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Asset price bubble identification and response

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Abstract

This paper investigates the existence of asset price bubbles. It first gives a history of financial crises and asset bubbles around the world throughout history as a background to the issue and then moves into finding the reason why they are able to exist in a market with both rational and irrational participants. Then by looking at the historical data for the United States housing and stock markets sets bubble identification rules based on standard deviation bounds. This method proves to be a very accurate way of identifying bubbles. The best response for both monetary policy authorities and market participants is then briefly examined.

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Introduction

Asset price bubbles are a very hot topic in the media today. This renewed interest comes after the recent financial crisis that was brought on by the implosion of the housing bubble that formed throughout the last decade. This renewed interest is not uncommon after such an event of this nature. Asset price bubbles are however not a new phenomena happening quite often throughout history. If something that has damaging real effects on the economy and has happened throughout history why does it always come as a surprise event when a bubble pops? Should we not be able to see it coming? There has been lots of research on the causes of asset price bubble models and their existence in a rational world. This paper will be organized as follows. In the first section I will look at the history of asset price bubbles and financial crises around the world. In the second section I will look at the different models that explain why bubbles are able to form in a rational world. In the third section I will use a standard deviation bound identification approach to test for bubbles in the United States housing and stock market data. In the fourth section I will make recommendations on the best response of monetary authorities to asset price bubbles. In the fifth section I will give suggestion on the best approaches for market participants and in the sixth section I will make my conclusions. In this analysis I will be focusing on asset price bubbles in the United States housing and stock markets. I do however believe that the identification method can be extended to all countries and asset classes.

History of Asset Price Bubbles

Asset price bubbles have a very long and recurring history of causing financial crises. With this long history it is very surprising that we still are somewhat surprised when they burst and lead us into crisis. I will go over this history as a background to justify the importance of this paper in developing a simple model on the identification of bubbles. I will cover both developed and developing nations in this history even though I will focus on developed nations and in particular the United States in my statistical analysis. I do this because I believe my model will be able to extend to the identification of developing nations even though root causes are not completely identical. The bubbles in assets of developing nations are also important to note as there is usually a spread to the developed world through the connection of capital.

The first asset price bubble in history was the Dutch "Tulip Mania" in 1636-37. In this episode the price of tulip bulbs went up by several hundred percent in the autumn of 1936. Some exotic varieties of bulbs had even larger increases in prices. (Kindleberger and Aliber 2011) As with all bubbles this reached a peak and when the prices fell it hurt the income and confidence of consumers and slow economic growth. This did not however lead to a depression which is an interesting side point about how large an effect an asset price bubble bursting has on the real economy. The reasons for this will be explored later in the paper.

The world's first international crisis came in 1825 after the overthrow of the Spanish empire. This allowed for trade between England and Latin America which led to large capital inflows from England to Latin America. This led to a boom in the stock market as well. This

increase in capital flows out of England impinged on the gold reserves of the Bank of England which raised its rates to stem future outflows. This raise in rates led to a stock market crash. At the same time the sudden stop of capital flows to Latin America led to defaults, banking panics and currency crashes throughout the region. (Kamalodin 2011)

The next notable global financial crisis took place with the collapse of the property boom in Germany and Austria in 1873. This panic caused European investors to dump US railroad stocks which had been undergoing a speculative boom from the large capital inflows from these European investors. This selling of railroad stocks was also brought on by the uncovering of fraud in many US companies. This sudden stop of capital outflows from Europeans also led to debt defaults and banking panics in Peru. (Kindleberger and Aliber 2011) Soon after this the developed world faced what is known as the Baring Crisis in 1890 after once again there were large capital flows to Latin America had created a land boom. Again the Bank of England and other European Central banks raised their policy rates to maintain the level of gold reserves. This stop in capital flow led to a banking crisis, debt default and a currency crisis in Argentina. This would usually not be a problem for the developed world but since Barings Brothers one of London's biggest banks was highly exposed to Argentine debt and became insolvent when the default occurred a large panic in the interconnected banking systems of many countries ensued. Countries that had panics included Japan, Australia, New Zealand, United States and many European Countries. (Kamalodin 2011)

The first panic of the 20th century occurred in 1907 when the US stock market fell 40%. The preceding boom had been financed by easy credit and excessive speculation. The

expansion preceding the crash was fueled by out of town banks lending unknown amounts in New York and New York Banks borrowing large amounts in London. This led to gold outflows from London and to a raise in interest rates. There were ample warnings that this speculation was destabilizing the financial system and even some miniature panics in the months preceding the major decline. This crisis spread to other countries including France, Italy, Denmark, Sweden and Japan. (Kindleberger and Aliber 2011)

The next major international financial crisis was the Great Depression which began in 1929 with a stock market crash. The bubble that formed in the stock market in the late 1920's was driven by the expansion in credit and in particular broker loans. This period also saw the rise of many securities affiliates and investment trusts. (White 1990) This expansion of credit in the form of broker loans was a great worry for the Federal Reserve. The monetary policy decisions throughout this crisis have drawn a lot of criticism and may have negatively contributed to the deepness of the depression that followed the stock market crash. The Federal Reserve Board was very worried about the amount of speculation in the stock market and favored using the direct approach of targeting the bubble by refusing access to the discount window for lenders that were financing speculation. The New York Federal Reserve Bank wanted to raise the discount rate. This led to a stalemate that caused insufficient policy action from the Federal Reserve. The ability of the Federal Reserve to target these broker loans may have been overstated since the source of these loans was from foreign banks and private investors. The amount of call loans from banks that were neither New York Banks or outside of New York banks rose from $2.2 Billion in 1926 to $6.6 Billion by October of 1929 while the level of call loans from New York banks fell from its peak of $1.6 Billion at the end of 1928 to $1.1

Billion in October of 1929. (Kindleberger and Aliber 2011) The rates on broker loans were increasing during this time while the balances still increased which also leads us to believe that the level was mainly caused by excessive demand not excessive supply weakening the idea that the Fed could target them. (White 1990) The stalemate came to an end in August of 1929 when the discount rate was increased from 5% to 6%. (Bordo and Jeanne 2002) At the time that this interest rate increase occurred the economy had already begun to show signs of a downturn. The industrial production index had started to decrease in July of 1929 falling from its peak in June of 127 to 122 by September. (Kindleberger and Aliber 2011) After the rate increase other economic indices also began to fall. (White 1990) It appeared that this rate increase as a response to speculation had come at a horrible time. In October of 1929 the stock market began to crash dropping 40% in the next 2 months. This fall caused the assets that banks held as collateral to decrease in value which prompted both banking panics and fire sales of stocks that led to further market declines. The Banking panics that occurred led to a collapse in financial intermediation, the money supply and aggregate demand. (Bordo and Jeanne 2002)

The period following the great depression and WWII was relatively calm in terms of asset price bubbles and financial crisis. This was mainly due to strict regulations on the financial sector and the exchange rate structure agreed to in the Bretton Woods conference following the war. Once the Bretton Woods system broke down in 1971, capital flows around the world surged. Throughout the 1970's there were small banking crises around the world but nothing that was significant enough for me to cover in this paper. This was however a period of very high inflation in many developed economies which set the stage for the Latin American Debt Crisis of 1982. This crisis which occurred throughout Latin America greatly resembled past

crises in the area. The area had received a boom in capital inflows following the breakdown of Bretton Woods. When the developing nations undertook strictly tight monetary policies to break the path of inflation these capital inflows came to a sudden halt. As in the past this led to many Latin American countries notably Mexico, Argentina, Chile and Ecuador to default on their debts. This spread too many countries around the world that had been financing these countries debts. Notable Banks that had to be bailed out were Citibank and Chase. (Kamalodin 2011)

In the late 1980's and early 1990's there was a major asset price boom and bust in Japan. This bubble was in both real estate prices and stock prices. This bubble which started in 1986 came to a peak in 1989. At its peak in 1989 the market value of Japanese equities was around $4 Trillion which at the time was 1.5 times the value of US equities and 45% of the world's total market capitalization. The average price to earnings ratio had gone from under 25 to over 60. The value of Japanese real estate had increased 75 times in the period of 1955 to 1990. By selling all of the properties in Metropolitan Tokyo you could have bought all the property in the United States. (Kamalodin 2011) The start of this bubble was the increase in land prices that were driven by easy mortgage lending. This rise in the values of land led to companies having increased value of collateral and higher cash flows. This value was translated into their stock prices which then rose dramatically. This boom was also fueled by the low interest rates in Japan at the time. Many believed that these assets were not far above their fundamental values because of the low interest rates. For this to be true however the interest rates would have to be expected to stay that low forever. (Ito and Iwaisako 1995) These low interest rates nonetheless allowed for the bubble to continue growing. In the time before the

crash the Bank of Japan had been implementing an expansionary monetary policy and lowering interest rates while asset prices were increasing in value. This is not consistent with the general monetary policy action of inflation targeting and many believe that the Bank of Japan was targeting the exchange rate during this time period. (Bernanke and Gertler 2000) In 1989 the policy of the Bank of Japan switched in an attempt to control asset price increases and interest rates were increased. This led to a crash in asset prices which had a highly damaging effect on the real economy. As asset prices decreased the Bank of Japan remained very restrictive in its monetary policy which may have contributed to the long downturn afterwards. (Bernanke and Gertler 2000) The rapid decrease in asset prices led to a collapse in bank lending as the value of collateral on loans decreased. Also since banks were allowed to hold capital in equities their capital decreased. The Bank of Japan however did step in as a lender of last resort propping up the insolvent banks. The downturn following the asset bubble popping was very prolonged. (Bordo and Jeanne 2002)

The United States in the time period after the Latin American Debt Crisis of 1982 was very calm in terms of crisis and had a very healthy economy. This was until the next bubble commonly known as the dot com or the technology bubble formed starting around 1995. The causes of this bubble were both hysteria over a new age and massive capital flows from the rest of the world to the United States. These capital flows came from Mexico after it had a financial crisis in 1994. These capital flows resulted in a price gain for US securities. At the same time as this was occurring, the Federal Reserve began to ease monetary policy which was a reverse from its strict policy of 1994. (Kindleberger and Aliber 2011) Many also believe that this bubble truly began in 1998 after the Asian Financial Crisis and the failure of Long Term Capital

Management which led to further easing from the Federal Reserve. During this boom period of the US economy from 1982 to 1999 stock prices increased by 13 times. There was only one year in this period that stock prices declined and in that year it was only by 5%. The market value of stocks increased from 60% of GDP in 1982 to 300% of GDP in 1999. (Kindleberger and Aliber 2011) This is just an aside to show how prosperous these times were for investors. As for the bubble of the late 1990's the gains in price were staggering. In December of 1996 Chairman Greenspan of the Federal Reserve was already wary of a bubble and was the first one to use the term "irrational exuberance". At that time the Dow Jones index was at around 6400 and the NASDAQ was at 1300. By the end of December 1999 the Dow Jones was trading at 11700 and the NASDAQ was trading at 5400. These were 83% gains and 315% gains for that period. Obviously his warning was ignored. (Kindleberger and Aliber 2011) After the Y2K scare turned out to be unwarranted the Federal Reserve began to extract liquidity from the market causing the bubble to implode. In the period from 2000 to 2003 the decline in market value of the Dow Jones index was 40% and the decline in the market value of NASDAQ stocks fell by 80%. The implosion of this bubble led to a decline in wealth and consumption that brought the US into a mild recession in 2002. This bubble did not start a banking panic since it was not driven by credit. (Kindleberger and Aliber 2011)

This brings us to our final and most current bubble and crisis commonly known as the Subprime Mortgage crisis. This crisis was caused by the formation of a housing bubble both in the United States and many other countries around the world. This bubble began in 2002 and peaked in 2006. In this time period the value of US residential real estate rose from $16,000 Billion to $23,000 Billion. In terms of GDP the value went from 110% of GDP to 150% of GDP.

(Kindleberger and Aliber 2011) This bubble formed because of the increase in mortgage lending that was brought on by securitization and the relaxing of lending standards that allowed for a huge growth in subprime mortgages. Securitization of mortgages began in the 1970's by taking a bundle of mortgages and putting them into a trust. This trust would then issue securities called collateralized mortgage obligations or CMO's for short. These CMO's were the rights to collect the interest payments from these mortgages. (Kindleberger and Aliber 2011) In the early 2000's there was a new form of securitization which caused a boom in the industry. This new form of securitization cut the CMO's into multiple slices called tranches. This was a way to make the securities more appealing to a wide range of investors. The first tranche had first priority on the interest income from the mortgages and a low yield while the last tranche had the last right but higher yields. This meant that investors who didn't want to take a large risk could buy the first tranche and investors willing to take more risk could buy the last tranche and investors that were in the middle of the spectrum could also take part. This process along with relatively low interest rates for mortgages allowed for large amounts of money to flow into the housing market easily. Amid the thirst for more mortgages to securitize lending standards began to relax and there was a boom in subprime mortgages which are mortgages that people with lower credit scores can gain access to. The amount of subprime mortgages grew from 6% of total mortgages in 2004 to 20% of total mortgages in 2006. (Kindleberger and Aliber 2011) These mortgages were also securitized. This boom in housing prices driven by credit turned out to be a recipe for disaster in the US financial system.

When the housing market began to decline from its peak in early 2006 it caused many borrowers who had small down payments to owe more on their mortgage than their home was

worth. This caused many people to send in their keys to the bank or sell their home in a fire sale and hope to just call it even with the bank if they were having trouble with their mortgage. This led to further declines in housing prices and mounting losses for all that were invested in mortgages. Since through the process of securitization many banks and investors were highly exposed to these mortgage defaults and a major banking crisis ensued with one of the most prominent Investment Banks Lehman Brothers going bankrupt and a large insurer AIG needing to be bailed out.

This history of bubbles and financial crises is meant to give background to and show the importance of the focus of this paper. Asset bubbles have had a long history of causing adverse effects on the economy. It is my hope that in creating a simple model to identify these bubbles as they form it will help to ease their effects. This may not be true since many people refuse to believe that a bubble is occurring but at the very least it would be nice to warn them.

