, it limits the systemic effect of the failure of any one bank (Smith 1776, Book II, Chapter II). The banks at the core of the recent crisis are very large ones; just a few small banks shut down. If Smith's observation is accurate, then something must be wrong with very large banks.

Apart from Smith's remarks, bank size was not at the heart of economic theory until recently. Marginalist economics, pioneered by the economists William Stanley Jevons (1835–1882) and Léon Walras (1834–1910), assumed that all markets were in continuous equilibrium. Actually, the Walrasian economic model of general equilibrium did not even involve a fiat currency. All contingent contracts could exist in terms of an arbitrary good chosen as the numeraire (adventurous readers may take a look at Debreu 1959), so cash was not necessary. Markets would be perfectly efficient, and by Say's law, anything produced would be sold. Therefore, there would be no crisis because of lack of aggregate demand.[13]

Schumpeter (1942) brought a new perspective. In his view, market disequilibrium was an effect of technical innovation. When an entrepreneur either found a new way to produce an existing good or invented a new good, that entrepreneur would be the monopolist of that special process or product. This situation would lead to excess profits, which contrasts with the results of a perfectly competitive equilibrium. Soon, imitators would enter the market and reduce those excess profits, gradually leading the market back to its competitive equilibrium with no excess profits. In other words, Schumpeter's view was that innovation brings short-term disequilibrium in markets and that such disequilibrium is a good thing because it fosters product variety and technical efficiency. Moreover, disequilibrium would be limited only to the markets where an innovation has recently occurred.

J.G. Knut Wicksell and Irving Fisher (see, for example, Fisher 1933) introduced a view of disequilibrium that centered on financial markets, particularly the difference between the market interest rate and the equilibrium interest rate. The Walrasian model shows that, in a competitive equilibrium, the interest rate should equal the marginal productivity of capital.[14] And it makes sense that the marginal product of capital (that is, the extra gain by adding an extra unit of capital goods) should equal the equilibrium interest rate (that is, the cost of hiring an extra unit of capital) because if capital did cost less, one could hire more of it and make money—which would violate the no-arbitrage condition. Some economists call this marginal cost of capital the "natural" interest rate.

[13] (Jean-Baptiste) Say's law, "supply creates its own demand," sounds mysterious when so expressed. What Say meant was that the revenues generated in the production of a good are sufficient to buy it; thus, there can never be a general glut of goods.

[14] Financial practitioners may be a bit puzzled here because most economic theory relies on just one interest rate, with neither a yield curve (because models often focus on one or two periods) nor a credit spread (because there is no uncertainty). If that is your point of reference, please bear with us because there are useful insights for everyone in the finance viewpoint, which incorporates multiple time horizons and uncertainty.

Wicksell and Fisher pointed out that bankers may be overly optimistic about the future (that is, they estimate that the marginal productivity of capital will be very high in the future) because of some technological innovation, and they thus lend an excessive amount of money to entrepreneurs. This situation means that the market interest rate differs from the equilibrium interest rate.

When reality hits, however, entrepreneurs realize that they overinvested and are now plagued by excess capacity—as happened around the world with telecommunication infrastructures during the technology boom of the 1990s. As a result, capital investments come to a sudden stop, and aggregate demand plunges, leading to unemployment and an economic crisis. Only after some of the excess capital has become obsolete and must be replaced will entrepreneurs go back to investing. In the meantime, GDP growth suffers.

The theory presented by Wicksell and Fisher implies that excessive lending causes financial crises that can stop an entire economy because they cause first a bubble and then a crash in many markets at the same time. This situation was unconceivable for the marginalists, who did not think that disequilibrium conditions were possible.

Keynes (1936) set forth a theory that markedly differed from those of his predecessors. He argued, loosely speaking, that some special markets are almost never in equilibrium. The labor market is generally in disequilibrium, if nothing else because there always are some people who would like to work but are currently unemployed—for example, new college graduates who are looking for their first job or people who just quit their jobs and are about to start a new one. Moreover, nobody wants to get a salary cut if the economy slows down; therefore, companies agree not to cut salaries but to cut employees when demand decreases, thus creating cyclical unemployment. Financial markets, Keynes quipped, "can stay irrational longer than you can stay solvent." With this, he meant that financial markets are not perfectly efficient and that government policy, specifically fiscal "stimulus" (deficit spending to accelerate the demand for goods and services), may be a necessary remedy when a serious recession ensues. Not everybody knows that Keynes did not advocate large, persistent government budget deficits; he supported only focused actions against the most serious recessions.

