DRW Investment Research

Investing by Probabilities

By Daniel R Wessels

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FROM THOSE THAT KNOW…

Risk comes from not knowing what you're doing.
Warren Buffett

And the day came when the risk to remain tight in a bud was more painful than the risk it took to blossom.
Anais Nin

You can measure opportunity with the same yardstick that measures the risk involved. They go together.
Earl Nightingale

The policy of being too cautious is the greatest risk of all.
Jawaharlal Nehru

History has not dealt kindly with the aftermath of protracted periods of low risk premiums.
Alan Greenspan

To be alive at all involves some risk.
Harold MacMillan

Adventure without risk is Disneyland.
Doug Coupland

I will tell you how to become rich. Close the doors. Be fearful when others are greedy. Be greedy when others are fearful.
Warren Buffett

Investing means putting your money on something that has a good chance of winning in the short to medium term, and an even better, if not dead-certain, chance of winning in the long term.
Paul Clitheroe

I am sure that back in 1914 the typical person had a much clearer idea of what he meant by investing his money, and what he meant by speculating with his money. He had no exaggerated ideas of what an investment operation should bring him.
Ben Graham

In this business if you're good, you're right six times out of ten. You're never going to be right nine times out of ten.
Peter Lynch

The greater the uncertainty, the more people are influenced by the market trends; and the greater the influence of trend following speculation, the more uncertain the situation becomes.
George Soros

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1. What is investment risk?

- **A Basic Premise** [1]

Most investors perceive investment risk primarily as the risk of losing capital, but it may also include the risk of not achieving a certain minimum return, for example, investment returns better than inflation. In short, investment risk can be defined as the possibility of being disenchanted with your investment plan in not meeting your investment objectives.

Understandably, it is immensely difficult to develop a uniformly accepted definition of investment risk since investors apply different time frames to the outcome of their investing efforts. For example, some investors do not want any capital losses over any period; another group might tolerate some short-term losses in the hope of doing well in the long run, while others realise that exceptional gains are not likely without exposing themselves to some real risk.

In order to gauge this likelihood of "disappointment", the professional investment industry uses a common indicator, namely the volatility of investment returns. The volatility of stock market investments can be defined as the dispersion of investment returns below and above the mean, otherwise known as the standard deviation of returns.

The concept of volatility is widely used in the investment industry. Typically, the allocation of investment strategies and fund selections to an investment plan are based on their respective volatilities and whether it fits the risk profile of the prospective investor. Therefore, it is important for investors to understand the limitations and uses of volatility as a barometer of investment risk.

[1] For a detailed description and analysis of stock market volatility see also my research article titled: "The Characteristics of Stock Market Volatility"
Available at: http://www.indexinvestor.co.za/index_files/MyFiles/StockMarketVolatility.pdf

- **Volatility as a benchmark for investment risk**

Firstly, it is important to understand how volatility is estimated. Typically, the volatility of investments spanning over different intervals is standardised, for example annualised volatility, to compare the riskiness of investment portfolios. The following annualisation rule applies:

Standard deviation over an interval x square root of the number of intervals per annum

For example, if the standard deviation measured on a weekly basis is equal to 2.5% and one wants to express the deviation on an annual basis, the following formula will apply: 2.5% x SQRT(52) = 18%.

Note that it is not merely volatility on a weekly basis times the number of weeks in a year, because such practice would lead to a gross overestimation of volatility. In essence, the volatility of stock prices exhibits a mean-reverting pattern.

Table 1 illustrates the various annualised rates over different measurement periods.

Table 1: Converting different volatility measures to a standard basis

	Measured volatility	Annualised volatility
Std deviation (daily)	1.2%	19.0%
Std deviation (weekly)	2.5%	18.0%
Std deviation (monthly)	5.5%	19.1%

Secondly, and in accordance with the first principle illustrated above, the passing of time reduces volatility.

Consider the following two examples – a five-year investment and a ten-year investment, shown in Table 2 below:

Table 2: The passing of time reduces volatility

Period	Capital value	Annual return
Year 0	100	
Year 1	115	15.0%
Year 2	106	-8.0%
Year 3	129	22.0%
Year 4	154	19.0%
Year 5	174	13.0%

Std deviation	**11.8%**
Average return	**12.2%**
Geometric or annualised return	**11.7%**

Table 2 (continued…)

Period	Capital value	Annual return
Year 0	100	
Year 1	115	15.0%
Year 2	106	-8.0%
Year 3	129	22.0%
Year 4	154	19.0%
Year 5	174	13.0%
Year 6	200	15.0%
Year 7	184	-8.0%
Year 8	224	22.0%
Year 9	267	19.0%
Year 10	301	13.0%

Std deviation	**11.1%**
Average return	**12.2%**
Geometric return	**11.7%**

In the above example both investments yielded the same return; in fact the five-year investment is identical to the ten-year investment, except for the term. Note that the standard deviation in the latter is lower than in the former investment (11.1% versus 11.8%).

From Table 2 two other important inferences are made, firstly the average return is higher than the geometric or annualised return and secondly, if the ten-year investment is identical to the five-year investment, then one would have expected the capital value after ten years to be exactly double the capital value after five years (174 x 2 = 348), but it is not!

A third principle is hereby introduced. Time reduces volatility, but not the value at risk. This phenomenon is explained by the degenerating effect of volatility on returns which lead to actual returns (geometric or annualised) being lower

than the average return. This difference is compounded with the passing of time and leads to lower returns than it would have been predicted otherwise (as illustrated in Table 2).

In general the following rule applies:

Degeneration of returns = average return minus 50% of portfolio variance (standard deviation squared).

A fourth principle is that volatility measures both the upside and downside deviations from the mean. Nobody would mind the upside (higher returns), but definitely the downside. Thus one can identify both "good" and "bad" volatilities. Examples of such investments are depicted in Table 3 below.

Table 3: Same volatilities, different outcomes

Period	Capital value	Annual return
Year 0	100	
Year 1	95	-5.0%
Year 2	112	17.9%
Year 3	125	11.6%
Year 4	139	11.2%
Year 5	150	7.9%

Std deviation	**8.5%**
Average return	8.7%
Geometric return	**8.4%**

Table 3 (continued…)

Period	Capital value	Annual return
Year 0	100	
Year 1	100	0.0%
Year 2	122	22.0%
Year 3	143	17.0%
Year 4	154	8.0%
Year 5	174	13.0%

Std deviation	**8.5%**
Average return	12.0%
Geometric return	**11.7%**

From Table 3 it is obvious that volatility should never be seen in isolation. Investment return is the flipside of investment risk and should always be the criterion upon which your investment decision is based.

Furthermore, although we know that high volatility leads to the degeneration of investment returns, it does not mean that volatility altogether should be avoided. In fact, low volatility investments (like cash) generally lead to low returns. Therefore, we should seek volatility to have any chance of making real gains. However, when we evaluate two similar risky investments one can compare their volatilities and respective returns. In essence, we want to invest in those investments or assets that yield the highest return per unit risk (volatility).

- **Investment risk is a multidimensional concept, concerning:**

    - The volatility of returns over time (volatility risk);
    - The risk of losing the purchasing power of money (inflation risk);
    - The risk of losing capital (capital risk or default risk)

Additional investment risk, such as liquidity risk (the ability to trade or cash-in an investment at any time), often poses a real threat to investors, especially if it is misunderstood or underestimated, like investments in physical property, unlisted securities and securities listed on alternative exchanges. However, well-regulated investments, like collective investments, should not present any liquidity risk for investors.

- **Two key strategies to address investment risk:**

    - Investment diversification across different asset classes;
    - Time diversification – the longer one's investment horizon, the smaller the probability that investment returns will disappoint one.

Note, however, that investment risk cannot be eliminated altogether, but only be managed in any sensible investment plan!

For example, if an investor wants to avoid volatility risk, and thus increases the exposure to less volatile asset classes, such as cash and bonds in an portfolio, it is more than likely that inflation risk – the likelihood that the investor's return will not keep up with inflation – will become a major concern.