Asset Price Bubble Models

The term "Bubble" was first used in England in 1720 following the collapse of the South Sea Company and was defined simply as an asset price that has risen above its fundamental value. (Lansing 2007) Since that time there has been many different views taken on whether bubbles exist in asset prices and if they do what model can explain why they exist. In the efficient markets theory there is no possibility of an irrational bubble. Since all market participants have the same information and all market participants make rational choices the balance of the opinions will always lead to the price equalling its fundamental value. This suggests that a bubble which is a deviation from fundamental values is impossible. Proponents of the efficient market hypothesis claim that even if there are some irrational participants in the market place their influence on prices will always be countered by the rational participants which will never allow a bubble to continue. (Brunnermeier 2008) In reality it seems that this is not the case since bubbles do exist. This leads us into the discussion of rational bubbles.

I will discuss later why the efficient market does not hold from the point of view of the limits to the power of rational participants but for now I will start with the explanation of a rational bubble. The main idea behind a bubble forming without any irrationality is that the expectations of future capital gains drive a rational participant to purchase the asset in question because they know that there will be a future gain in price. (Blanchard and Watson 1982) This model does have some support in that in many bubbles there has been an element of sophisticated investors who knowing the fundamental value of the asset chose to ride the bubble and make money from the capital gains that could be captured. This phenomenon has

been shown in the analysis of hedge fund holdings in the technology bubble in the late 1990's by (Brunnermeier and Nagel, Hedge Funds and the Technology Bubble 2004) where it is shown that many funds had significant exposure to the technology sector during this period. It could be argued that these funds truly believed that fundamental values justified these higher prices but as we can see in this quote from Stanley Druckenmiller of the Quantum fund many knew that prices did not reflect fundamental values and were riding the bubble.

"We thought it was the eighth inning and it was the ninth" (Abreu and Brunnermeier 2003)

None of these sources however were claiming that this supported the rational bubble model. In fact they were disproving the efficient market hypothesis that rational participants would act in a way that would restore prices to fundamental values. I will explore this evidence further later in this section. The problem with the rational bubble model is that it requires an infinite number of rational participants to continue buying higher and higher above fundamental value which in itself is somewhat irrational. (Lansing 2007)

The next model that has been used to explain the presence and formation of bubbles is a feedback model. In this model the formation of a bubble begins after success of one individual or a group of individuals leads to others buying. This success then leads to more people buying and the extrapolation of this recent success far into the future fuels market participants to ignore the previous fundamentals. In this model there is usually a belief that a new era has arrived. This new era concept is often associated with bubbles. The problem with this model is that it goes too far in assuming that the bubble is fueled by irrational participants. Although I agree that there is definitely an irrational element to the persistence of bubbles I do

not agree that all participants are irrational. Referencing the previous quote from Stanley Druckenmiller it is obvious that there are rational participants who are not extrapolating recent results farther into the future but are instead trying to maximize their gains while riding the bubble.

After the previous discussions of the rational and the irrational feedback model of bubbles it is clear to me that the persistence and continued growth has both rational and irrational elements. In this model which has been explained in (Brunnermeier, Bubbles 2008) and (Abreu and Brunnermeier 2003) the market has both rational and irrational participants. According to efficient market hypothesis the rational participants should exert enough force to cause prices to remain at their fundamental values. This model provides a great reasoning on why that in fact does not occur and a bubble is able to develop. The first reason that the rational market participants are unable to exert sufficient downward price pressure is that they face a capital constraint as individuals and as a group. This means that even though there is a rational participant in the market that realizes the mispricing they will hesitate to act on it and favour riding the bubble because they, as an individual, can't make an impact and can be correct in their fundamental analysis but lose in the trade because the market continues to depart from fundamentals.

Apart from this capital constraint there is also significant risks that a rational market participant takes when they go against the bubble that deter them from this path. The first risk that deters the rational participant from going against the bubble is fundamental risk. This is the risk that the fundamentals underlying the asset price will improve and the price of the asset

will become justified. This will cause the rational participant to lose when they try to exert a corrective force in the market. The next risk that repels rational participants from exerting a corrective force is noise trader risk. This is the force of irrational traders forcing the price even further above fundamental values. If this occurs after a rational trader has traded against the rise in price they will lose money in the short term. Since these traders have to concern themselves with short run performance as bad performance can lead to fund outflows especially when the rational participant is losing while the rest of the market is gaining. This risk of a further price increase from irrational participants leads the rational participant to ride the bubble instead of exerting a corrective force. The next risk that leads rational participants to shy away from exerting their corrective force on markets has to do with both their individual capital constraint and the trading by other rational participants and is called synchronization risk. This is the risk that since the single rational participant has a capital constraint that prevents them from bringing down the price of the bubble asset they must try to time the response of other rational participants in order to join the synchronised effort of the market corrective force. This is very tough to do and since attacking the bubble too early or too late they will lose profits these participants may not want to remain in the asset and choose to trade in non bubble assets. For rational participants that choose to stay in the market for this bubble asset they must try to predict the market timing of when the bubble will collapse. Since many different opinions on the timing of the peak will exist, their will generally be a lack of synchronization among the participants. This dispersion of opinions on where the peak is allows for the bubble to persist and grow further until an event occurs that acts to synchronise opinions of rational participants.

This synchronising event is often the start of the crash but when it is not powerful enough can lead to the strengthening of the bubble. When I say that it is not powerful enough I mean that it is not recognized by enough rational participants to encourage enough of a downward force on the price. The price may drop a bit but not fully crash. This leads to the strengthening of the beliefs in irrational participants that the current price is justified. Synchronising events are commonly a news event that may not have a ton of informational value but is enough to cause a disproportionate effect on the price of the asset. A large price drop can also be a synchronising event in that rational participants decide that the peak has been reached and they rush to sell because they do not want to miss the peak. This rushed selling causes the much larger price decrease that is usually termed a crash. (Abreu and Brunnermeier 2003)

This last model explaining the existence and persistence of Asset Price bubbles is the most realistic and convincing. The idea that rational participants will tend to ride a bubble instead of exerting a corrective force as predicted by efficient markets theory can be seen in the real world. As mentioned before an analysis of hedge fund holdings in the Technology bubble by (Brunnermeier and Nagel, Hedge Funds and the Technology Bubble 2004) gives strong supporting evidence to this bubble riding phenomena. There are other cases that lead to the similar conclusion of rational participants riding bubbles. One particular instance is that the Hoares bank profitably rode the South Sea Bubble while giving many indications that it believed the stock was overvalued. (Brunnermeier, Bubbles 2008)

Although this model provides us with an understanding of how a bubble can persist it does not go so far as to say why a bubble starts. The general consensus on how bubbles start is that usually there is a combination of easy credit in the time period that there is also some new innovation that holds the promise of great returns in the future. This is the case in developed countries but in developing nations the usual cause of a bubble is the opening of their borders to direct investment. This opening leads to excessive speculation from foreign capital holders. This foreign element leads to the spread of the crisis following the bubble bursting in developing nations to the developed nations that the speculative capital originated from. My focus on developed nations in this paper leads to the conclusion that bubbles are caused by easy credit and new innovations in both real and financial assets.

Data Analysis / Identification

In this section I will look into both historical US housing and historical US stock price indices in order to uncover a bubble identification method for each asset class. The data that I use is from the online database compiled by Robert Shiller. In both datasets I have chosen to use real prices rather than nominal to allow for greater historical comparisons. The US housing data that I use was originally annual data from 1890 to 1952 and quarterly data after that point. By interpolating this data I have been able to convert it to monthly data which helps in the accurate identification of bubbles. The US stock price data is a monthly average of an S&P Composite index of US stock prices from 1871 up to present. I have chosen to only analyze the percent change in the real price index. Many who have previously studied stock price bubbles have chosen to use a measure of stock prices relative to some fundamental factor such as dividends. Although I believe there is nothing particularly wrong with this approach I choose to differ from it because I do not believe that whether a bubble is driven by fundamentals or not matters much in the identification of that bubble. Since I will only determine that a bubble has occurred if there is a significant price drop following its peak it does not matter what the reason was for the price increase. This could lead to a higher amount of wrongful bubble identifications in this model but I believe that this will be minimal.

The overall approach that I use in identifying periods of abnormally high returns is to first take the mean and standard deviation of the datasets then set appropriate bounds for determining normal prices and price changes. I am then able to identify price changes or price

levels that fall outside of this boundary as abnormal and note that a bubble is forming. I will start my analysis by looking at the US Housing index data.

The US Housing data from 1890 to the current period has a mean of 103.5 and a standard deviation of 23.42. By setting my boundary measure for bubble determination at one standard deviation above the mean I get a boundary level for the home price index at 126.92. This boundary and the data are shown in Chart 1 in the appendix at the back of this paper. It appears in this chart that the only bubble that has occurred in housing is the most recent bubble in the housing market which reached its peak in February of 2006. In looking at the chart there are other sections that it is quite evident that there have been other episodes of large price increases that were followed by large declines. To look further into these periods I determined that it was reasonable to exclude the data from the period of 2000 up until the current time. The reason for this is twofold. The first reason is that the including the data from 2000 onwards greatly increases both the mean and standard deviation of the dataset. The second and more justifiable reason for exclusion is that this episode had not happened yet. This is very important because by excluding it we are better able to get an accurate result on whether a boundary model can identify bubbles based on the past data which is all that one would have if they were identifying that a bubble was forming. Ideally in this model we would exclude any data past the date being analyzed but in order to maintain a large enough dataset for accurate testing I will settle on excluding those that have a great impact on the boundaries.

By excluding the data from the 2000's I get a mean housing index level of 98.24 with a standard deviation of 15.9. By again setting my boundary measure at one standard deviation

above the mean I get a boundary level of 114.14. These new measures along with the housing index data are shown in Chart 2 in the appendix at the back of this paper. In this chart it can be seen that there are five periods that by using this boundary approach are determined to be bubbles in housing prices. The first bubble identified reached its peak in June of 1894 at a level of 123.98. The one standard deviation bound level of 114.14 that determined a bubble was forming was crossed in March of 1894. After reaching its peak the housing price index fell until June of 1896 when it reached the level of 100.3. This was a 19.1% decrease in US housing prices over a two year period.

The second period which this boundary model identifies a bubble occurred in the 1950's and 1960's. The standard deviation bound was breached in February 1953 and the peak was reached in August 1955 at a level of 115.97. The following decline in the housing price index lasted until August 1968 when it reached 104.49 a 9.9% decrease over this time period. This slow decrease which occurred over more than a decade leads me to the conclusion that this may be a false positive result. I will explore this further later in this section in regards to further data exclusion as well as a higher boundary level.

The third period where a bubble is identified in this model is in the late 1970's. In January 1978 the standard deviation boundary was broken. The bubble reached its peak in February 1979 at a level of 121.81. The US house price index then fell until August 1982 when it reached the level of 103.31 a 15.19% decrease from its peak. This large decrease in value over the three and a half years following the peak is consistent with the determination that there was a bubble in the late 1970's.

The fourth period in which a bubble was identified in this model was in the late 1980's. The bound determining that a bubble was forming was broken in October 1986. The index reached its peak level of 125.85 in August 1989. The US housing index then declined at first rapidly and then gradually to its bottom level of 106.73 in November 1996. This was a 15.19% decrease in US housing prices. This was a long period of decline somewhat similar to the period in the 1950's and 1960's but since as is visible in Chart 2 the decline was initially rapid I conclude that this was not a false positive identification of a bubble.

The fifth period where the boundary was breached indicating that a bubble was forming is the most recent housing bubble which occurred in the 2000's. For this bubble we will refer back to our previous boundary level formed by including the data from this massive bubble. The one standard deviation bound was breached in July 2000. This bubble then breached the two standard deviation upper bound in April 2003 and reached its peak at a level of 198.01 in February 2006. Since this peak the US housing price index has declined rapidly and is possibly still decreasing. As of October 2011 it had decreased to 115.52 which is a 41.66% decrease.

Before I go further into the previous bubble identifications I would like to note another interesting feature that I have included in all of the charts in this paper. The yellow shaded areas show when recessions as defined by the NBER occurred over this time frame. It is interesting to note that after every peak that I have discussed there has been a recession that occurred as housing prices decreased. I cannot say with any certainty that there is a significant causality between the fall in housing prices and the following recessions but it is possible nonetheless.

A further look into the housing bubbles excluding the most recent episode is needed to fully explain why there was one result that could be classified as a non-bubble cyclical movement in prices. In addressing this problem I can either raise the determination boundary higher than one standard deviation or I can make more data exclusions to allow for more accurate results. The problem with raising the determination boundary is that although I will not have the false positive I will also miss another bubble that occurred. This is why I have chosen to exclude the data from before 1946 in making determinations. This has its issues in that it is conceivable that in the time periods that these bubbles were forming a person may have included these years in the dataset. I believe that this is acceptable because the great depression was an extended period of low prices well below the mean. This period being included lowers the historical mean and contributes to a much higher standard deviation. I believe that following this period many would agree with me that the prices were so low below the mean for so long that they have the effect of overstating the standard deviation and it is justified to exclude them. By doing this I am able to set a new determination boundary of two standard deviations away from the mean in which both events in this time period previously identified as bubbles are captured while the false positive is no longer captured. This can be seen visually in Chart 3. Although the identification of a bubble comes later when the pre-1946 data is excluded it is a much stricter measure of identification and the breaking of the first bound still serves as some warning of a possible bubble formation. The performance that this simple boundary determination model has in predicting housing price bubbles is very impressive.

I will now move my analysis to stock market bubble identification. As stated previously I will focus solely on the price of stocks in determining whether a bubble is occurring. More specifically I will be looking at the percent change in stock prices on a month to month basis. It would be impractical to use the same price level analysis that I used for the previous analysis of housing prices. This is mainly because as companies increase their earnings the price of their stock increases. In the long run the pattern, stock prices should be gradually increasing. For my determination and identification of stock market bubbles I will set boundaries based on the mean monthly increase in stock prices of .25% and the standard deviation of the percent change in prices of 4.15%. Since there is great volatility in the movement of stock prices I will not make bubble identifications based on one breach of the boundary but will instead look for a high frequency of breaches.