Hayek (1932) had a different view on government policy. His view was that when governments and central banks try to expand credit to sustain the economy when a recession is feared, as they typically do, they end up causing a deeper recession. Therefore, Hayek criticized Keynes's intervention policy because he saw government intervention as the trigger of a Wicksell–Hayek crash, where the market interest rate diverges from the natural rate. Hayek trusted markets to be efficient enough to take care of themselves; prices and wages would change, and markets would go back to equilibrium right away. He thought that workers should accept lower wages when the marginal product of their labor decreased and that governments prevented wage falls for demagogic reasons, which in the end hurt workers.

Minsky (1986, 1992) studied why markets are, in Keynes's words, irrational, whereas modern portfolio theory relied heavily on market efficiency, which is the exact contrary. Minsky's insights fit nicely with the findings of behavioral finance. Briefly, Minsky argued that a lack of crises is the cause of future crises; that is, market stability is self-destructing. When market participants have been in a state of calm, they start believing that markets will remain calm for the foreseeable future and, therefore, start underestimating risk. As a result, they behave just like the overoptimistic bankers of Wicksell and Fisher. Minsky suggested some government intervention to prevent this kind of excess.

2007–09 Crash. How do the events of 2007–2009 fit into the aforementioned theories? It is now clear that many financial institutions had taken on too much debt and extended too much credit, thus accumulating an excessive amount of risk. In our opinion, this was a failure in several dimensions:

- Regulators allowed such accumulation of risk by allowing excessive leverage.
- Shareholders and boards of directors did not require sound risk management.
- Market participants underestimated risk.
- Academics believed too much in market efficiency and were reluctant to admit the possibility of market irrationality, even though some had spent the previous decade analyzing the technology bubble of the 1990s and the subsequent crash.
- Politicians were all too happy to see the economy grow at an excessive speed because that was good in the short run.
- Financial company CEOs were also quite happy to see short-term profits swell, hoping that the inevitable crash would occur after they had retired and cashed out of the company.

The events of the residential real estate markets in the United States, and in other countries such as Spain and Iceland, summarize the key points of the crisis. Home prices kept increasing, and people wanted to buy homes hoping not just to live in them but also to profit from their appreciation in value. Mortgage brokers, whose compensation depended on the number and size of mortgages they originated, gave mortgages to as many people as possible, regardless of whether these people could afford the mortgage. Banks, in a period of low spreads, were looking for fee income and looked for mortgages to be securitized and sold to investors. Investors, frustrated by otherwise low yields, were eager to purchase higher yielding mortgage-backed securities, without too much worry about the quality of the securities and, therefore, the sustainability of the yields. Bond-rating agencies, whose income (ironically) comes from bond issuers, made billions of dollars by trusting faulty risk models that gave AAA ratings to questionable mortgage-backed securities. Regulators did not recognize the risk of excessive leverage and allowed banks and other nondepository financial firms (e.g., investment banks) to use off-balance-sheet vehicles to hide the risks of securitization from their financial statements.

Therefore, this period saw market inefficiency, inadequate or inconsistent government vigilance, and a Wicksell–Fisher–Hayek–Minsky chain of events leading to excessive lending, a bubble, and a crash (see Cooper 2008). The crash causes a Keynesian aggregate demand drop with ineffective monetary policy because of already low policy interest rates. This is the so-called liquidity trap (see Keynes 1936), which can be represented in an IS/LM diagram by a horizontal line.[15] In such an environment, a monetary policy change has no effect on real output because any shifts to the right of the LM schedule do not change the intersection with the IS curve; therefore, income and interest rates remain the same. (For more about the liquidity trap in the current crisis, see Krugman 2008.)

Policy Conclusions

To prevent a repeat of the same type of crisis in the future, we believe that more-comprehensive regulation of the financial system is necessary. This does not mean that we advocate red tape but that supervisors must guarantee transparency and limit leverage. Moreover, this regulation should not be limited to banks but should also apply to insurance companies, investment banks, other nondepository financial institutions, and their holding companies (the so-called shadow banking system; see Paul McCulley's article in this book).

When market participants realized that a crash was imminent, they tried to sell all risky assets to take refuge in safe investments, such as short-term government bonds. The leading risk models used by most participants did not consider this possibility. As a result, we believe that risk models must consider scenarios of sudden flight to quality, and financial analysts should consider this kind of risk when building portfolios and developing their risk models (see Appendix B on risk models).