2. Asset Class Returns

- **The past fifty years (1961-2010):**

From Table 4 and Table 5:

- Equities yielded an average return of 20% per annum or annualised return of 18% per annum over the past fifty years, but with a standard deviation (volatility) of 25%, while bonds and cash yielded much more modest average returns (11% and 10% respectively) but at much lower volatilities.

Table 4: Annualised returns from asset classes

Return	EQUITY	BONDS	CASH
Average return	20%	11%	10%
Std deviation	25%	11%	5%
Annualised return	18%	10%	10%

Table 5: Lowest to highest annual returns (1961-2010)

Category	Equity	Bonds	Cash
Decile 1	-9%	-4%	5%
Decile 2	-2%	2%	6%
Decile 3	8%	5%	8%
Decile 4	13%	7%	9%
Decile 5	19%	10%	10%
Decile 6	23%	14%	11%
Decile 7	31%	16%	12%
Decile 8	40%	20%	14%
Decile 9	55%	29%	16%
Decile 10	94%	36%	22%

From Table 6 and Table 7:

- Equities yielded a real return of 9% per annum while bonds and cash performed only slightly better than inflation.

Table 6: Real return from asset classes

Return	EQUITY	BONDS	CASH
Average	12%	2%	2%
Std deviation	25%	12%	5%
Annualised return	9%	2%	2%

Table 7: Lowest to highest annual real returns (1961-2010)

Category	Equity	Bonds	Cash
Decile 1	-19%	-11%	-3%
Decile 2	-12%	-7%	-1%
Decile 3	-1%	-4%	0%
Decile 4	3%	-2%	1%
Decile 5	14%	1%	2%
Decile 6	17%	4%	2%
Decile 7	24%	7%	3%
Decile 8	26%	13%	4%
Decile 9	43%	19%	7%
Decile 10	80%	28%	14%

- **The dispersion of asset class returns**

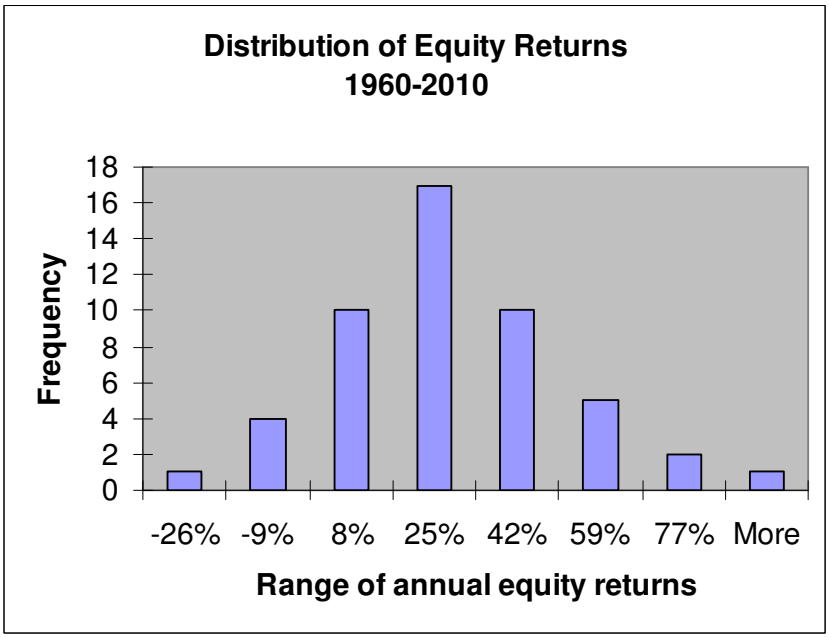

Chart 1: Distribution of annual equity returns

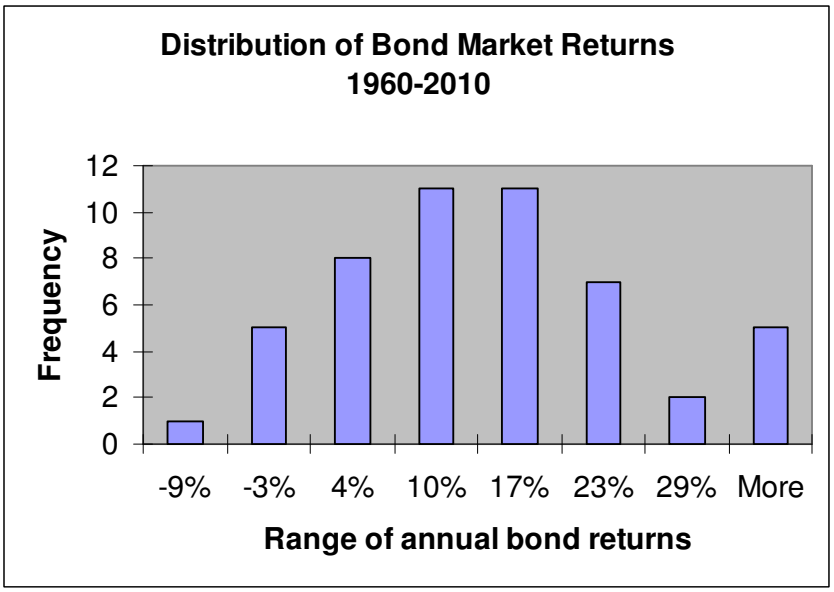

Chart 2: Distribution of annual bond returns

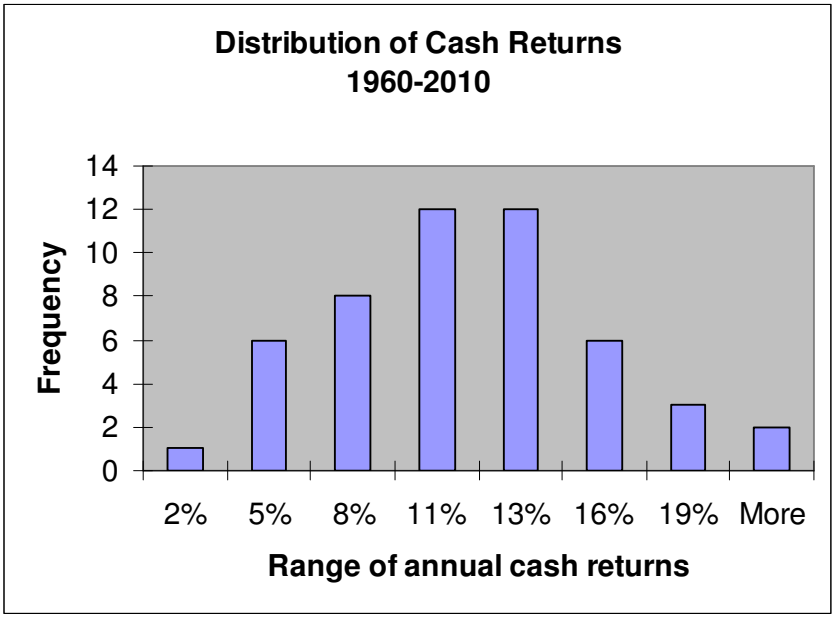

Chart 3: Distribution of annual cash returns

3. Managing Equities: The Riskiest Asset Class

- **The value of time diversification**

Reduction in risk = Square root of time

For example, if the standard deviation of equity returns over a one-year holding period is 20%, over a four year-holding period the volatility should be:

20% divided by square root of four years = 10%, etc.

- Chart 4 depicts the expected and actual volatility of equity returns over different holding periods. Clearly, the volatility of equity returns over longer term periods is lower than predicted by statistical inference.