The bubble identification rule that I will use is four months with price increases above the standard deviation boundary within a twelve month span that does not include more than one breach of the negative standard deviation boundaries. I will then qualify these identifications as accurate bubble identifications by seeing if there was a breach of the negative standard deviation bounds of -8.04% and -12.19% that I have also put in place. This measure produces some false positive determinations but by looking at the events in each time period they can in most cases be explained by the circumstances preceding them. I will start by giving a brief description of the charts that I will be using in my analysis which are numbered 4 through 18 in the appendix of this report. The blue line shows the percent change in the value of the S&P Composite Index. The horizontal red line shows the mean percent change in the index while the two horizontal lines above this represent the standard deviation and the two

standard deviation bounds, the two horizontal lines below show the negative two and negative three deviation bounds used to qualify bubble identifications as accurate. The vertical yellow lines show just as in the housing charts when the US was in a recession. The other vertical lines are used to show the point in time that the different boundaries have been breached. The red vertical lines show a breach of the single standard deviation boundary while the green lines show a breach of the two standard deviation boundary. The purple vertical lines show that the negative two standard deviation bound has been breached and the blue vertical lines show that the negative three standard deviation bound has been breached. The whole dataset including all of these elements is shown in Chart 4. By looking at this chart it is impossible to pick out the time periods where bubbles have occurred which has led me to break the data into 10 year spans in Charts 5-18.

I will start by looking first at the time periods that were accurately identified and verified as bubbles by the model and will then discuss the false positive cases and possible missed bubble identifications and make suggestions as to why they occurred. The first bubble that is identified by the parameters I have set was identified in April 1901 after there were four breaches of the upper bounds in a twelve month span. In July of 1901 there was a significant decrease in the index but not a breach of the lower bounds that would verify a bubble. It was not a verified bubble until there was a decrease of 9.48% in October 1902 that broke the lower bound. This time period can be seen in Chart 7 on the far right and Chart 8 on the far left.

The second time period where a bubble is identified by the parameters of my model is in the late 1920's. Beginning in August of 1927 and through August 29 there were many

breaches of the one standard deviation bound. The first identification of a bubble came with the fourth breach within a twelve month span in April 1928. The crash that occurred following this bubble came in October and November of 1929 with index declines of 10.58% and 26.47% respectively. This high frequency of breaches preceding a massive decline is very obvious when looking at Chart 10. This bubble and crash is very famous for marking the start of the Great Depression. Preceding this crash there was great volatility in the market and while there were many breaches to the upper bounds there were also breaches to the lower bounds within these spans which meant that no bubble was identified. This held true until July of 1933 after four consecutive months where the percent change breached the positive standard deviation boundaries and a 28.74% increase in May. This period was not identified as a bubble since there were two breaches of the negative bounds in the 12 month span. This high frequency picked up again in 1935 and early 1936 with 8 breaches within a twelve month span. This bubble which was identifiable after July 1935 can be verified by the breach of both lower bounds in September and October 1937 with decreases of 14.75% and 14.54% respectively. This pattern is clearly shown in Chart 11 where you can also see that prior to September there were other decreases that could be seen as a slow pullback but since the decreases in September and October broke both lower bounds they satisfy the requirements of a crash and verify that a bubble occurred.

The next bubble identification made using my parameters came in March 1986 after there were four breaches of the upper bound within a twelve month period. This was followed by several more breaches in the upper bounds through the first half of 1987 and was verified to be an accurate bubble identification after a crash in October and November broke the negative

two standard deviation bound with decreases of 12.31% and 12.64% respectively. This bubble and crash episode is shown in Chart 16 very clearly. The stock market crash of 1987 is very famous but is not usually referred to as a bubble episode. It does however meet the criteria set forth in this paper and I am very confident in my bubble conclusion.

The next bubble identified in this data can be identified by looking at Chart 17. This bubble is identifiable in the data as of July 1997 following four breaches of the upper bounds within a twelve month span. This frequency continues throughout the rest of this decade which serves to strengthen this identification. I am able to verify this bubble by looking at Chart 18 where there are several breaches of the lower bound throughout 2001 and 2002. To be more specific these breaches occur in March and September of 2001 and July of 2002 with decreases of 9.39%, 11.76% and 10.99% respectively. This bubble that has been identified is commonly known as the Dot Com Bubble and although we detect it using composite index data we would most likely see a much clearer picture if we were using NASDAQ data since this bubble was mainly in the technology sector.

The last bubble identified is perhaps could be seen as a false positive since the crash that verifies it was preceded by a US Government debt downgrade and its identification came directly after a crisis and recession which as I will discuss later is a common theme when evaluating false positive identifications. It does however fit the bubble criteria with four breaches of the upper bounds within a twelve month period and is verified by a future breach in the lower bound. This bubble was identified as of March 2010. There were decreases following the high frequency of upper bound breaches but none breached the lower bound

until August of 2011 when there was a decrease of 10.8%. This last bubble can be seen in Chart 18 following the great decrease in the index following the financial crisis in 2008.

With the bubble identification model parameters that I have used there has been some bubble identifications made that are not followed by a crash. The time periods that were identified falsely were 1885-1886, 1907-1908, 1921-1922, 1942-1943, 1954-1956 and 2002-2003. Several factors that I believe contribute to the false identification are that most of these time periods are directly following a recession, many of these time periods follow a time period where there has been significant breaches of lower bounds which are attributable to past crises internal or external and many of these time periods have negative index movements afterwards that are just not quite big enough to breach the lower bounds.

In June 1886, a bubble was identified but there was no crash that followed. I was surprised to see this, but upon further observation of Chart 6, I can see that the factors discussed in the last paragraph could explain why this occurred. In Chart 6 I can see that this period is immediately on the heels of a recession which may have contributed to a depressed index value because of a negative future outlook. I can also see that there were many negative movements in the index preceding this period which supports the previous idea. Although these negative movements don't break the lower bounds on an individual basis they still could have had a depressing influence on the index at an aggregate level. In looking at the changes in the index value after the identification is made I can see that the majority are negative changes. Thus even though the identification can't be verified by a crash there was a good reason to worry about future price drops.

The next false identification was made in November 1908. This identification was also made on the heels of a recession which referring back to the argument in the last paragraph could have been a large factor in the misidentification. This identification also came after a global financial crisis in 1907 which as you can see in Chart 8 caused multiple breaches in the lower bounds which were brought on after the capital flows from England to the United States dried up and were not necessarily reflective of the business performance underlying stock prices.

The next false identification took place in April 1922 and can be seen in Chart 10. This also was preceded by a recession and several lower bound breaches. It was right after the end of WWI which was an optimistic time and although this is somewhat of a stretch there is a possibility that it could have been the true start to the bubble of the late 1920's. Another misidentification that is somewhat could be stretched to a verifying crash was made in February 1943. By looking at Chart 12 it is not unreasonable to believe that this bubble could be linked to the breach of the lower bounds in the crash of 1946. There was a recession in between the two events but no large index movements. This may or may not be a misidentification but since there is some question I cannot conclude for certain that the two events are linked.

The next possible misidentification is in November 1955. This was also preceded by a recession and came during a period of very high volatility. As is evident in Chart 13 there was many downward movements during the twelve month span that this bubble was identified and a significant downward movement in October 1957 but no lower bound breaks to disqualify or verify the bubble identification. The last possible misidentification came in June 2003. This

time period is shown in Chart 18. By looking at the chart you can see that this identification was preceded by both a recession and several lower bound breaks that were from the previous Dot Com bubble. It is conceivable that the increases that triggered this identification were the recovery from the previous price decreases and recession which may be the cause of many of these misidentifications.

The overall theme of these possible misidentifications is that most have been preceded by a recession and price declines. In identifying future bubbles this is something to take into consideration. When an index increase seems to identify that a bubble is forming it may be a good idea to look at the previous index level and determine whether these increases are a recovery from a depressed level or are truly a bubble.

In regards to the possibility that there could be failures to identify bubbles in this model I will concede that it is possible but very unlikely. By looking over the charts there are times when the lower bounds are breached that this model does not predict. If you look at these declines and believe that the model has failed to identify a bubble you would be mistaken. These instances are caused by external factors which are not connected to any asset price bubbles. The fact remains that the stock market can crash unexpectedly for a variety of reasons. These reasons can include recessions, bankruptcies, major world events, and many other things. Asset price bubbles sometimes are the cause of these crashes and by using this model they should no longer come as a surprise to both policy makers and market participants. The question now remaining to be answered is having identified a bubble what is the best action to take.

Monetary Policy Response

In determining how monetary policy should deal with asset price bubbles there is two main schools of thought. There is on one side the idea that monetary policy should use a proactive approach and try to lean against non-fundamental asset price movements and another which believes that monetary policy should take a reactive approach and only deal concern themselves with asset price movements in respect to their contribution to inflation. The main proponents of the proactive approach are Stephen G. Cecchetti, Hans Genberg, Sushil Wadhwani, Michael D. Bordo and Olivier Jeanne. Although they differ in opinion in some respects they all believe that a proactive approach in dealing with asset price bubbles is most effective.

Cecchetti, Genberg and Wadhwani believe that monetary policy should aim to reduce asset price bubbles because this will minimize the boom-bust cycle and lessen the distortion that asset price bubbles have on both investment and consumption. They do not believe that asset prices should become the target of monetary policy officials but that they should only react to them with changes in interest rates under certain circumstances. (Cecchetti, Genberg and Wadhwani 2002) They also believe that just by making it public knowledge that monetary authorities would lean against asset price bubbles the probability of an asset price bubble forming would greatly decrease. They agree with critics that in many cases this approach would not be an appropriate course of action but maintain that when the source of the shock is financial in nature and not real in nature a proactive policy will be most effective. By determining the nature of each shock and not going as far as targeting asset prices in their

regular decision process they believe there is space for targeting unjustified asset price alongside the standard inflation targeting monetary policy framework. (Cecchetti, Genberg and Wadhwani 2002)

The case for the proactive monetary policy response to asset price bubbles made by Michael D. Bordo and Olivier Jeanne takes this previous idea a step further. They believe that the use of a standard monetary policy rule such as the Taylor Rule is the right way to make decisions stressing a need for more discretionary decision making based on different circumstances that arise. They also propose the idea that even if the asset price bubble is based on apparent fundamental values, large price reversals can have a large adverse effect on the economy. Instead of proposing that the decision to use proactive monetary policy be based on a determination of whether the shock is real or financial they propose that this decision be made based on the balance sheet risk to asset price movements. (Bordo and Jeanne 2002) By analyzing the great depression and the Japanese asset price bubble of the late 1980's they conclude that monetary authorities should sometimes restrict monetary policy above and beyond what it takes to reach their inflation targets. In this manner they would be able to control the debt levels on balance sheets which would slow the asset price increase and reduce the risk of a credit crunch instead of alleviating the credit crunch after it occurs. In doing this they propose that there must be a balance between current output and the probability of a credit crunch. In balancing these two variables they must make a determination on whether the loss in current output from a proactive restrictive monetary policy will be larger or smaller than the loss from a credit crunch. If the current output loss is larger, the proactive policy is not

optimal, and if it is smaller, the proactive policy is the optimal policy decision. (Bordo and Jeanne 2002)

The view that monetary policy should take a reactive approach when dealing with asset price bubbles is dominated by the current Federal Reserve Chairman Ben Bernanke and Mark Gertler. They believe that monetary policy should only react to asset price movements in terms of their impact on inflationary pressures. By only focusing on the inflationary and deflationary pressures associated with the asset price movement monetary policy authorities do not have to make distinctions between fundamental price movements and non-fundamental price movements which can be very tough to do. They believe that targeting inflation alone can have a sufficient deterrent effect on asset price bubble formation through the countercyclical movement of interest rates. (Bernanke and Gertler 2000) Another interesting point that they bring up is that asset price bubbles usually form because of either financial regulatory liberalization reforms that allow easy access to credit or capital inflows or irrational exuberance. This means that even when a proactive monetary policy is used to target an asset price bubble it could be very ineffective because it doesn't match up well with the regulatory framework. This approach has a high risk of inciting panic by inadvertently pricking the bubble instead of impeding its growth. (Bernanke and Gertler 2000) They do however agree with Bordo and Jeanne that the most important element in causing major harm to the real economy is the condition of balance sheets. If balance sheets are highly leveraged when a bubble implodes the adverse effects on the real economy will be very large. This is because when an asset bubble implodes so does the value of collateral that they put up against loans. This leads to an even higher amount of leverage and a significant pullback in bank loans. This process is

commonly known as a credit crunch. They believe that it is the job of monetary policy authorities to react to the credit crunch by injecting liquidity into the system so that banks will not stop making loans. By taking this reactive approach instead of a proactive approach they are able to only intervene when a credit crunch occurs and not intervene proactively when they are not fully informed. (Bernanke and Gertler 2000)

After my research I believe that a reactive monetary policy approach is the best way to deal with asset price bubbles. The main reason that I am against the proactive approaches is that they rely very much on predicting the impacts of unpredictable events. Although my model does a great job in identifying asset price bubbles predicting their possible impacts in the future is a whole other task. Using a proactive approach to balance a loss in current output with a possible loss that a credit crunch would bring could easily lead to a choice of decreasing current output when you can't be certain that a credit crunch will occur. Since it is impossible to predict when a bubble will implode it will also be impossible to predict the amount of leverage in balance sheets at that time. Another issue is that by proactively targeting asset price bubbles in monetary policy decisions could lead to pricking the bubble and causing a panic which is the exact opposite of what the goal is. This pricking of the bubble would come at a time where balance sheets are at the leverage point that posed such a large problem that it prompted the monetary policy authorities to act. The proactive policy also has faults in that it lacks the transparency of a Taylor Rule reactive system. This lack of transparency can be a big deal because when the monetary authorities raise interest rates and don't provide their reasoning it may lead to a decrease in credibility and confidence in them. The reactive policy has the advantage in this respect because it sets its goals based on a clear target for inflation.

By remaining focused on this while not trying to interfere in the free market prices of assets that may or may not be at their fundamentals it is able to keep its credibility by not overstepping its bounds. There have been many episodes where this proactive approach of targeting asset prices has led to the pricking of a bubble and major adverse effects on the real economy. The most notable examples of this are the great depression and the episode in Japan in the late 1980's and early 1990's. By not sticking to the dual mandate of managing inflation and output and instead targeting asset price bubbles monetary authorities run the risk of losing sight of the big picture which brings poor performance.