Moreover, we believe that some aspects of the financial infrastructure, such as the derivatives market, need reform. In particular, a reduction of over-the-counter derivatives transactions would lead to a more transparent and safe financial sector.

[15]The IS (investment = saving)/LM (liquidity demand = money supply) diagram illustrates the relationship between interest rates and GDP consistent with macroeconomic equilibrium in the real and monetary markets. John Hicks and Alvin Hansen, based on the work of Keynes, initially developed it. A summary of the model is available at http://homepage.newschool.edu/het/essays/keynes/hickshansen.htm.

Appendix A. Index and Drawdown Computation Methodology

Using the data from the sources identified in Table 1, we use the following methodology to create a series of inflation-adjusted indices.

Let

$R(s,t)$ = nominal total return on the index in local currency over the period s to t

$R\$(s,t)$ = nominal total return on the index in U.S. dollars over the period s to t

$\pi(s,t)$ = local currency inflation rate over the period s to t

$I(t)$ = real value of the index in local currency at time t

$I\$(t)$ = nominal value of the index in U.S. dollars at time t

An annual return is denoted if s and t are year-end dates, and a monthly return is denoted if s and t are month-end dates. Where price returns are used in place of total returns, because of limitations on data availability, this substitution is disclosed.

For the U.S., U.K., and Japanese markets, we calculate an inflation-adjusted (real) index that is 1.0 on the last day of 1870, 1899, and 1952, respectively.[16] Where the source is in nominal terms, we calculate the index levels from the total return and inflation data as follows:

$$I(t) = I(s)\frac{1+R(s,t)}{1+\pi(s,t)}. \tag{A.1}$$

For the United States, Japan, and the regions of Asia ex-Japan, Europe, and Latin America, we calculate U.S. dollar-denominated indices that start at $1 on the last day of 1987 as follows:[17]

$$I\$(t) = I\$(s)\left[1+R\$(s,t)\right]. \tag{A.2}$$

We define periods of drawdown and recovery. Drawdown is the simple (not annualized) percentage decline from the previously reached high point of an index to the subsequent low. To calculate drawdown, we first calculate, for each index, a corresponding time series of the peak values, P, of the index, which, like the index itself, starts at 1.0:

$$P(t+\Delta t) = \max\left[P(t), I(t+\Delta t)\right], \tag{A.3}$$

[16] The starting dates for the U.S. and U.K. indices were determined by the starting dates of what we consider to be reliable data. The returns reported by Dimson, Marsh, and Staunton (2002) show the Japanese stock market losing more than 97.5 percent of its real value over the 1943–47 period, clearly a result of World War II. Because data on the TOPIX starts just a few years later in 1952, for Japan, our analysis takes 31 December 1951 as the starting point.

[17] The last day of 1987 is the start date of the MSCI regional indices.

where Δt is the most granular time increment available in the data at time t.

Figures 3, 4, and 5 plot the indices and peaks for our historical real total return series for the United States, the United Kingdom, and Japan, respectively. The periods with gaps between the peak and the index are where the market in question fell below its own immediate past peak and later recovered. Where the gap is large, we refer to such periods as consisting of drawdown and recovery. To measure the extent of a crash or bear market and the length of the subsequent recovery period, we calculate a time series of drawdowns, D, as follows:

$$D(t) = \frac{I(t)}{P(t)} - 1. \tag{A.4}$$

When $D = 0$, the index is climbing to a new peak. When D falls below zero, a drawdown period has begun. When D returns to zero, the recovery (to the previous peak) period is over and the index is starting to move toward a new, higher peak.

Let t_0 and t_1 be the beginning and end of a drawdown–recovery period. In other words, $D(t_0) = D(t_1) = 0$ and

$$D(t) < 0 \text{ for } t_0 < t < t_1. \tag{A.5}$$

The maximum drawdown for the period is

$$D_{\max}(t_0, t_1) = \min\left[D(t) \mid t_0 < t < t_1\right]. \tag{A.6}$$

The trough, t^*, is the time at which the maximum drawdown is realized:

$$D(t^*) = D_{\max}(t_0, t_1). \tag{A.7}$$

In our summary of the history of market crashes, we focus on the time of the peak (t_0), the severity of the decline ($D_{\max}$), and the time until recovery ($t_1 - t^*$).

To interpolate monthly total returns for the United States from 1886 through 1925, we relied on data in Pierce (1982).