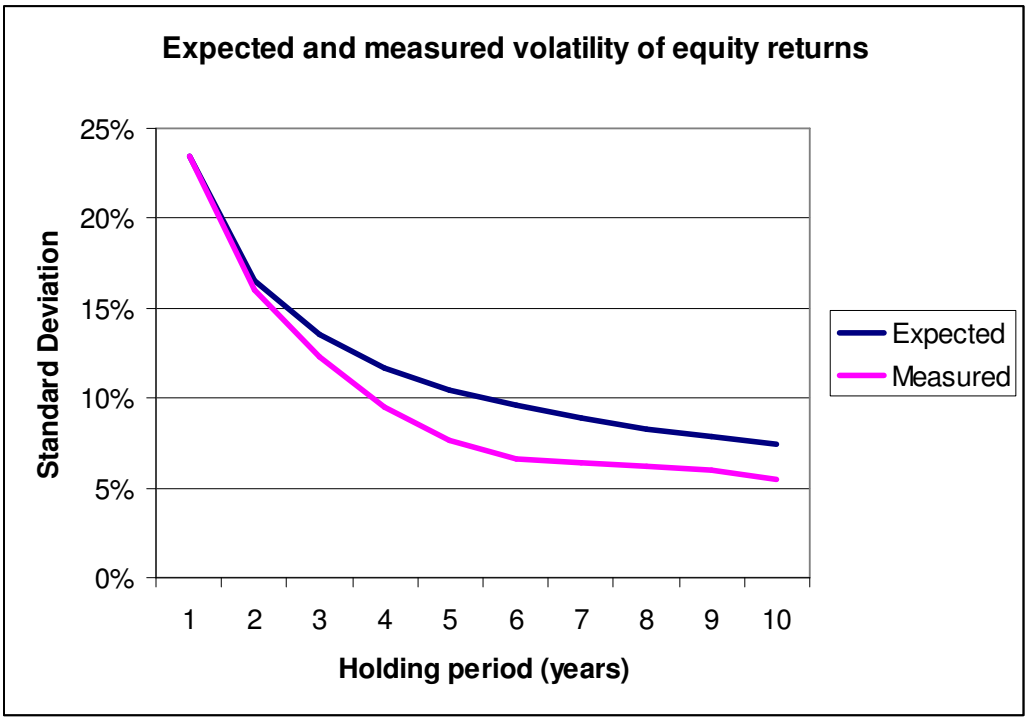

Chart 4: Expected versus realised volatility of equity returns over different holding periods

- Chart 5 and Chart 6 illustrate the range of annualised equity returns over different holding periods. During the past fifty years no negative equity return was ever recorded for any investment period longer than four years. Furthermore, equity returns over longer holding periods revert to the mean, i.e. a relatively small divergence of annualised returns for ten-year investment periods, etcetera.

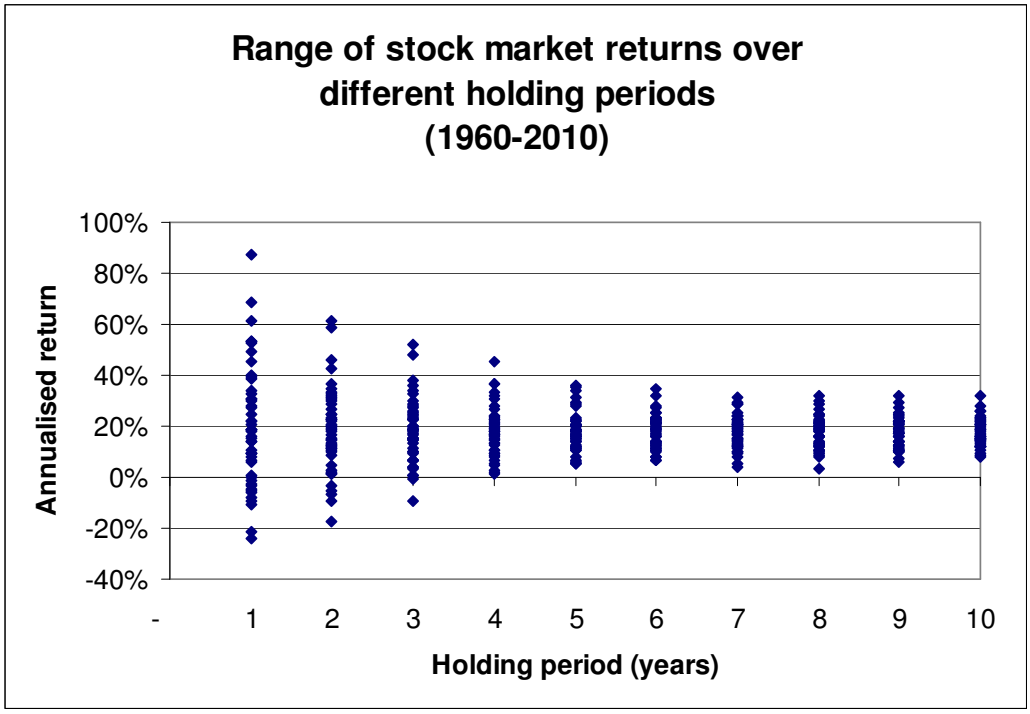

Chart 5: Range of equity returns over different holding periods

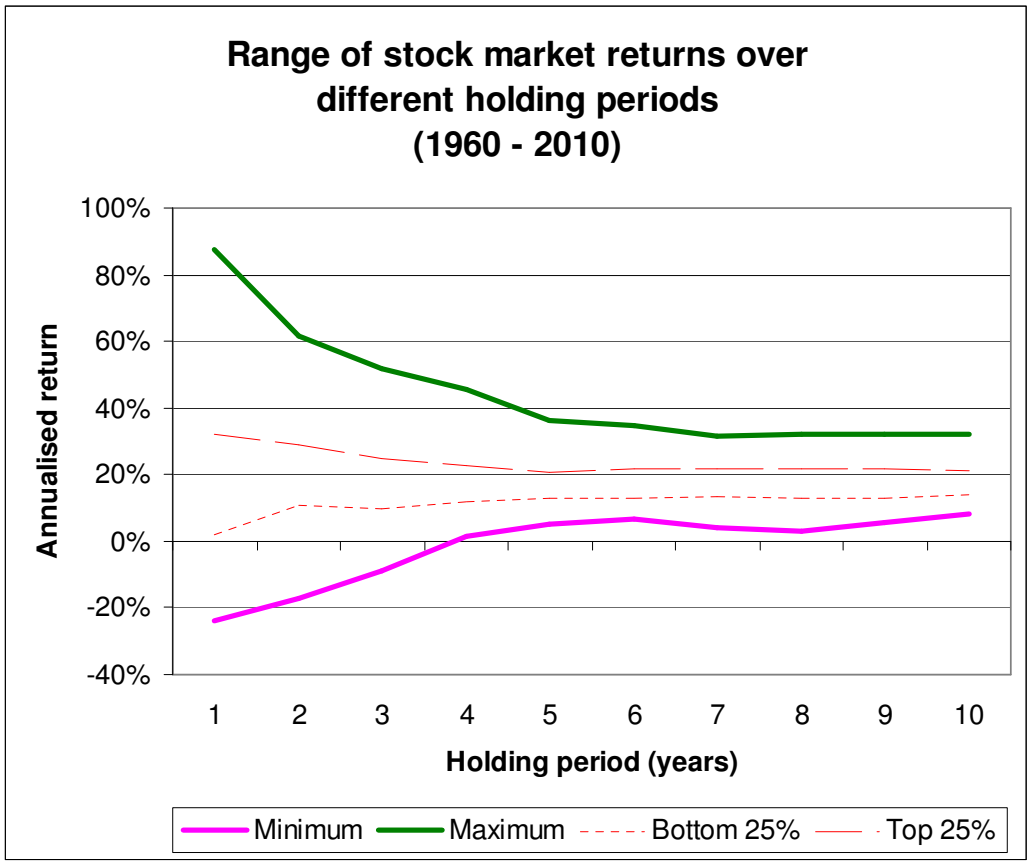

Chart 6: The highs and lows of equity returns over different holding periods

- **Why volatility is not necessarily bad for the long-term investor**

Stock market volatility is by no means a constant and like our oceans is characterised by periods of storms (high volatility) and periods of relative calmness (benign market volatility). The former is usually brought about financial and economic uncertainties (crises) or geopolitical tensions that may surface from time to time. Once the threat of such a crisis seems to be under control or well-managed, one can expect market calmness to return. The latter state, however, does not represent the "normal" or "usual" condition. Rather, it is normal for markets to exhibit both high and low volatilities, hence the analogy with conditions we might experience at sea.