Market Participant Approach

After realizing that a bubble is forming it is very tough to say definitively what the best approach for each market participant is. Since many fund managers are limited by the approach of the fund for example some funds are equity only and some funds are allowed more freedom in investment asset choices. The efficient market theory would predict that when a rational participant realizes that an asset is above its fundamental value they will work against the mispricing until it returns to its fundamental value. As discussed in the bubble model earlier in this paper this is usually not the case when a bubble is formed. Many of these participants will attempt to ride the bubble and time the market so they sell at the peak. This is very tough to do and is a very risky approach.

In the case of a stock price bubble the safest approach would be to sell stocks upon identification and move into safer asset classes that are not highly correlated with equity prices. In this way you may underperform slightly in the short run but in by preserving capital and waiting on the sidelines in a sense you will have a great opportunity to buy after the inevitable crash. Even in the case of a false bubble identification there is significant declines in the stock markets following the identification even though there is no crash. The approach of shorting the market upon identification of a bubble can be the right approach but since the bubble may persist for some time this strategy could be very costly in the short run in both performance and fund outflows. It is much easier to explain to shareholders that you are invested in US treasuries because you foresee a crash and want to be safe while still earning a modest return

than to explain that you are short equities and losing money while the rest of the market is performing at an extremely high level.

In housing market bubbles which present themselves less often there is also a variety of approaches. Since easy credit is usually synonymous with a housing bubble many may see a large opportunity to buy a house or multiple houses and sell them at their peak value. I would warn against this approach for a few reasons. Since the housing market is not very liquid in nature it may be very tough to sell at its peak. Also by overextending yourself with a high amount of debt in purchasing a home or series of homes you become very leveraged and when there is a crash in prices which is usually followed by a recession and very tight lending your ability to make mortgage payments could fall and you may be foreclosed upon and take a severe loss in the sale.

My advice for a homeowner after identifying a bubble is that you should make sure that you are not overextended with your current mortgage. You may have the urge to sell your home in these circumstances but since housing prices as a whole are high the next home that you purchase will also be at the same elevated price level. Since you need a place to live this perceived profit that you gain will be negated by the loss on your next home. The tendency may be to sell and trade up by buying a bigger and better home with another mortgage. This may not be a bad idea if you can easily afford the mortgage and are not depending on the increase in value of that home to sell it at the peak. Since your house is where you live it still may not be the best idea to see it as an investment asset. By not concerning yourself with making profits on housing purchases and making sure that you are secure in your mortgage and

would not have to sell in a downturn the price of your home decreasing will not have a large effect on you. The value of a home only matters when you are selling or buying, so by staying in your home during booms and busts you will experience neither positive or negative impacts from this cycle. There is something to say about timing when you move. If you are moving for reasons other than gaining a profit it is best to do so before a bubble bursts. By doing this you can realize a profit on your home and even though the home you move into will be selling at a premium you will be able to stay in it during the downturn and these negative price movements will not affect you. Another strategy that can be considered which is not an option for most people would be to sell your home after realizing a bubble and then rent until after the bust occurs and by again at the lower prices. The only problem with this approach is that it is very tricky to time the market just as in the case of equities.

These are just my opinions on approaching asset investments during bubble periods. I hope that by reading this market participants can gain some wisdom in how to protect themselves from the adverse effects of a bubble implosion and will be able to preserve their capital.

Conclusion

In this Thesis I have developed a technique for identifying asset price bubbles in the equities and housing markets of the United States. I do however believe that the same techniques can be used in other countries around the world. Financial crises and asset price bubbles have been with us throughout history and will continue to occur in the future. By identifying asset price bubbles we give ourselves a chance to position ourselves so that we can avoid the majority of the negative consequences. This does not in any way mean that we will have the power to stop them from occurring.

The technique that I have used is extremely simple and is quite effective. In housing markets especially this technique has yielded extremely accurate results. In the stock market this technique has also been very effective but has yielded some possible false bubble identifications. These possible identifications are not of huge concern to me since in many cases a downward price movement occurred afterwards that was not a crash but still a predicted decline. In further research it may be a good idea to add variables such as investor sentiment to be able to more accurately decide whether a bubble will continue to grow to the point where a crash occurs or will there be a more immediate downward correction in prices. This could possibly yield more accurate bubble identifications.

The identification of a bubble is very useful for all market participants. How to approach the bubble after identification so that it does not have damaging effects to the real economy is even more important. The strength of balance sheets is the main determining factor in what effect a bubble implosion will have on the real economy. If balance sheets are highly leveraged

in the boom period the probability of a credit crunch becomes very high. Upon realization of a bubble the strength of all consumers, corporations, small businesses and banks should be the first concern. If these parties are able to lower the leverage in their balance sheets upon realization of a bubble the effect of the implosion on the real economy will be minimized. There will still be a loss of wealth for the holders of the bubble asset but the overall economy will still be able to operate in an effective way.

The unbiased identification of bubbles is very important for all market participants and the economy as a whole. I hope that the technique and advice given in this paper can provide this service and also provide education on the nature of asset price bubbles and their implications for the economy.