Pierce reports daily closing values for the various Dow Jones averages from their inceptions. We use the month-end values for four averages as follows:[18]

Dow Jones Average	Period
12-stock average	Jan 1886–Sep 1889
20-stock average	Sep 1889–Dec 1896
Prewar DJIA	Jan 1897–Jan 1915
Modern DJIA	Jan 1915–Dec 1925

[18]We thank Kailin Liu for manually entering the data in Pierce (1982) into a spreadsheet file. To our knowledge, this is the first electronic record of this dataset.

The first Dow Jones average that we use is a 12-stock mixed (railroad and industrial) average and runs from January 1886 to April 1896. (We use the value of this average on the first trading day of January 1886 as if it occurred on the last day of December 1885 so that we can calculate a return for January.) A broader (20-stock mixed railroad and industrial) average was started in September 1889 and runs to December 1896. Because we use the broadest index whenever possible, we switch to the 20-stock average in September 1889.

The pre–World War I Dow Jones Industrial Average (DJIA) is a 12-stock industrial average that starts January 1897. Because the 20-stock average was discontinued after December 1896, we switch to the prewar DJIA in January 1897 with no overlap between the series.[19] During 1914, the market was closed for almost five months, so Pierce contains no month-end values for August through November. To maintain a continuous monthly series, we fill in the July value for these months, thus making their price returns zero.

When the market reopened, Dow Jones had decided to constitute a new, broader industrial average. Both the old and new DJIAs were calculated through September 1916. The ratio of the value of the two indices is highly variable throughout the common period because they contained different stocks. In 1987, Ibbotson Associates determined that the best month to switch series was January 1915. We do the same here.

To link together the four series, we calculate three divisors as follows:

1. *Div*1 links the 12-stock average and the 20-stock average. It is the September 1889 value of the 20-stock average divided by that of the 12-stock average.
2. *Div*2 links the 20-stock average and the prewar DJIA. Because there is no overlap between these two indices, we divide the value of the prewar DJIA on the first trading day of January 1897 (2 January 1897) by the month-end December 1896 value of the 20-stock average. In other words, we assume that the daily return on the 20-stock average on 2 January 1897 would have been zero had the index existed.
3. *Div*3 links the prewar DJIA and the modern DJIA. It is the January 1915 value of the modern DJIA divided by that of the prewar DJIA.

Our final series is calculated as follows:

Period	Calculation
Jan 1886–Aug 1889	12-stock avg × *Div*1 × *Div*2 × *Div*3
Sep 1889–Dec 1896	20-stock avg × *Div*2 × *Div*3
Jan 1897–Jan 1914	Prewar DJIA × *Div*3
Jan 1915–Dec 1925	Modern DJIA

[19] See the construction of the divisor *Div*2 later for details on how we linked these nonoverlapping series.

Price Returns. Ibbotson, Goetzmann, and Peng (2000), henceforth IGP, report annual price and total returns for the U.S. stock market for years prior to 1926. For a given year, let:

PR_{IGP} = the annual price return reported by IGP
$P_{DJ}(m)$ = the value of our linked Dow Jones index in month m
$P_{DJ}(0)$ = the value of our linked Dow Jones index for December of the prior year
$PR(m)$ = our interpolated price return for month m

For m = 1, 2,…, 12, we calculate

$$PR(m) = \left[\frac{1+PR_{IGP}}{P_{DJ}(12)/P_{DJ}(0)}\right]^{\frac{1}{12}}\left[\frac{P_{DJ}(m)}{P_{DJ}(m-1)}\right]-1. \tag{A.8}$$

In this way, the difference of the annual price growth rates of the IGP and our Dow Jones series is spread equally across the 12 months of the year.

Total Returns. For each year, we interpolate monthly total returns by assuming a constant level of monthly dividends, d. Let

TR_{IGP} = the annual total return reported by IGP
$TR(m,d)$ = our interpolated price return for month m if the dividend level is d
$CPR(m)$ = the cumulative price return for months 0 through m

We calculate

$$CPR(m) = \begin{cases} 0, & \text{if } m = 0 \\ \prod_{n=1}^{m}\left[1+PR(n)\right]-1, & \text{if } m > 0 \end{cases} \tag{A.9}$$

so that

$$TR(m) = PR(m) + \frac{d}{1+CPR(m-1)}. \tag{A.10}$$

The 12 monthly total returns must link to TR_{IGP}. Hence, we find d by solving the equation

$$\prod_{m=1}^{12}\left[1+TR(m,d)\right] = 1+TR_{IGP}. \tag{A.11}$$

Appendix B. Mathematical Models of Market Crashes

Mathematical models of stock market crashes have been studied extensively, but no single model satisfies every researcher. In this appendix, we will discuss some of the more interesting models that are used to describe and explain the characteristics of market crashes. First, we will cover statistical distribution models that describe the distribution of stock market returns more realistically than the conventional normal distribution (Gaussian) or lognormal model does.[20] Returns have historically generated "fatter tails" than are implied by the normal or lognormal distribution. Next, we will cover extreme value theory, which focuses only on the tails of distributions, and how to estimate these from the data. Last, we will explore herd behavior and explain why it can give rise to fat tails.