Chart 7 depicts the annualised standard deviation of the stock market, based on the rolling 36-month volatility over time. It is apparent that the transition between low and high market volatility is not gradual, but swift. Furthermore, a period of high or low volatility is "sticky" – meaning it will typically remain in that state for a considerable period of time before changing course again.

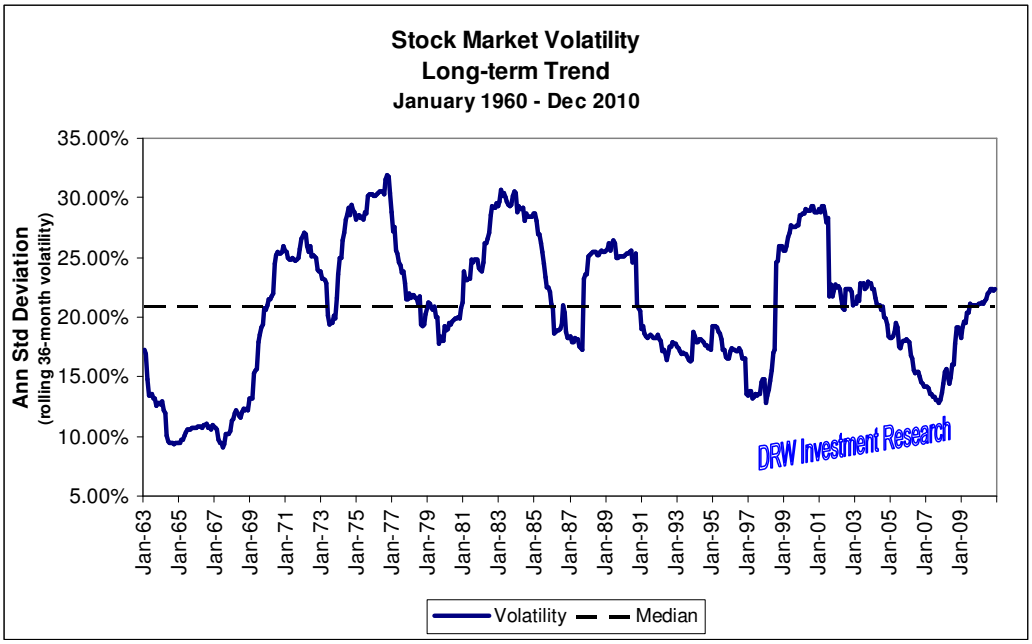

Chart 7: The cyclical nature of volatility

What does the cyclical nature of stock market volatility imply for the investor? While periods of high market volatility may not be reassuring or comfortable for the investor, it poses often fantastic investment opportunities.

For example, consider the subsequent 5-year historical returns from the stock market when an investment was made at various volatility levels. Chart 8 shows a significant positive relationship between the level of market volatility at the start of the investment and subsequent market returns (total return over 5-year holding periods). Alternatively, when market volatility is divided between above-the-median (high volatility) and below-the-median (low volatility) periods, the former period showed an average total return of 168% over the subsequent five years, while investments made at low market volatility yielded 110% on average over the same holding period.

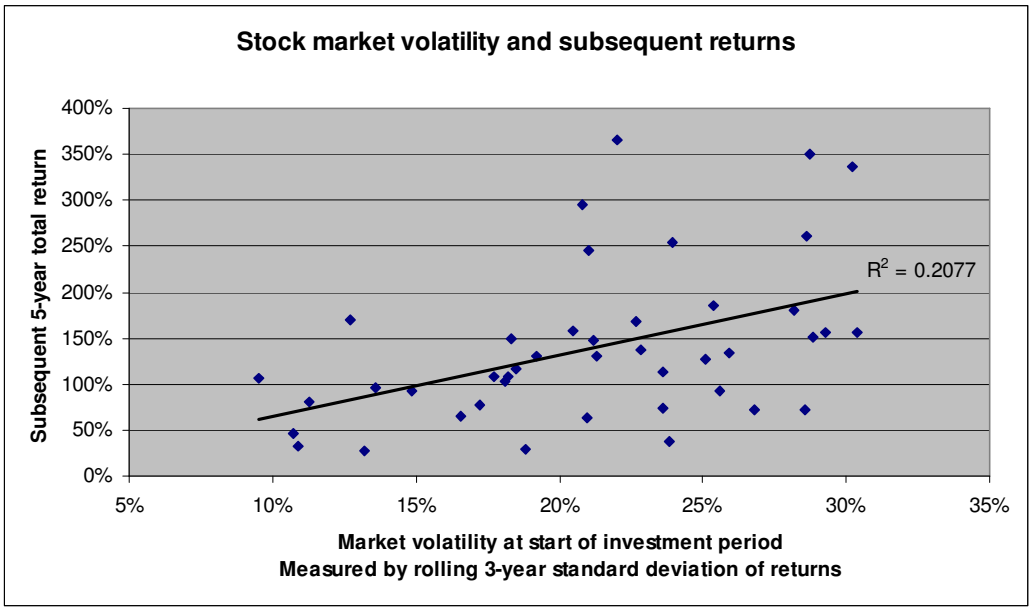

Chart 8: Investment opportunities

Thus, while a great deal is usually said of high stock market volatilities, two important aspects should not be forgotten: *One*, market volatility will not be permanently higher, but will revert to lower volatility at some point in the future. T*wo*, chances are that higher subsequent returns will result from periods characterised by high volatility and uncertainty than periods of relative calmness and confidence about future investment prospects.

4. Equity Investing: Know what to expect

What should equity investors know about the potential prospects and outcome of their investments? More specifically, what is the likelihood of negative returns – both nominal and real – in any one year and over different holding periods?

While the idea is certainly not to emphasise only the probabilities or risk of bad outcomes from equity investing, it is important that an investor should be informed and prepared for such experiences. Any investor should make investment decisions on the balance of probabilities (what is likely to happen) and not based only on good stories or recent investment experiences.

- **The probabilities of negative returns**

From Table 8 and Table 9:

- Table 8 shows the frequency and cumulative frequency of annual equity returns over the calendar years 1961 to 2010 (in total 50 data points). Nearly a quarter (24%) of all annual equity returns was negative over this period. Four percent (or two calendar years) of the observations yielded losses greater than 20% per annum. The majority of returns (18% or nine calendar years) was between 10% and 20% per annum. In total 44% of all observations yielded returns of more than 20% per annum.

- Thus, if historical evidence is anything to go by, some risk exists that equities may yield a negative return in any one year, but the balance of evidence points to very satisfactory returns from the stock market.

Table 8: Range of annual equity returns

Range	Frequency	Cumulative
-30%	0%	0%
-20%	4%	4%
-10%	6%	10%
0%	14%	24%
10%	14%	38%
20%	18%	56%
30%	12%	68%
40%	10%	78%
50%	8%	86%
60%	8%	94%
70%	4%	98%
80%	0%	98%
90%	0%	98%
100%	2%	100%

- Table 9 focuses on the likelihood that a negative equity return will occur at least once over specific holding periods, based on the historical evidence shown in Table 8. For example, the probability that a negative return will occur at least once in a five-year period is 75%; the probability that this loss will be greater than 10% is 41% and that the loss will be greater than 20% is 18%, and so forth. [2]

- Basically, the longer the investment period, the greater the likelihood that a negative return will occur at least once during that period – it is near certain that a negative equity return will occur at least once during a ten-year period!