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Appendix

Chart 1 US Housing Price Index 1890 – Current

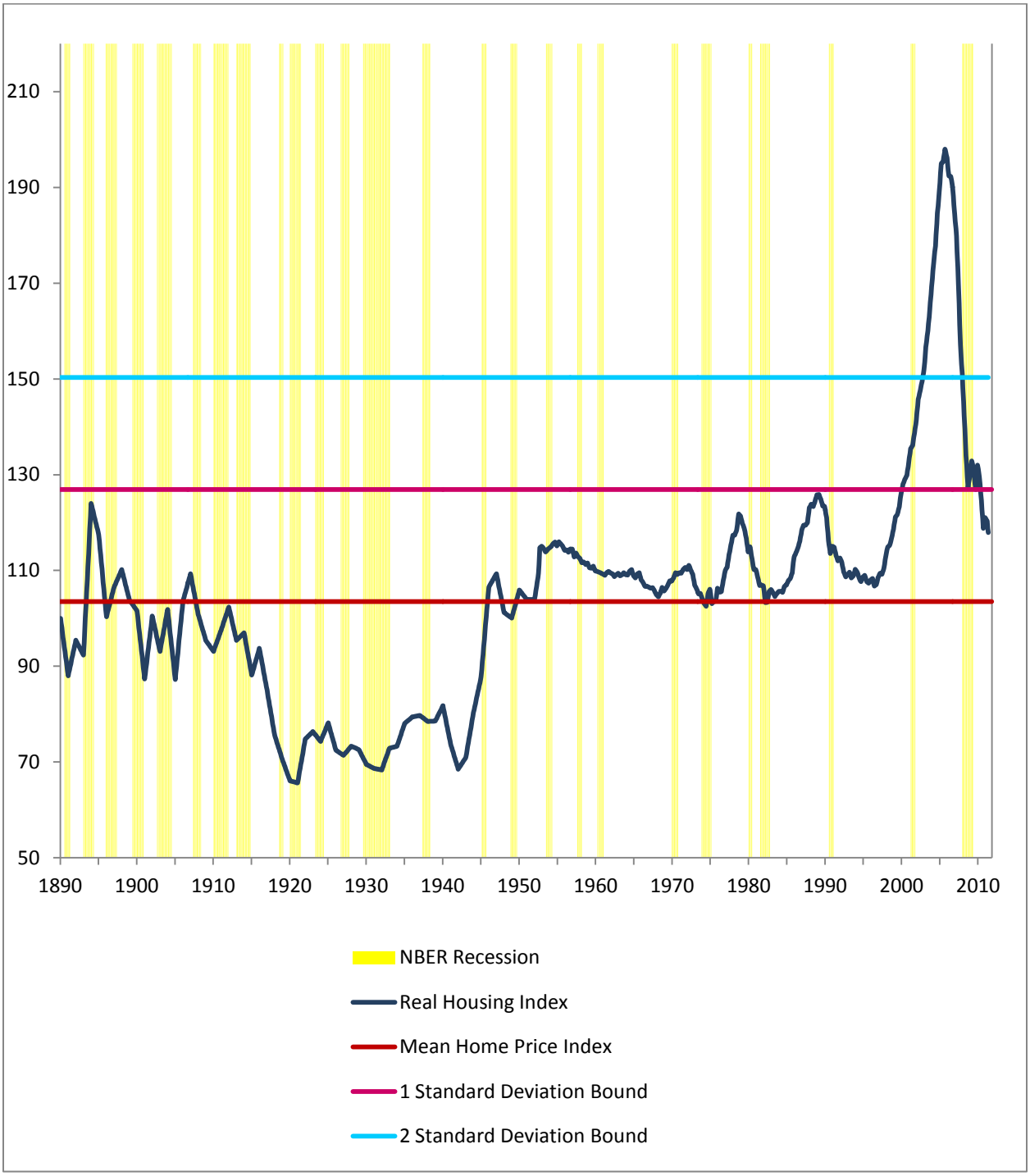

Chart 2 US Housing Price Index 1890 – 2000

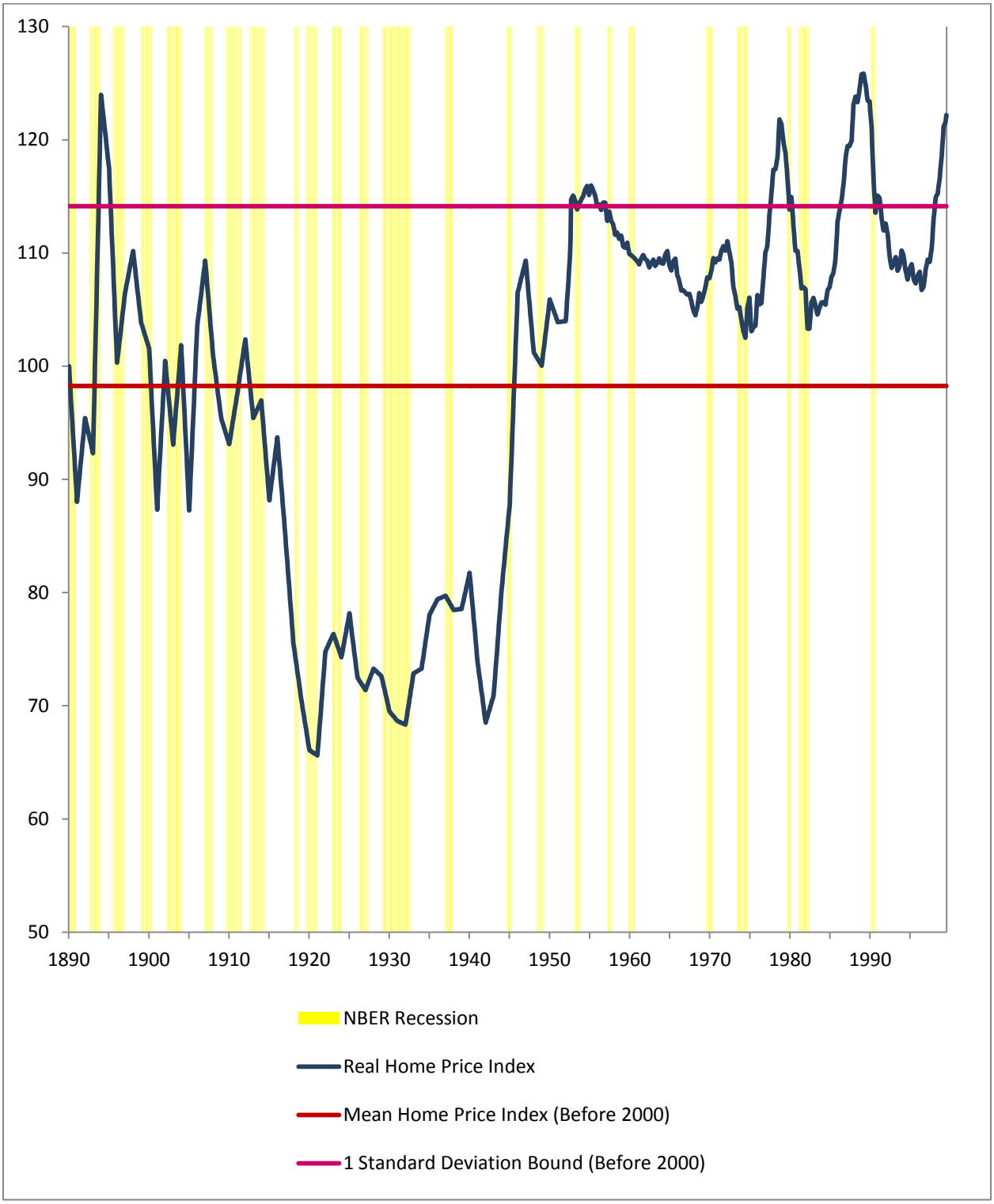

Chart 3 US Housing Price Index 1946 – 2000

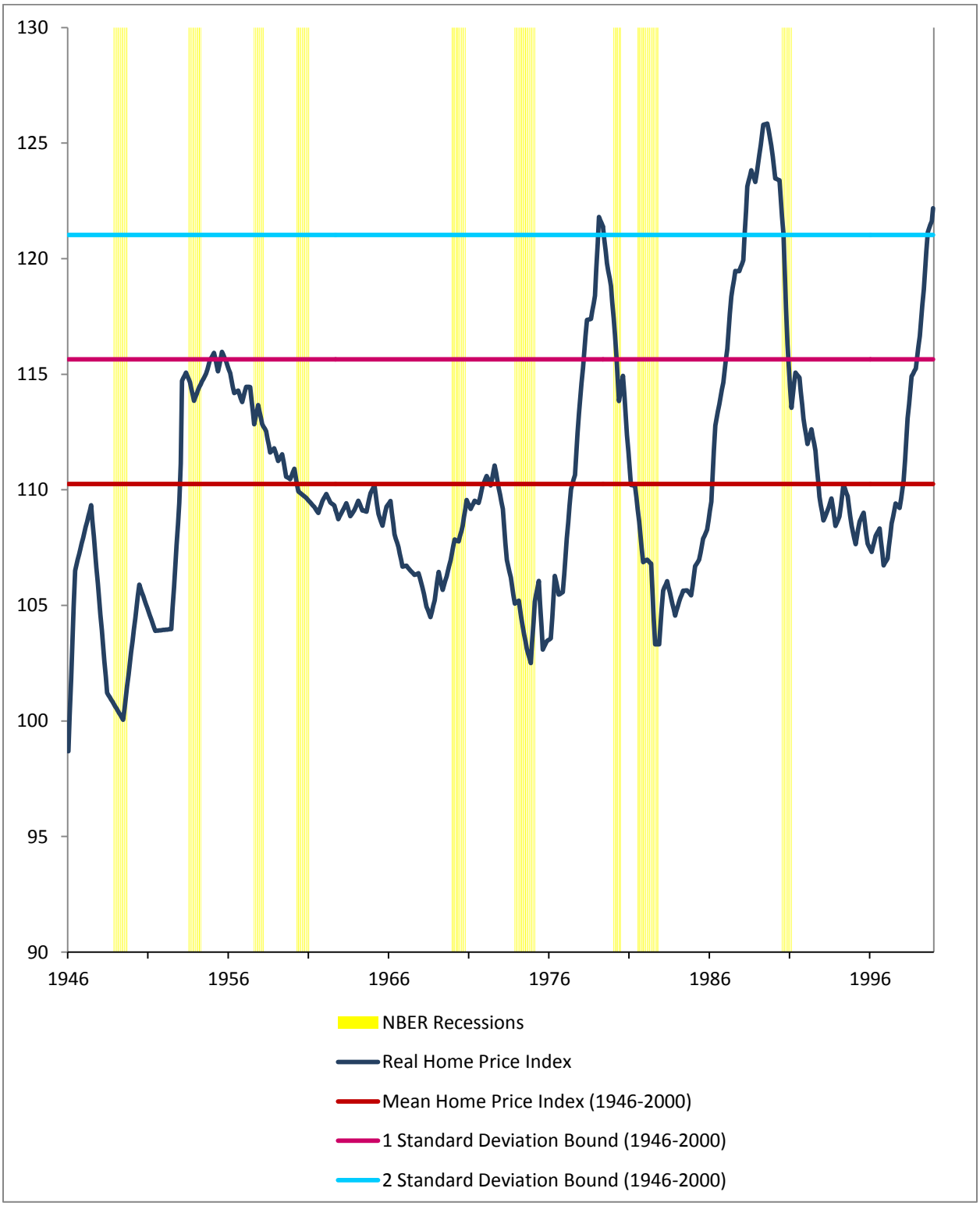

Chart 4 US Stock Price 1871 – Current