Statistical Distribution Models. The most common model of asset returns is the normal or Gaussian distribution, which was first suggested by the French mathematician Louis Bachelier in his 1900 doctoral dissertation. This model is natural if one assumes that the return over a time interval is the result of many small independent shocks. The central limit theorem (CLT) implies that, under such conditions, returns follow a Gaussian distribution. The central limit theorem states that the sum of a sufficiently large number of independent random variables, each with finite mean and variance, will be approximately normally distributed. The model provides a first approximation of the behavior observed in empirical stock return data. Return distributions, however, are more leptokurtic (or "fat-tailed on the left-hand side") than implied by the Gaussian distribution model.

The normal distribution can be used to describe, at least approximately, any variable that tends to cluster around the mean. The probability of an asset return (or event) occurring that is three standard deviations below its mean (also known as a three-sigma event) is only ~0.13 percent (i.e., one would expect this to occur only 13 in every 10,000 times).

For example, from January 1926 to April 2009, the S&P 500 total return index had a monthly mean return of 0.91 percent and a monthly standard deviation of 5.55 percent. A negative three-sigma event would be a return of –15.74 percent. During this time period, there were 10 monthly returns worse than –15.74 percent, as shown in **Table B1**. These data imply that the probability of a three-sigma event is 1 percent rather than 0.13 percent, or eight times greater than one would expect under a normal distribution. Hence, a normal distribution fails to describe the "fat" or "heavy" tails of the stock market.

[20] The lognormal model differs from the classic Gaussian normal distribution model by assuming that the logarithms of return relatives, $\ln(1 + r)$, not the returns themselves (r), are distributed normally. This adjustment reflects the fact that stock returns cannot be less than –100 percent.

Table B1. Worst 10 Monthly Returns for the S&P 500, January 1926–April 2009

Period	S&P 500 (%)
Sep 1931	−29.73
Mar 1938	−24.87
May 1940	−22.89
May 1932	−21.96
Oct 1987	−21.52
Apr 1932	−19.97
Oct 1929	−19.73
Feb 1933	−17.72
Oct 2008	−16.79
Jun 1930	−16.25

Source: Based on data from Morningstar EnCorr.

By definition, market crashes are distributed in the far left tails, as shown in Table B1. Because the normal distribution model fails to describe the heavy tails, it will also fail to describe market crashes.

Many statistical models have been put forth to account for the heavy tails. Examples are Benoit Mandelbrot's stable Paretian hypothesis (Mandelbrot 1963), Student's *t*-distribution (Blattberg and Gonedes 1974), and the mixture of Gaussian distributions model (Clark 1973). The latter two models—Student's *t*-distribution and the mixture of Gaussian distributions model—both possess finite variance and fat tails, but they are not stable, which implies that their shapes are changing at different time horizons and that distributions at different time horizons do not obey scaling relations.

An alternative model is the Lévy (1925) stable distribution model, also known as the stable Paretian distribution or simply the stable distribution. In 1963, Mandelbrot, the mathematician best known as the father of fractal geometry, studied changes in cotton prices over time. He found that the changes did not follow a normal distribution but instead a stable distribution, where the distribution of returns had an infinite variance. Later, his student Eugene Fama applied the model to changes in stock prices in his doctoral dissertation (Fama 1965).

In the context of logarithm of asset return "relatives" (where the relative is the asset return plus 1), the corresponding models are the lognormal and log-stable models. Kaplan (2009) illustrates that the lognormal distribution fails to fit the left tails of the S&P 500 return distribution and that the log-stable distribution does a much better job. The stable distribution, however, suffers from an infinite variance