[2] The probability of a negative return occurring at least once over a certain period is calculated by the following formula:

$$1-(1-P)^n$$

Where: P = probability of a negative return in any one year
n= Period in years

For example, the likelihood of a negative return over a five-year period = $1-(1-0.24)^5$
Likewise, the likelihood of a negative return greater than 20% over the same period = $1-(1-0.04)^5$

Table 9: Probability of negative returns over different holding periods

Negative return greater than:	**-30%**	**-20%**	**-10%**	**0%**
Risk of negative return in any year	0%	4%	10%	24%
Risk of negative return at least once in any three-year period	0%	12%	27%	56%
Risk of negative return at least once in any five-year period	0%	18%	41%	75%
Risk of negative return at least once in any seven-year period	0%	25%	52%	85%
Risk of negative return at least once in any ten-year period	0%	34%	65%	94%

From Table 10 and Table 11:

- When considering real equity returns - thus accounting for inflation risk - over the same period, it is found that more than 30% of the observations yielded negative returns in real terms. Nonetheless, the greatest majority of observations (50%) was found between 0% and 30% real returns per annum with an additional 18% of the observations performing better than 30% real return per annum.

Table 10: Range of real annual equity returns

Range	Frequency	Cumulative
-30%	4%	4%
-20%	4%	8%
-10%	16%	24%
0%	8%	32%
10%	16%	48%
20%	16%	64%
30%	18%	82%
40%	4%	86%
50%	8%	94%
60%	4%	98%
70%	0%	98%
80%	2%	100%

- Table 11 shows the likelihood of a negative real return occurring at least once over specific holding periods. As shown in Table 9, the likelihood that a negative real return will occur at least once in a period will increase with the duration of the investment period. In this case, however, the probabilities are even higher than when only considering nominal returns.

Table 11: Probability of negative real returns over different holding periods

Negative return greater than:	**-30%**	**-20%**	**-10%**	**0%**
Risk of negative return in any year	4%	8%	24%	32%
Risk of negative return at least once in any three-year period	12%	22%	56%	69%
Risk of negative return at least once in any five-year period	18%	34%	75%	85%
Risk of negative return at least once in any seven-year period	25%	44%	85%	93%
Risk of negative return at least once in any ten-year period	34%	57%	94%	98%

- **Capital Losses at the end of a period**

The aforementioned analyses highlighted the risks associated with negative returns occurring at least once during an investment period. However, it does not reveal anything about the risk that the final investment value will be less than the initial investment (capital risk). For this purpose a Monte Carlo simulation model was used to assess the potential risk of capital losses.[3]

[3] Kritzman and Rich (2002) proposed a specific methodology and algebraic function how to calculate the probabilities of within-period capital losses. A discussion of this function, however, necessitates an intimate knowledge of higher algebra, which I do not wish to impose on the reader. To this effect a simulation model with an adequate number of repetitions serves the purpose very well. The following parameters were used in the simulation model: A normal distribution function with an average (expected) nominal return of 20% per annum or 12% real return and a 25% standard deviation. No assumption was made about prevailing market valuations, which clearly may also have an important bearing on the likelihood that a capital loss may occur over time.

From Table 12:

- The likelihood that the final value of an equity investment will be less than the initial investment after three years is calculated to be 12%, an 8% probability that the capital loss would have been more than 10% and about 5% probability that the final value would have been less than 80% of the initial investment.

- The likelihood of a capital loss after 5-years will reduce to 7%; about 5% after seven years and only 2% after ten years. Thus there is statistically a very low probability that capital losses will occur with the passage of time. [4]

Table 12: Probabilities of capital losses at the end of a period

Probability of final value	**Less than initial value**	**More than 10% loss**	**More than 20% loss**
Final value after 3-years	12.1%	7.9%	4.5%
Final value after 5-years	7.1%	5.4%	3.4%
Final value after 7-years	4.8%	3.9%	2.9%
Final value after 10-years	2.0%	1.7%	1.3%

Based on the outcome of 1,000 simulations, a normal distribution assumption, an average return of 20% per annum with a standard deviation of 25% will occur.

[4] Typically, a normal distribution function underestimates the risk of equity investing in the short run, but overestimates the risk of capital losses over the long term.

From Table 13:

- The likelihood that real capital losses will be experienced after, say, three years, is significantly higher than that of a long-term investment period, of say, ten years.

Table 13: Probabilities of real capital losses at the end of a period

Probability of final value	Less than initial value	More than 10% real loss	More than 20% real loss
Final value after 3-years	26.0%	19.2%	13.0%
Final value after 5-years	22.7%	17.4%	12.7%
Final value after 7-years	17.3%	14.1%	11.3%
Final value after 10-years	12.9%	10.2%	8.2%

Based on the outcome of 1,000 simulations, a normal distribution assumption, average real return of 12% per annum and with a standard deviation of 25% will occur.

- **Investor behaviour**

In practice investors do not review their investments only after three years, five years or whatever investment horizon they may have decided upon at the start of their investment term. More likely, investors are constantly reviewing portfolio performances. What if investors experienced a slump in investment value below the initial value within the investment period? More than likely investors will consider taking some drastic action. Thus we are not only concerned about the risk of capital losses at the end of an investment period, but also what happens to the investment value within the holding period.

For example, an investor has set herself a long-term investment horizon, typically more than ten years, to invest in the equity market. After, say, three years the stock market is experiencing a sharp correction and the value of the investor's portfolio drops below the initial investment value. An investor will be tempted at that stage, especially with the usual pessimism abound after such a sharp correction, rather to withdraw from the market and park her monies in more secured investment options. However, in all likelihood this will be the worst possible strategy, because possible temporary losses will be made permanent.

Investors, therefore, need to be aware upfront of the potential risk that investment values may drop below the initial value within an investment period, especially if such losses are only temporary in nature. Also, note that the risk of such losses, whether permanent or temporary, should be higher than the probabilities of capital losses measured at the end of an investment period.

- **Capital losses within-period**

From Table 14:

- A substantial risk (more than 30% probability) exists that the investment value at any time may fall below the initial investment value within the investment period.

Table 14: The probabilities of capital losses within-period

Probability of investment value	**Less than initial value**	**More than 10% loss**	**More than 20% loss**	**More than 30% loss**
Within 3-year period	30.2%	16.7%	10.9%	5.5%
Within 5-year period	32.4%	19.0%	12.1%	6.4%
Within 7-year period	33.2%	19.5%	12.9%	6.7%
Within 10-year period	33.4%	19.9%	13.2%	7.1%

Based on the outcome of 1,000 simulations, a normal distribution assumption, average return of 20% per annum with a standard deviation of 25% will occur.

From Table 15:

- A significant risk – between 45% and 50% probability – exists that the real value of the investment may fall below the original investment value at any time within the investment period.

Table 15: The probabilities of real capital losses within-period

Probability of investment value	**Less than initial value**	**More than 10% real loss**	**More than 20% real loss**	**More than 30% real loss**
Within 3-year period	44.7%	31.8%	20.1%	11.3%
Within 5-year period	49.4%	36.1%	24.8%	15.0%
Within 7-year period	51.9%	38.8%	27.5%	18.1%
Within 10-year period	53.7%	40.1%	29.7%	20.4%

Based on the outcome of 1,000 simulations, a normal distribution assumption, average real return of 12% per annum with a standard deviation of 25% will occur.

5. Asset Class Diversification: Know what to expect

- Consider a managed portfolio that is invested in different asset classes, namely:

  50% Equities
  30% Bonds
  20% Cash

- Return profile:

Average annual return over the past fifty years:	15%
Average annual real return over the past fifty years:	7%
Volatility of annual return over the past fifty years:	14%
Annualised return over the past fifty years:	15%
Annualised real return over the past fifty years:	6%

- **The probabilities of negative returns**

From Table 16 and Table 17:

- Based on the historical evidence over the past fifty years, a 10% probability exists that the annual return from a managed portfolio will yield a negative return in any year. The greatest majority of annual returns (44% of observations) were between 10% and 30% return per annum.