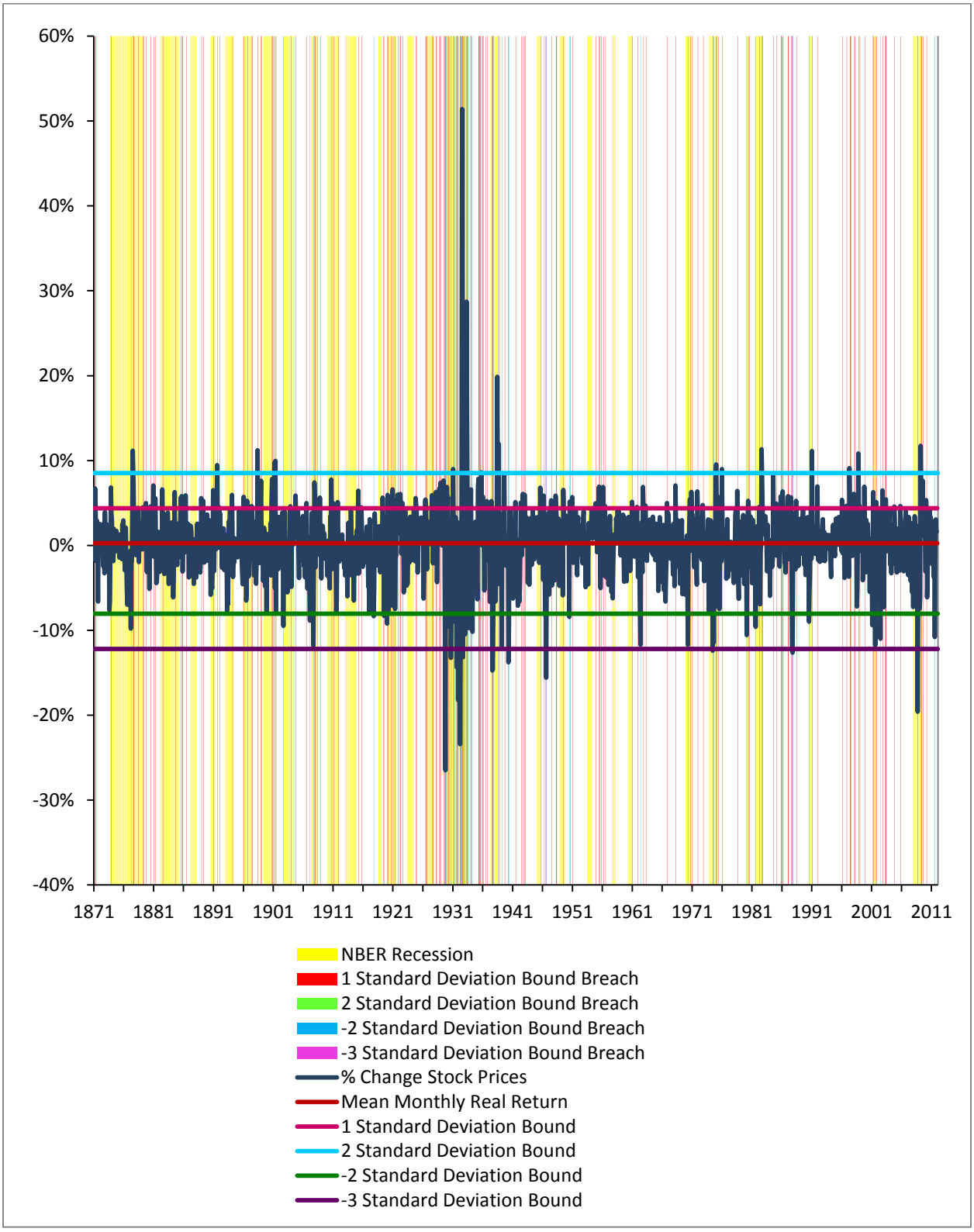

Chart 5 US Stock Price 1871 – 1881

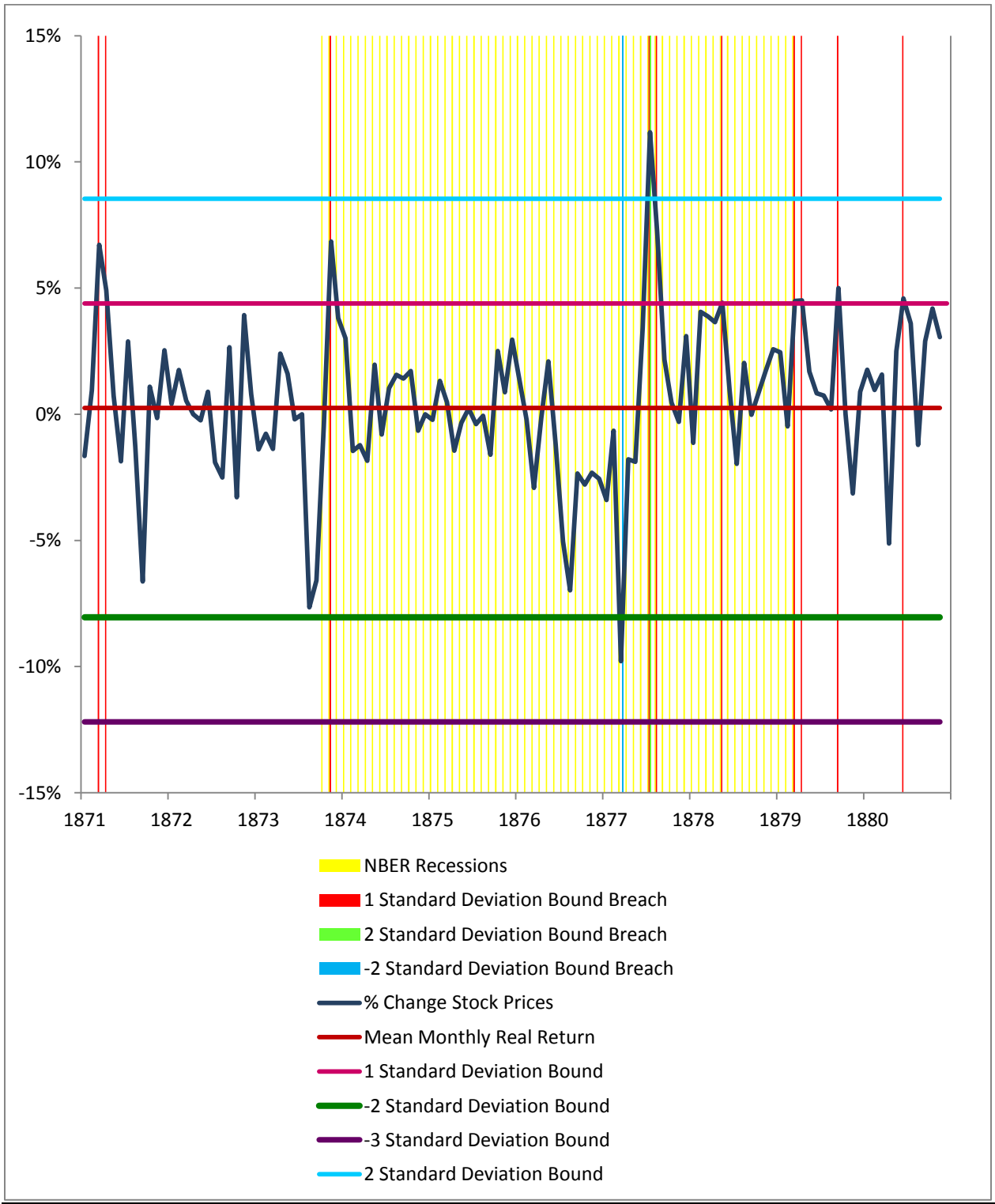

Chart 6 US Stock Price 1881 – 1891

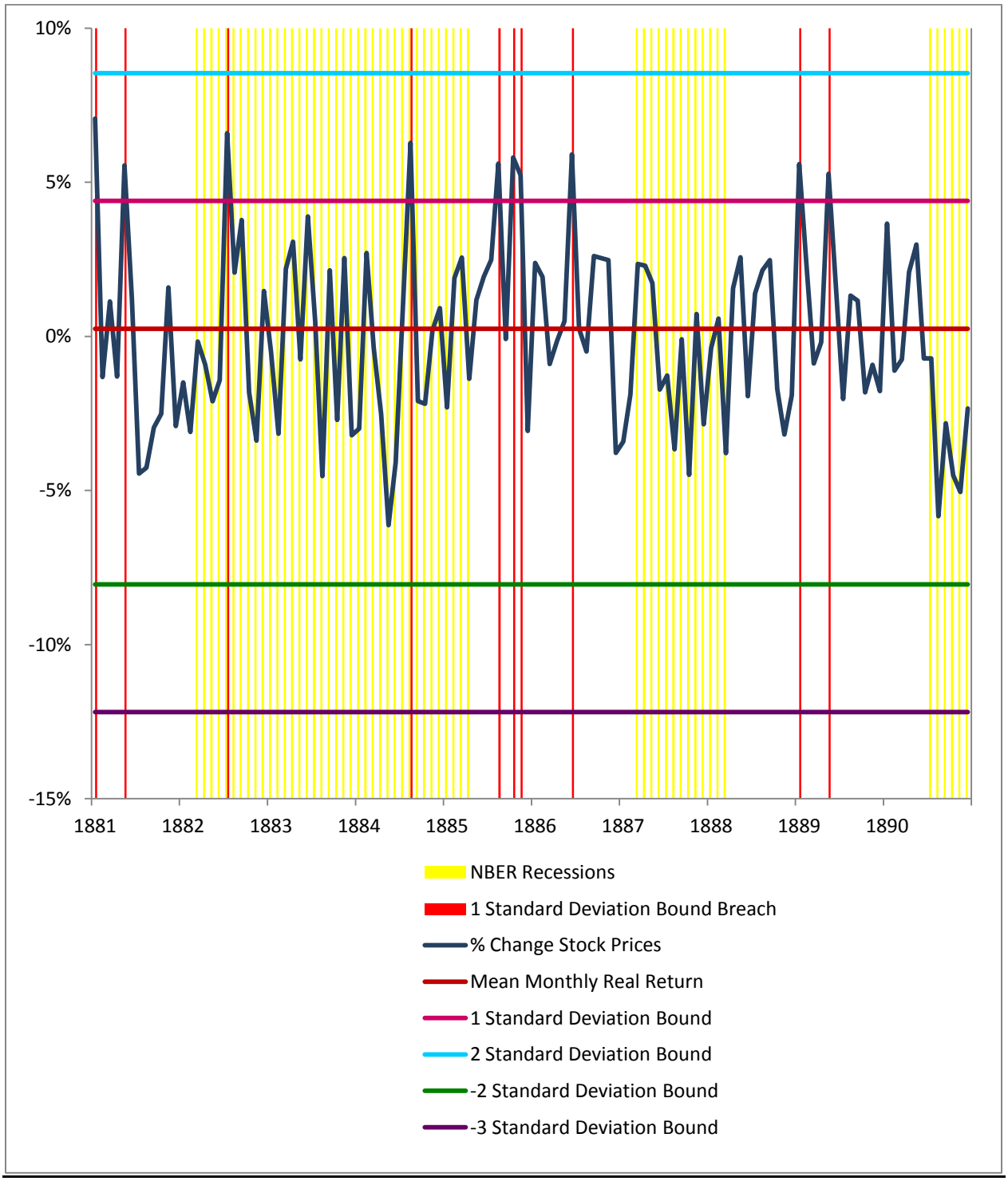

Chart 7 US Stock Price 1891 – 1901

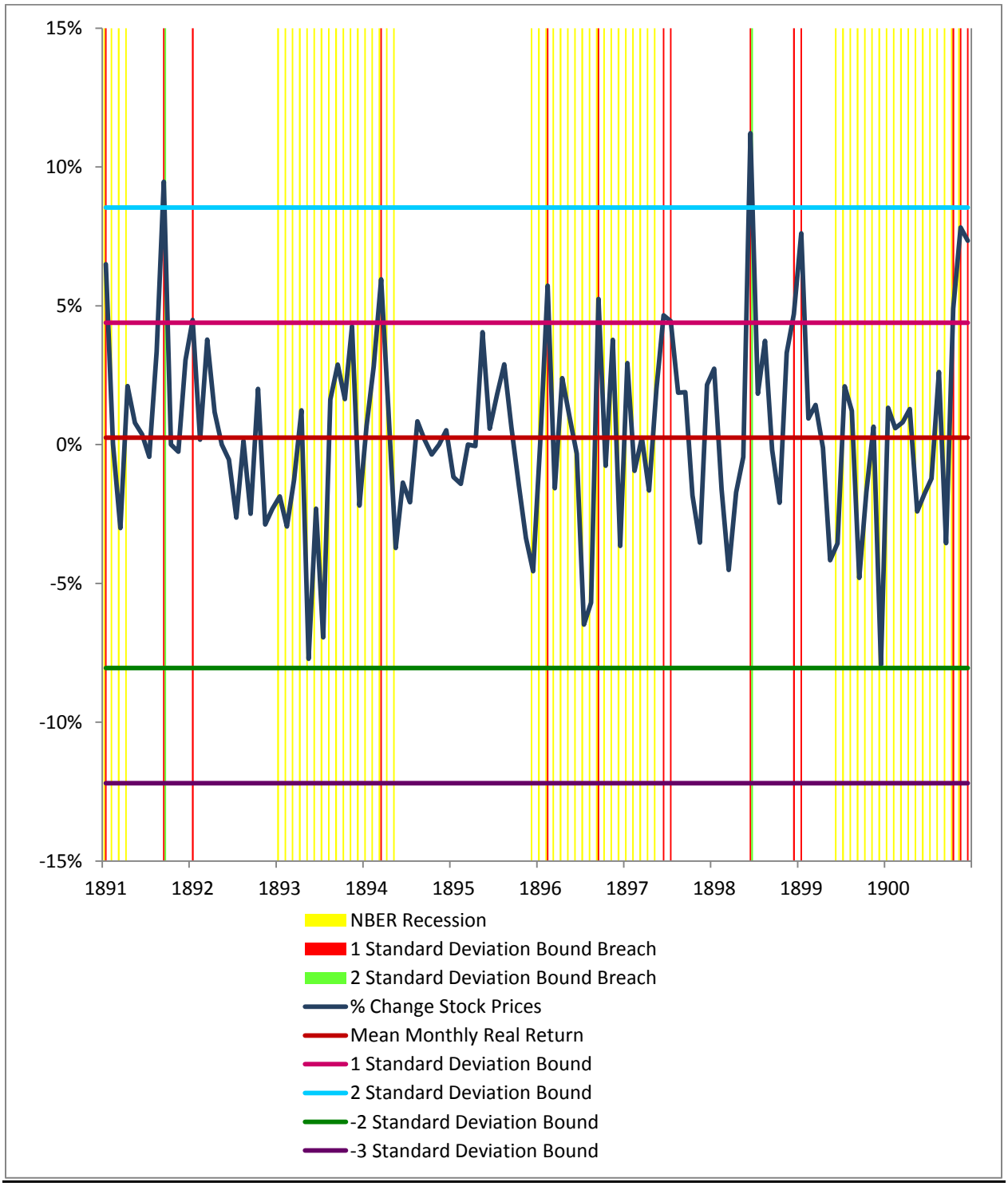

Chart 8 US Stock Price 1901 – 1911

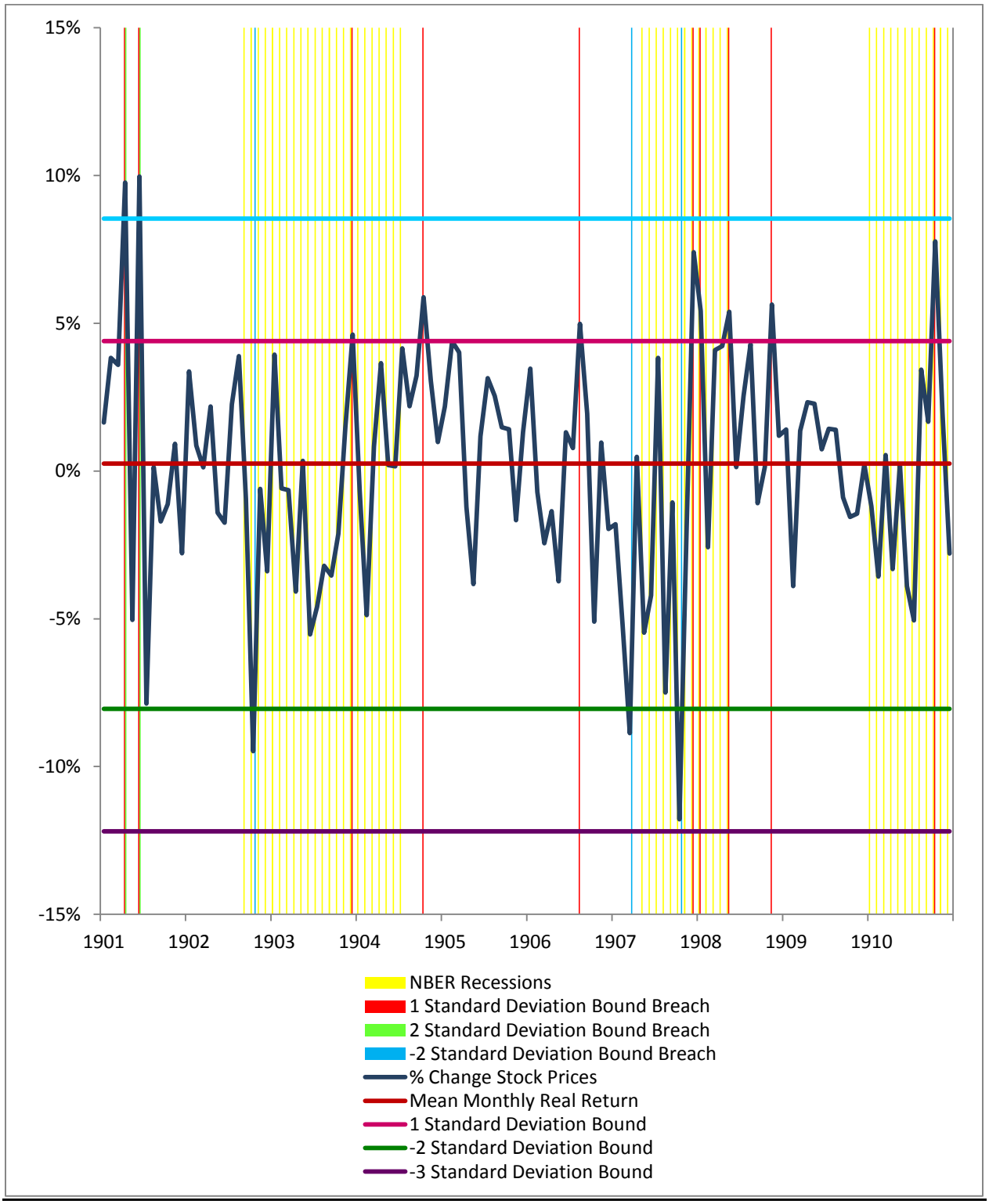