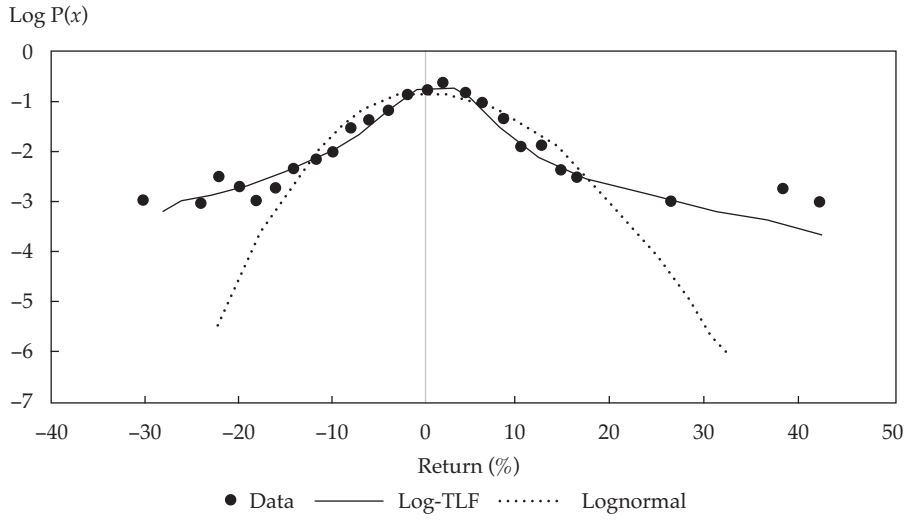
as mentioned earlier, and thus, its tails are perhaps too fat. A simple solution is to truncate the tails of the stable distribution, which results in what is known as the Truncated Lévy Flight (TLF). The TLF distribution has finite variance and fat tails.

Previous studies (Mantegna and Stanley 1999) have demonstrated that the TLF model describes return distributions measured at high-frequency time horizons quite well. **Figure B1** compares the log-TLF model with the lognormal model in fitting the historical return distributions for the S&P 500 (Xiong 2009). One can see that the log-TLF model provides an excellent fit for the S&P 500 in all aspects: center, tails, minimum, and maximum.

Extreme Value Theory. Stock market crashes are extreme realizations of the underlying return distribution. The bulk of statistical methods is concerned about finding the probabilistic characteristics of the whole population of a dataset (i.e., its mean, variance, and distribution). In contrast, extreme value theory (EVT) focuses only on the tails of distributions and how to estimate them from data.

EVT requires extensive data because the most informative events are historical crises, which are relatively rare events by their very nature. It is critically important that the data used to estimate extreme events contain some information about extreme events.

Figure B1. The Semi-Log Historical Distributions of S&P 500 Monthly Returns Fitted by the Log-TLF and Lognormal Models, January 1926–April 2009



Source: Based on data from Xiong (2009).

EVT is a practical tool that allows risk managers to estimate tail risk. It can be used to compute the probabilities of extreme events. An interesting application is to determine whether emerging markets have fatter left tails than developed countries have. LeBaron and Samanta (2005) demonstrated that crashes appear to be more frequent in emerging than developed markets. The characteristics of emerging market crashes within the same region, such as Latin America or Asia, appear to be very similar, indicating the geographical nature of market crashes. This fact has important implications for international portfolio managers.

Herd Behavior and Stock Market Crashes. The statistical models discussed earlier consider the market to be a "black box" and are not based on any economic model. Economic models are needed to explain why market crashes occur and what to do about them.

Cooper (2008) reminds us of the important role of Minsky's financial instability hypothesis in understanding the origin of financial crises (Minsky 1986, 1992). Cooper noted that the existence of extreme events, such as bank runs, has been well understood in finance for hundreds of years; however, their presence is entirely ignored by mainstream financial theory. In contrast, Minsky's theory of self-reinforcing positive feedback processes can be used to understand these extreme events.

The positive feedback processes are closely related to herd behavior. Shiller (2000) provides massive evidence to support his argument that irrational exuberance produced the ups and downs of the stock and real estate markets. He demonstrates that psychological factors, such as herd behavior and epidemics, exert important effects on markets. For example, the influence of authority over the human mind can be enormous, and people are ready to believe authorities even when they plainly contradict matter-of-fact judgment; people tend to imitate other people's actions rather than choosing to exercise their own judgment about the market; most people purchase stocks based on direct interpersonal communication instead of independent research; and so on.

A mathematical model that connects herd behavior to fat tails was developed by Cont and Bouchaud (2000). The model assumes that agents group together in clusters. For example, a cluster can represent a group of security analysts who herd together. The Cont and Bouchaud model ultimately gives rise to heavy tails in the distribution of stock price variations, similar to distributions observed in empirical studies of high-frequency market data. The model provides a link between two well-known market phenomena: the heavy tails observed in the distribution of stock market returns, on the one hand, and herding behavior in financial markets, on the other hand.

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