Table 16: Range of annual managed portfolio returns

Range	Frequency	Cumulative
-20%	0%	0%
-10%	2%	2%
0%	8%	10%
10%	32%	42%
20%	26%	68%
30%	18%	86%
40%	8%	94%
50%	4%	98%
60%	2%	100%

- Based on the historical annual return distributions of a managed portfolio, more than a 25% probability exists that such a portfolio will yield a negative return at least once within a three-year period. The likelihood of a negative return to occur at least once will increase to 41% over a five-year period, 52% over a seven-year period and 65% over a ten-year period. Nonetheless, these probabilities are much less than that of an equity-only portfolio as shown in Table 8.

Table 17: Probability of negative returns over different holding periods

Negative return greater than:	**-20%**	**-10%**	**0%**
Risk of negative return in any year	0%	2%	10%
Risk of negative return at least once in any three-year period	0%	6%	27%
Risk of negative return at least once in any five-year period	0%	10%	41%
Risk of negative return at least once in any seven-year period	0%	13%	52%
Risk of negative return at least once in any ten-year period	0%	18%	65%

From Table 18, Table 19 and Table 20:

- A significant number of the annual returns from a managed portfolio over the past fifty years would have yielded negative real returns (34%), which is not much different from an equity-only portfolio.[5]

Table 18: Range of real annual managed portfolio returns

Range	Frequency	Cumulative
-20%	0%	0%
-10%	10%	10%
0%	24%	34%
10%	24%	58%
20%	24%	82%
30%	14%	96%
40%	2%	98%
50%	2%	100%

- Table 19 shows the probabilities of a negative real return occurring at least once over different holding periods, based on the real return distribution over the past fifty years.

[5] This finding might be somewhat surprising since 50% of the managed portfolio would have been invested in fixed interest investments, which typically offer 1% to 3% real yield (before taxation) with moderate to low volatility over time. Then again one should bear in mind that the Reserve Bank's positive real interest rate monetary policies have been applied only for the past two decades. Hence, the possible distortions of real return data from fixed interest investments are apparent when measured over the past fifty years.

Table 19: Probability of negative real returns over different holding periods

Negative return greater than:	**-20%**	**-10%**	**0%**
Risk of negative return in any year	0%	10%	34%
Risk of negative return at least once in any three-year period	0%	27%	71%
Risk of negative return at least once in any five-year period	0%	41%	87%
Risk of negative return at least once in any seven-year period	0%	52%	95%
Risk of negative return at least once in any ten-year period	0%	65%	98%

- Table 20 exhibits an "adjusted" probability distribution that a negative real return will occur at least once over different holding periods, based on real return data since 1988, to account for a more rational monetary policy approach since then. While it is basically certain that a negative real return will materialise at least once over long-term holding periods, the odds are relatively small that such a negative real return would be greater than a 10% real loss in such a year.

Table 20: Probability of negative real returns based on data since 1988

Negative return greater than:	**-20%**	**-10%**	**0%**
Risk of negative return in any year	0%	4%	22%
Risk of negative return at least once in any three-year period	0%	12%	52%
Risk of negative return at least once in any five-year period	0%	20%	71%
Risk of negative return at least once in any seven-year period	0%	27%	82%
Risk of negative return at least once in any ten-year period	0%	36%	91%

- **Capital losses at the end of a period**

From Table 21:

- The likelihood that the final value of a managed portfolio will be less than the initial investment is very low – from less than 4% probability after three years to virtually zero after a ten-year investment period.

Table 21: Probabilities of capital losses at the end of a period

Probability of final value	Less than initial value	More than 10% loss	More than 20% loss
Final value after 3-years	3.8%	1.5%	0.6%
Final value after 5-years	0.5%	0.5%	0.1%
Final value after 7-years	0.3%	0.1%	0.0%
Final value after 10-years	0.1%	0.0%	0.0%

Based on the outcome of 1,000 simulations, a normal distribution assumption, and an average return of 15% per annum with a standard deviation of 14% will occur.

From Table 22:

- The likelihood that a managed portfolio will yield a negative real return after three years is calculated to be more than 20%, but this probability will decline to less than 10% over long-term holding periods.

Table 22: Probabilities of real capital losses at the end of a period

Probability of final value	Less than initial value	More than 10% real loss	More than 20% real loss
Final value after 3-years	22.4%	11.4%	4.5%
Final value after 5-years	17.0%	9.1%	4.6%
Final value after 7-years	11.2%	6.5%	4.0%
Final value after 10-years	8.2%	5.0%	3.0%

Based on the outcome of 1,000 simulations, a normal distribution assumption, and an average real return of 7% per annum will occur with a standard deviation of 14%.

- **Capital losses within-period:**

From Table 23:

- The probability that the investment value of a managed portfolio will decline to less than the initial investment at any stage of an investment period is calculated to be about 15%, and with very low probabilities that such declines will be more than 10% losses.

Table 23: The probabilities of capital losses within-period

Probability of investment value	**Less than initial value**	**More than 10% loss**	**More than 20% loss**	**More than 30% loss**
Within 3-year period	15.5%	6.0%	1.1%	0.1%
Within 5-year period	15.6%	6.4%	1.2%	0.1%
Within 7-year period	15.8%	6.5%	1.2%	0.1%
Within 10-year period	15.8%	6.5%	1.2%	0.1%

Based on the outcome of 1,000 simulations, a normal distribution assumption, an average return of 15% per annum with a standard deviation of 14% will occur.

From Table 24:

- A significant risk – between 45% and 50% probability – exists that the real value of a managed portfolio will fall below the initial investment value at any time within the investment period.

- The probability of steep real losses – more than 20% – occurring within-period, however, is limited to only 10% - 15% of the outcome range.

Table 24: The probabilities of real capital losses within-period

Probability of investment value	**Less than initial value**	**More than 10% real loss**	**More than 20% real loss**	**More than 30% real loss**
Within 3-year period	44.4%	21.7%	9.2%	2.2%
Within 5-year period	47.9%	25.8%	12.1%	3.5%
Within 7-year period	49.2%	27.5%	14.1%	4.8%
Within 10-year period	50.5%	30.2%	15.1%	5.7%

Based on the outcome of 1,000 simulations, a normal distribution assumption, an average real return of 7% per annum with standard deviation of 14% will occur.

6. Summary

- Investment risk is multidimensional in nature and refers to the likelihood of the loss of capital in nominal and real terms, volatility of returns and liquidity of an investment.

- The standard deviation or volatility of returns is typically used to express investment risk, but is an incomplete representation of investment risk.

- Based on historical evidence it can be argued that periods of high market volatilities often represent good investment opportunities, whereas periods of low market volatility may well be “expensive” investment periods resulting subsequently in suboptimal returns.

- In an investment plan investment risk can be managed and mitigated, but not completely eliminated.

- Sensible ways of reducing investment risk include: Invest in regulated investments and listed securities, asset allocation and portfolio diversification, and the appropriate time horizon.

- Portfolio diversification (asset allocation) reduces the volatility of returns and the possibility of negative returns and capital losses in nominal and real terms.

- The likelihood of capital losses is largely reduced by the investment period. A vast difference exists in the likelihood of nominal and real capital losses between a three-year and a ten-year investment period.

- While the risk of nominal and real capital loss over a long-term investment period is finite, the risk of capital loss within-period is much greater. Chances are that these losses will be temporary, and thus it is best for investors not to panic and to remain invested.

- Inflation risk or the likelihood that an investment will lose its purchasing power over time poses probably the biggest challenge to most investors. When investors are overly concerned about the risk of losing capital in nominal terms or price volatilities, it is likely that very conservative portfolios will be preferred at the expense of the ability to manage inflation risk.

- Investing by probabilities means that an investor is aware of the possibilities and likelihood of various outcomes of investment portfolios over time. It provides a framework for making informed investment decisions based on the overweight of likely outcomes, and not solely relying on past performances or some good stories and prospects about future performances. Past performance is only one outcome from many that could have transpired in the past. Likewise, good stories do not guarantee future performances and are often told for a reason, namely to market a fund or securities to the investing public.