Chart 9 US Stock Price 1911 – 1921

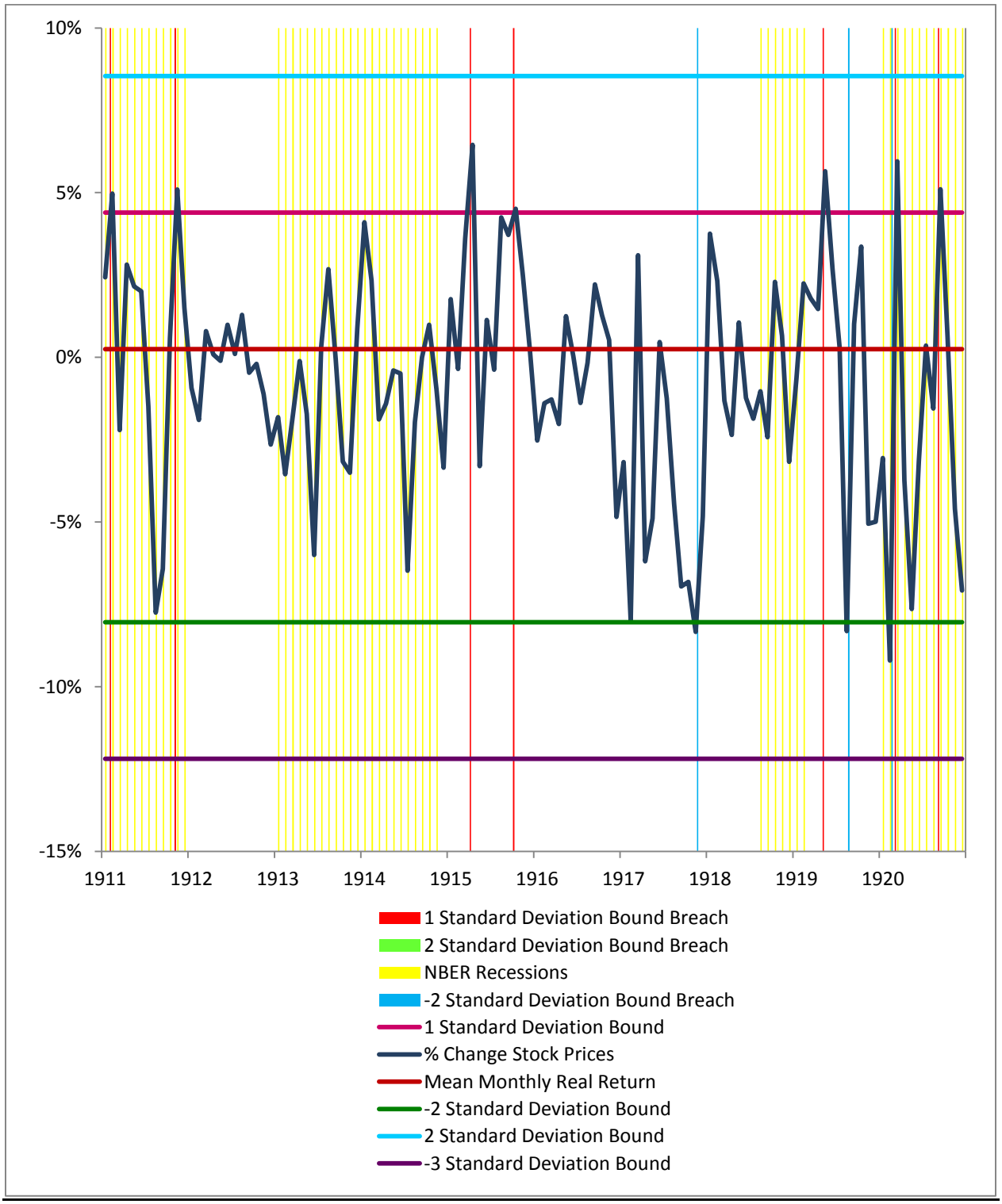

Chart 10 US Stock Price 1921 – 1931

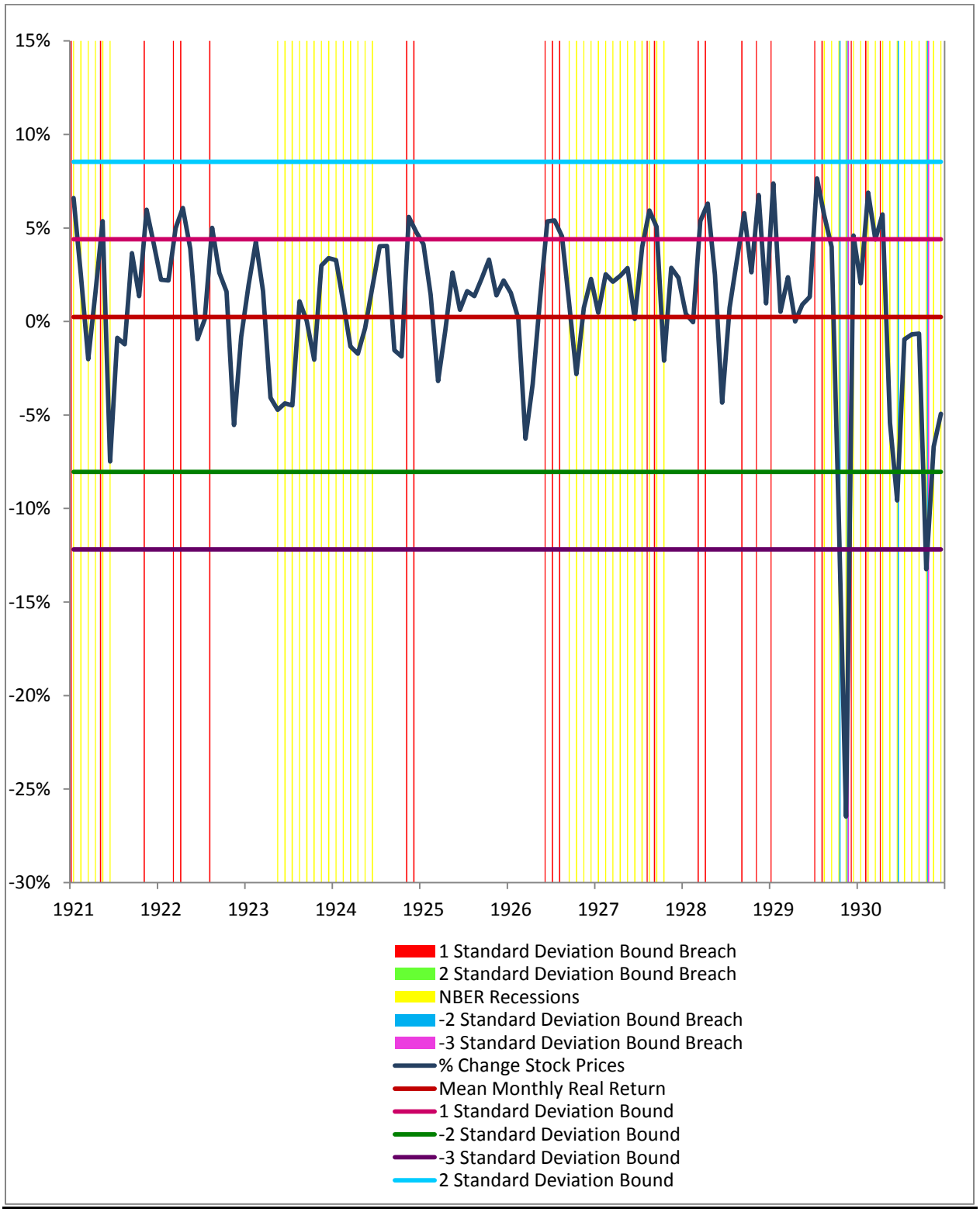

Chart 11 US Stock Price 1931 – 1941

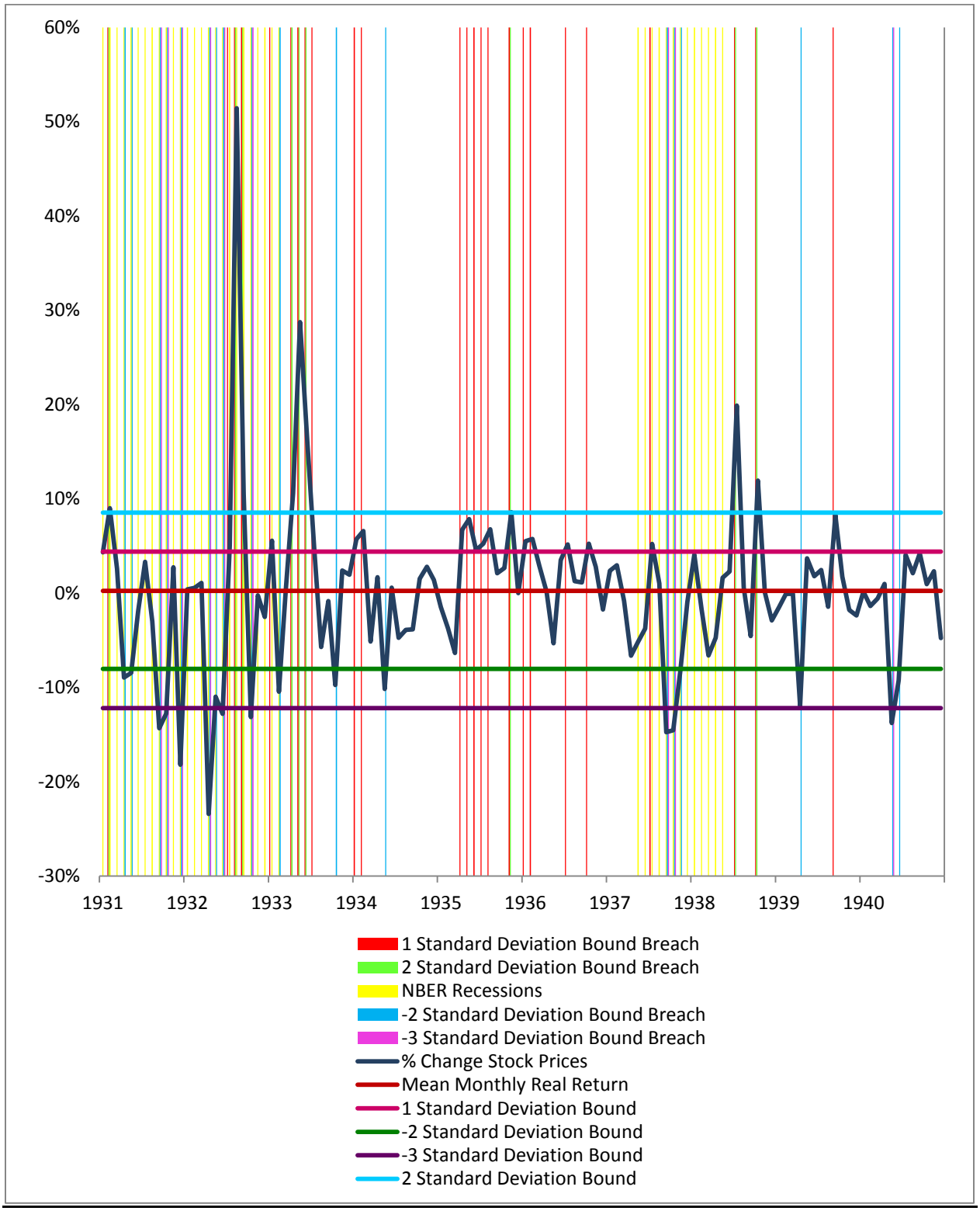

Chart 12 US Stock Price 1941 – 1951

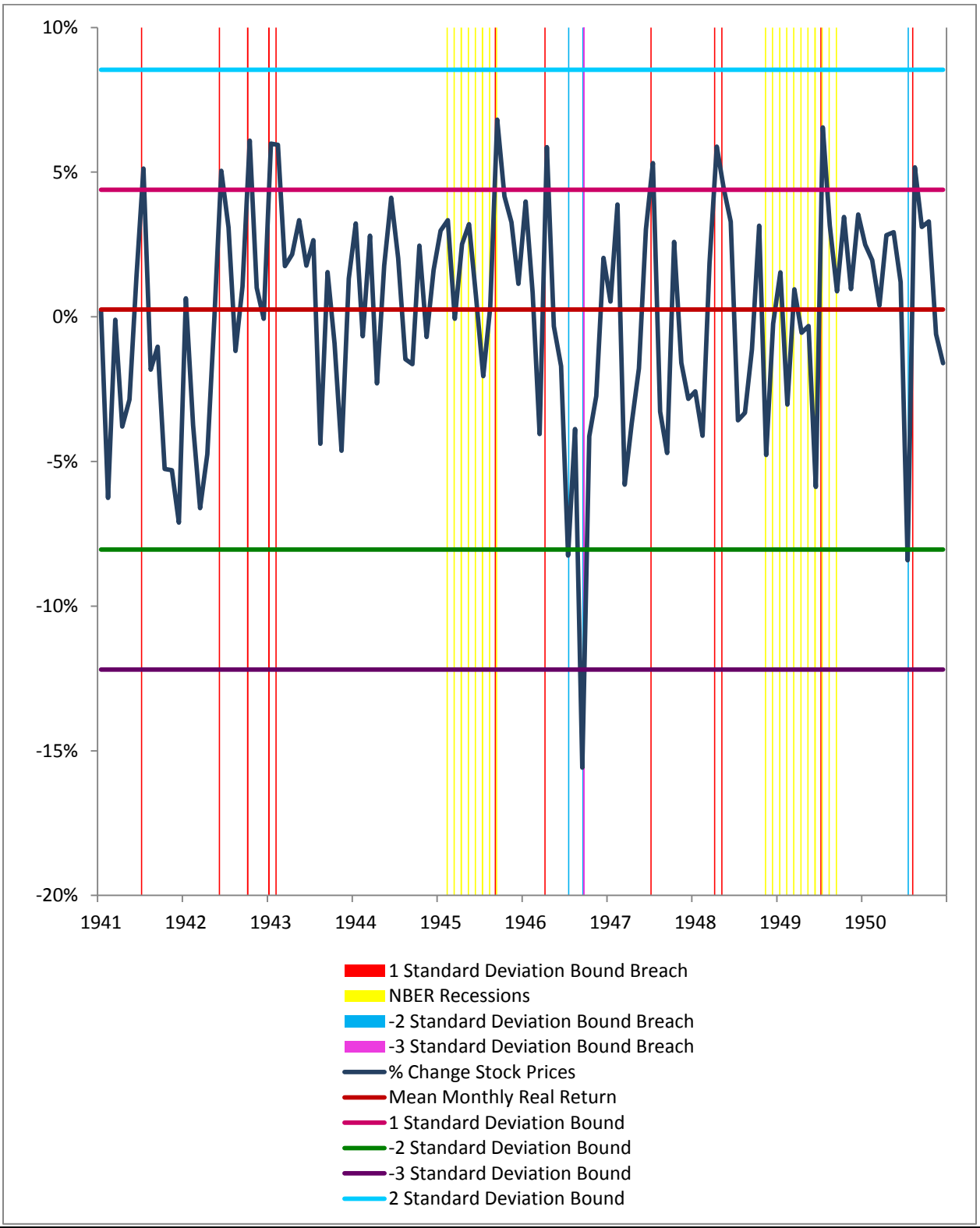

Chart 13 US Stock Price 1951 – 1961

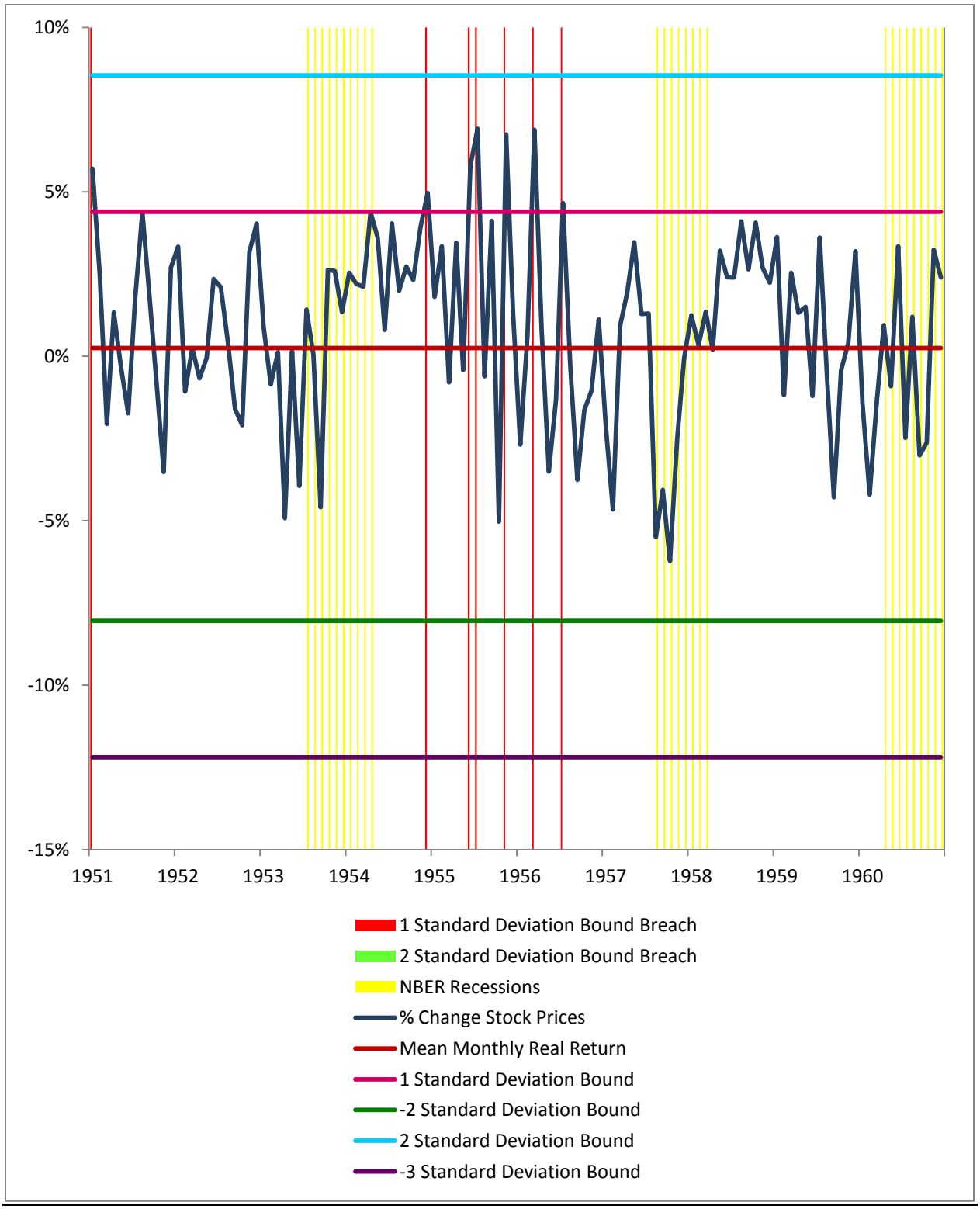