Additional Sources:

Franco Busetti, 2009. "The Effective Investor", Pan Macmillan SA (Pty) Limited.

Mark Kritzman, and Don Rich, 2002. "The Mismeasurement of Risk", Financial Analysts Journal, May/June edition, pp 91-99.

Wessels, Daniel R., 2006. "The Characteristics of Stock Market Volatility"
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APPENDIX

Asset Class Returns

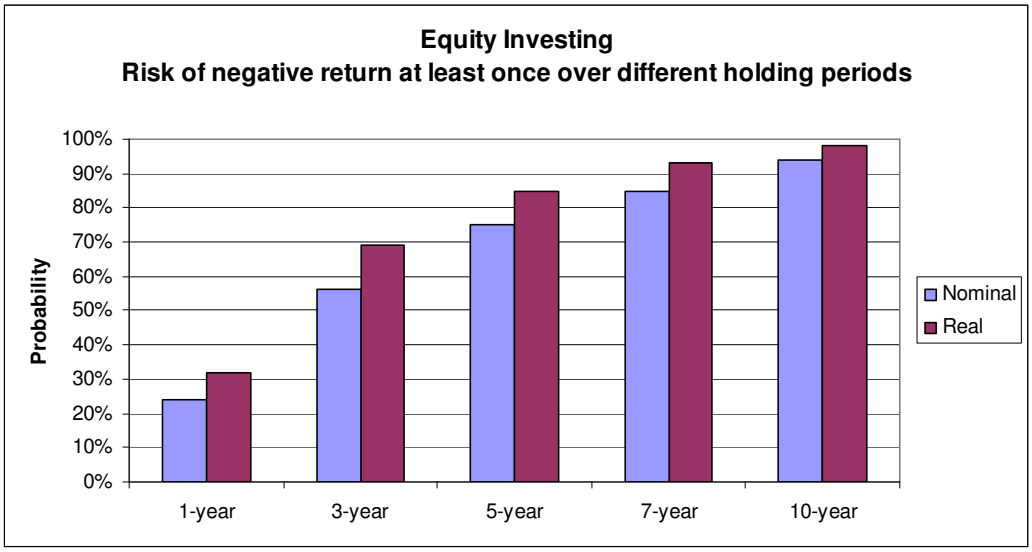
YEAR	EQUITY	BONDS	CASH
1961	11%	0%	5%
1962	29%	21%	3%
1963	24%	5%	2%
1964	19%	2%	3%
1965	7%	-7%	5%
1966	21%	0%	5%
1967	20%	7%	6%
1968	51%	7%	6%
1969	-11%	7%	6%
1970	-26%	-6%	7%
1971	10%	1%	8%
1972	64%	13%	7%
1973	5%	10%	6%
1974	15%	-5%	11%
1975	-13%	5%	10%
1976	-3%	2%	12%
1977	31%	14%	10%
1978	37%	21%	9%
1979	94%	13%	6%
1980	40%	-7%	5%
1981	1%	2%	13%
1982	38%	32%	18%
1983	14%	-4%	15%
1984	9%	2%	22%
1985	42%	11%	22%
1986	57%	36%	13%
1987	-5%	15%	10%
1988	15%	8%	13%
1989	56%	22%	14%
1990	-5%	16%	15%
1991	31%	14%	14%
1992	-2%	28%	12%
1993	55%	32%	11%
1994	23%	-9%	10%
1995	9%	30%	11%
1996	9%	7%	12%
1997	-5%	29%	17%
1998	-10%	5%	17%
1999	61%	30%	16%

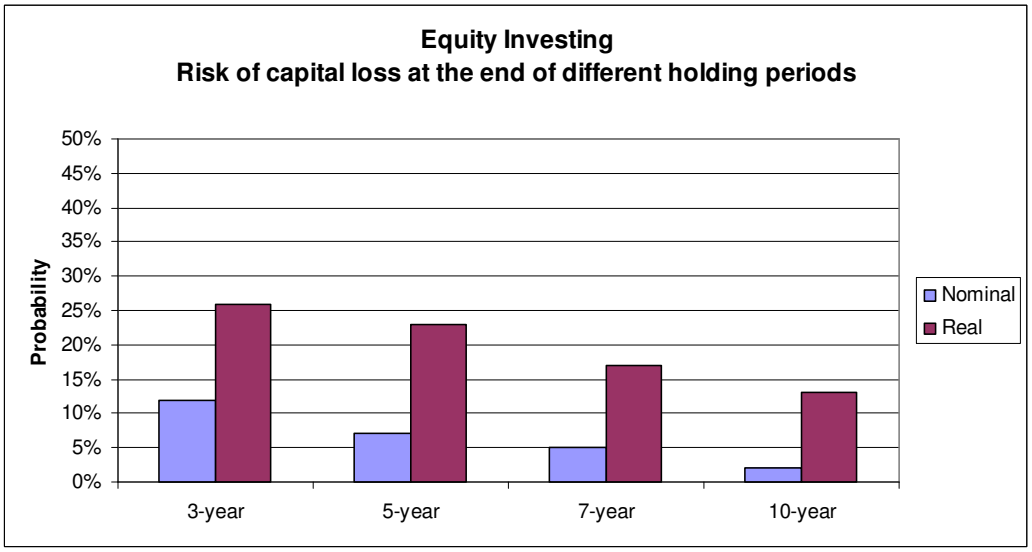
YEAR	EQUITY	BONDS	CASH
2000	0%	20%	11%
2001	29%	18%	11%
2002	-8%	16%	12%
2003	16%	18%	12%
2004	25%	14%	8%
2005	47%	11%	8%
2006	41%	5%	8%
2007	19%	4%	9%
2008	-23%	17%	12%
2009	32%	-1%	9%
2010	19%	15%	7%
Average	**20%**	**11%**	**10%**
Std deviation	**25%**	**11%**	**5%**
Annualised return	**18%**	**10%**	**10%**