Chart 14 US Stock Price 1961 – 1971

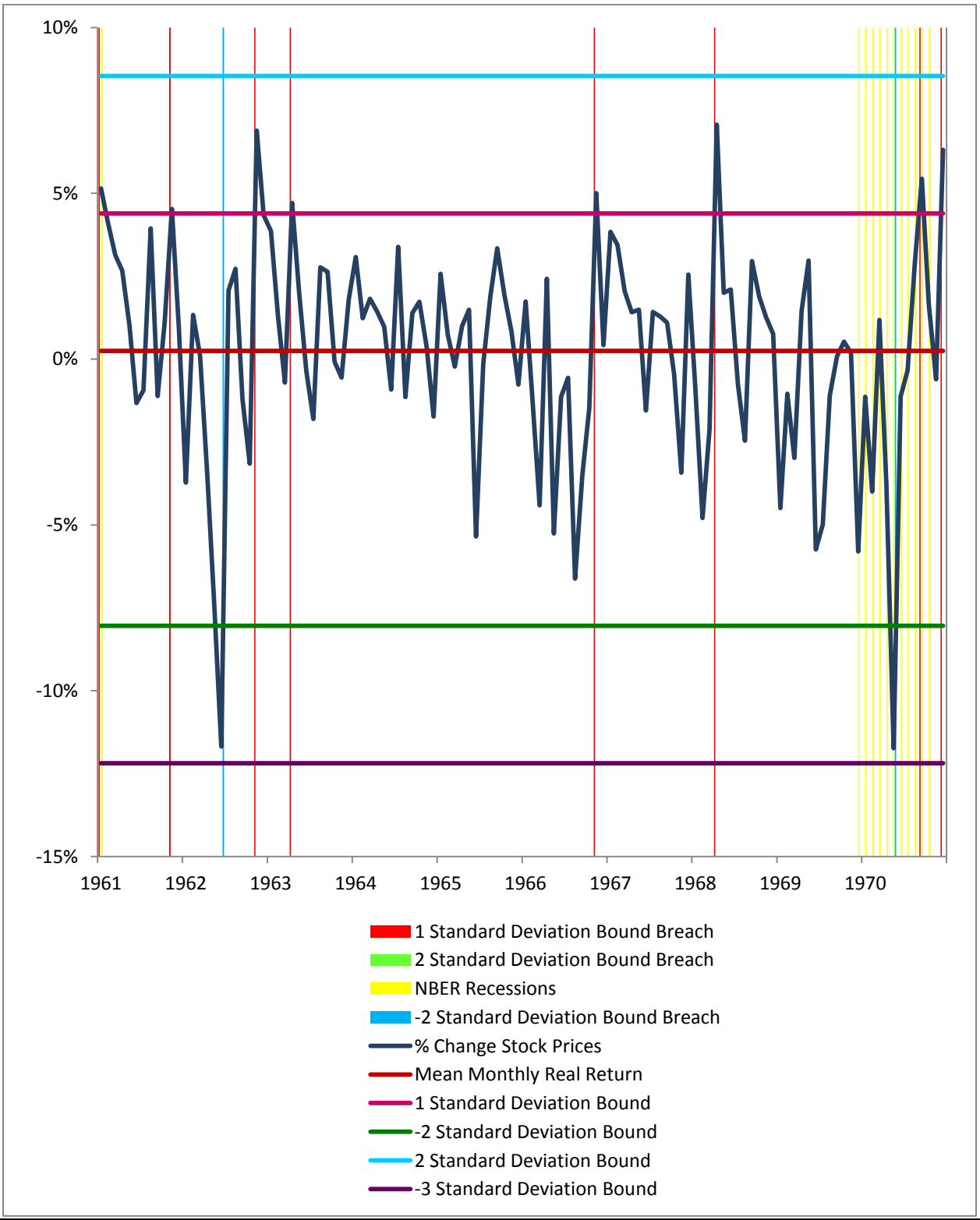

Chart 15 US Stock Price 1971 – 1981

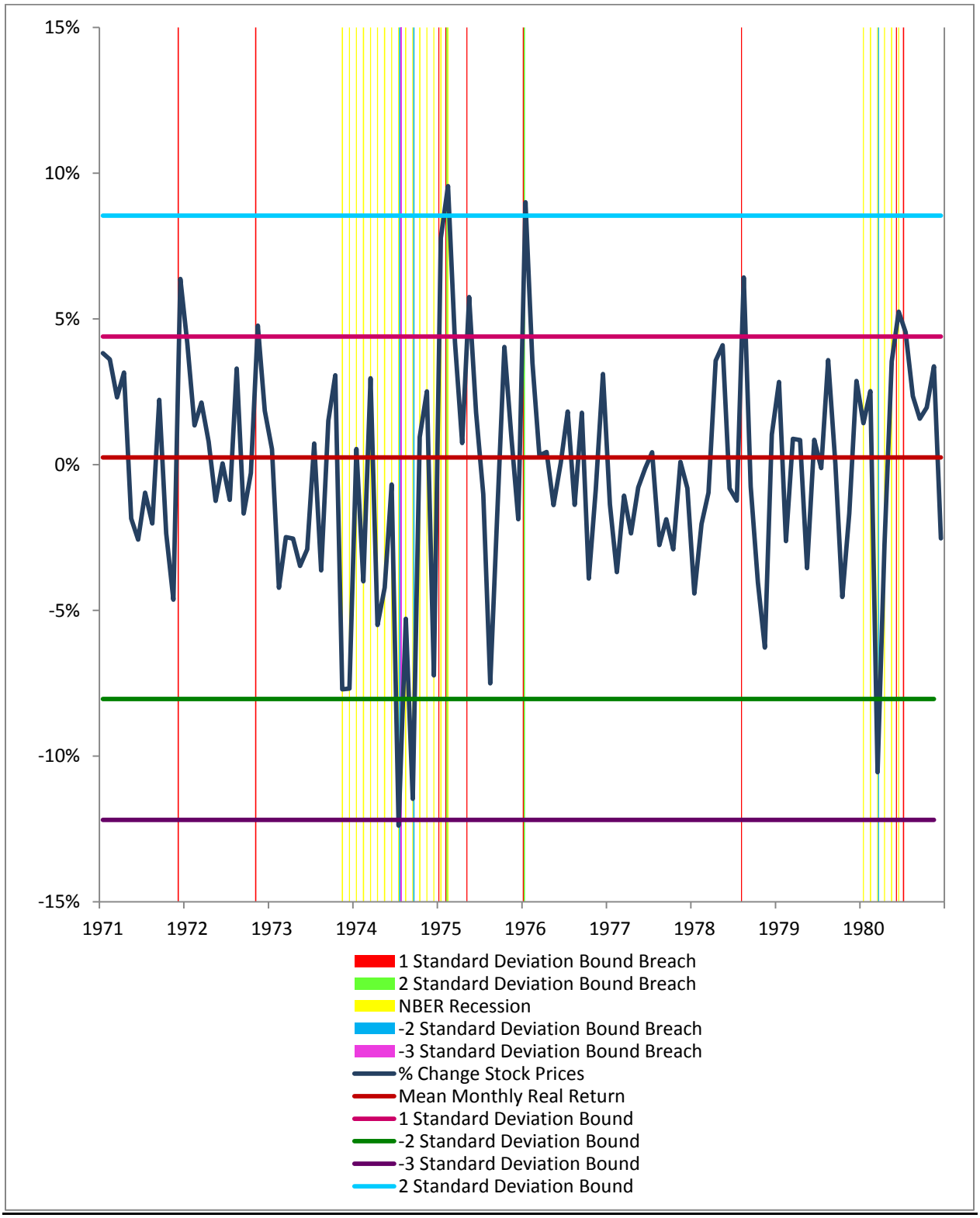

Chart 16 US Stock Price 1981 – 1991

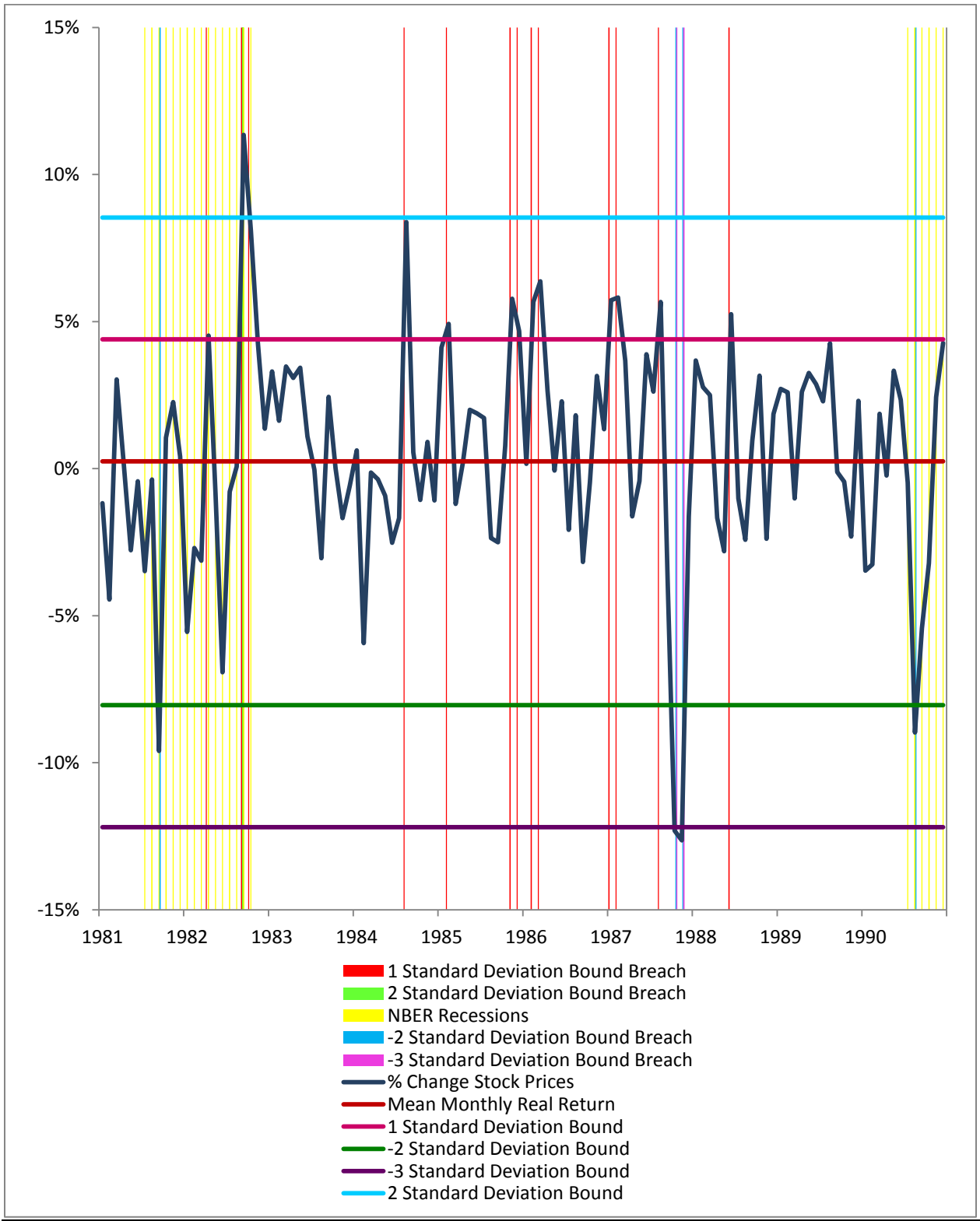

Chart 17 US Stock Price 1991 – 2001

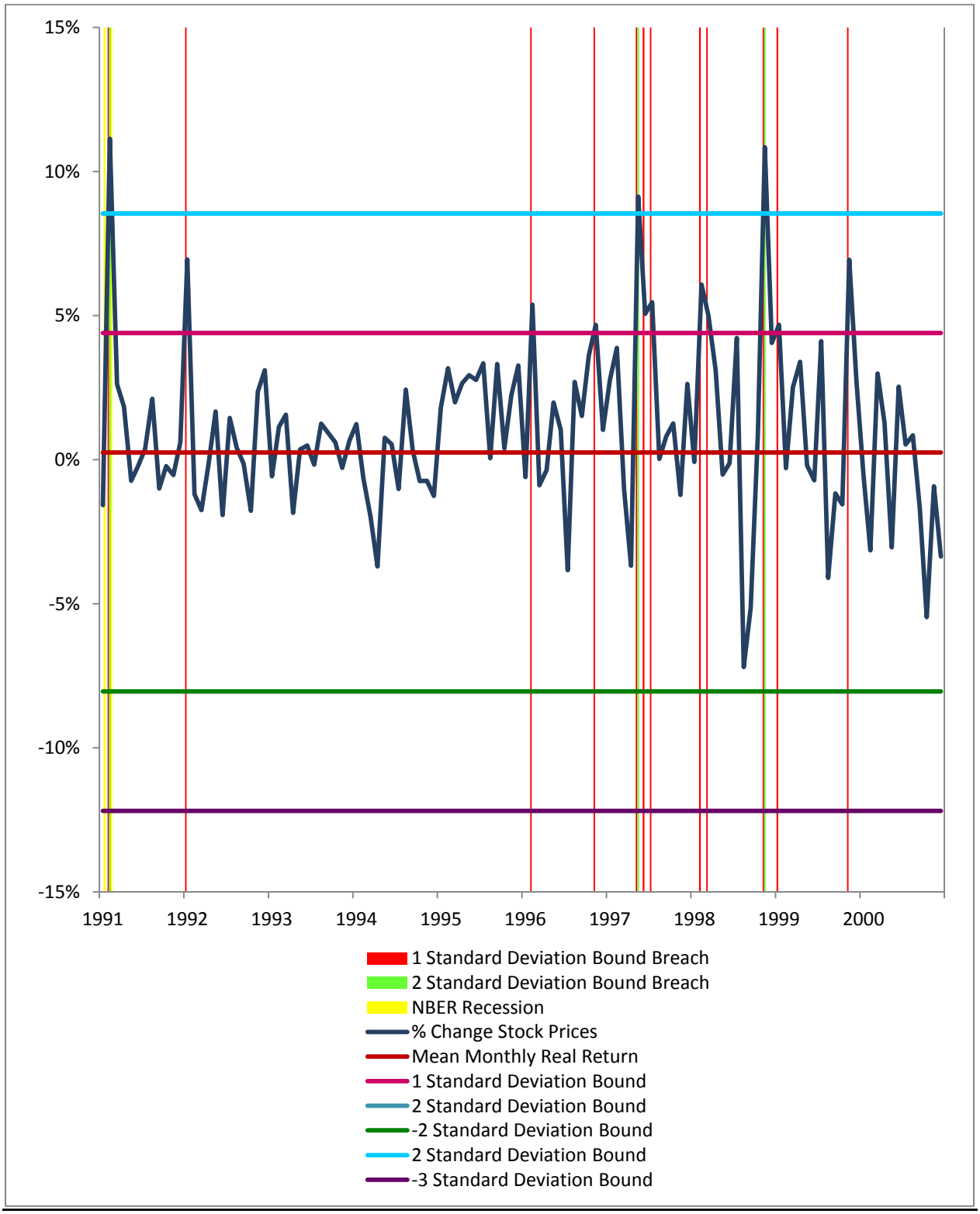

Chart 18 US Stock Price 2001 – Current