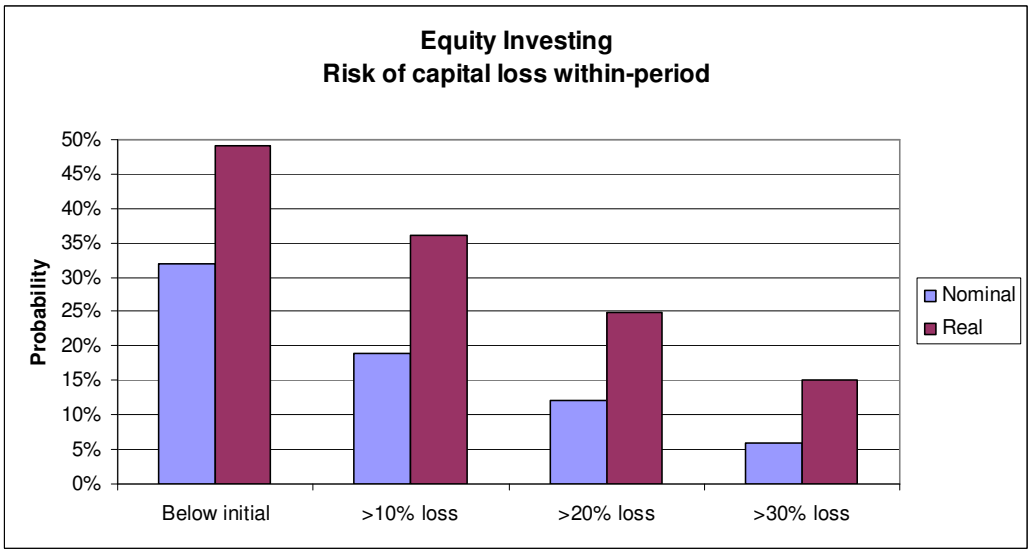
Asset Class Real Returns

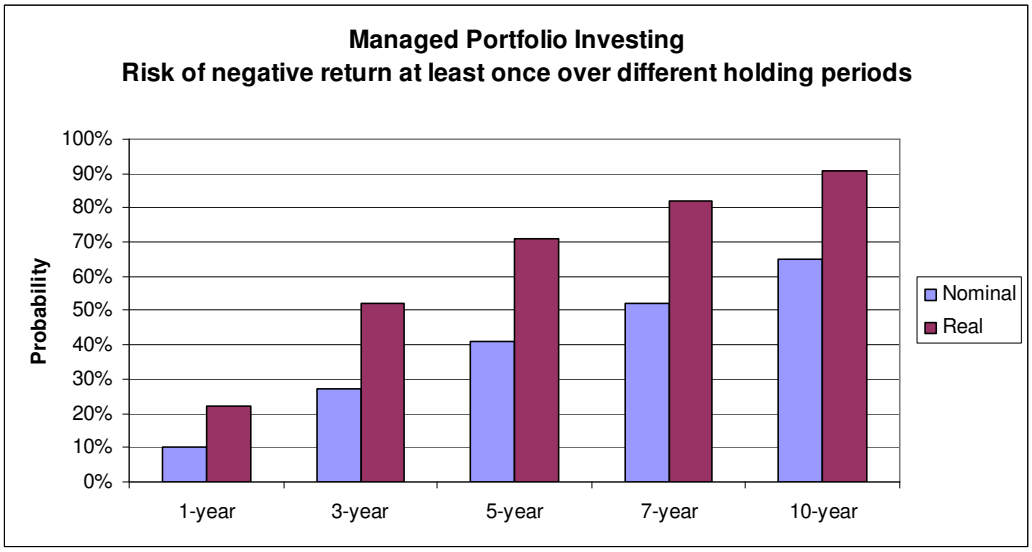
YEAR	EQUITY	BONDS	CASH
1961	10%	-2%	3%
1962	27%	20%	2%
1963	22%	4%	1%
1964	15%	-2%	-1%
1965	4%	-10%	2%
1966	16%	-4%	1%
1967	18%	5%	4%
1968	49%	4%	3%
1969	-15%	3%	2%
1970	-31%	-11%	2%
1971	3%	-6%	1%
1972	56%	5%	0%
1973	-4%	0%	-4%
1974	1%	-19%	-3%
1975	-25%	-7%	-2%
1976	-14%	-9%	1%
1977	20%	3%	-1%
1978	25%	10%	-3%
1979	80%	-1%	-8%
1980	24%	-22%	-11%
1981	-13%	-12%	-1%
1982	25%	19%	5%
1983	3%	-15%	4%
1984	-4%	-11%	8%
1985	23%	-7%	3%
1986	38%	18%	-6%
1987	-19%	0%	-5%
1988	2%	-4%	1%
1989	40%	6%	-1%
1990	-20%	2%	0%
1991	15%	-2%	-2%
1992	-12%	18%	2%
1993	45%	23%	1%
1994	13%	-19%	0%
1995	2%	23%	4%
1996	0%	-3%	3%
1997	-11%	23%	11%
1998	-19%	-4%	8%
1999	59%	28%	14%
2000	-7%	13%	4%
2001	25%	14%	6%

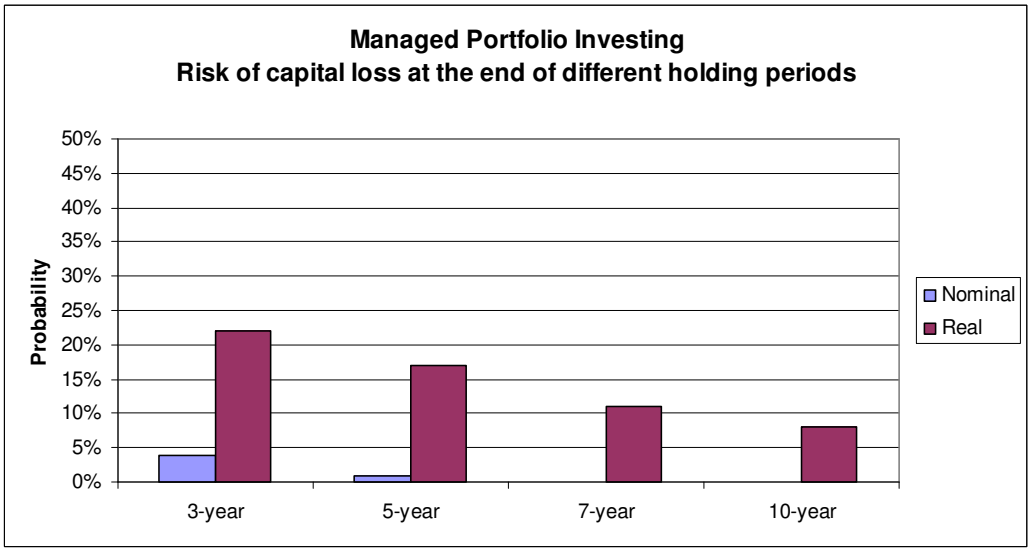
YEAR	EQUITY	BONDS	CASH
2002	-21%	4%	0%
2003	15%	18%	12%
2004	21%	11%	5%
2005	43%	7%	4%
2006	35%	0%	2%
2007	10%	-5%	0%
2008	-33%	8%	2%
2009	26%	-7%	3%
2010	16%	12%	4%
Average	12%	2%	2%
Std deviation	25%	12%	5%
Annualised return	9%	2%	2%

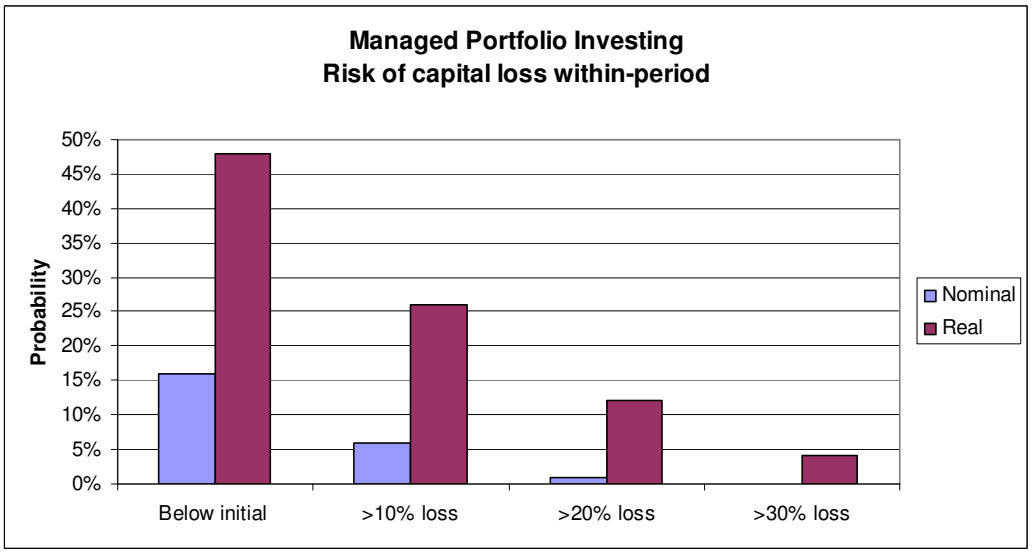

Equity Investing
Risk of negative return at least once over different holding periods
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1-year
3-year
5-year
7-year
10-year
Nominal
Real


Equity Investing
Risk of capital loss at the end of different holding periods
Probability
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
3-year
5-year
7-year
10-year
Nominal
Real


Equity Investing
Risk of capital loss within-period
Probability
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Below initial
>10% loss
>20% loss
>30% loss
Nominal
Real


Managed Portfolio Investing
Risk of negative return at least once over different holding periods
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1-year
3-year
5-year
7-year
10-year
Nominal
Real


Managed Portfolio Investing
Risk of capital loss at the end of different holding periods
Probability
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
3-year
5-year
7-year
10-year
Nominal
Real


Managed Portfolio Investing
Risk of capital loss within-period
Probability
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Below initial
>10% loss
>20% loss
>30% loss
Nominal
Real

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