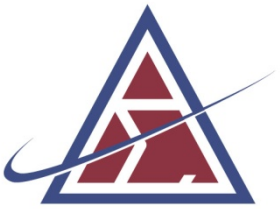

Institute of Actuaries of Australia

Rebalancing Revisited

Prepared by Syd Bone and Andrew Goddard

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The Institute of Actuaries of Australia
Level 7 Challis House 4 Martin Place
Sydney NSW Australia 2000
Telephone: +61 2 9233 3466 Facsimile: +61 2 9233 3446
Email: actuaries@actuaries.asn.au Website: www.actuaries.asn.au

Rebalancing Revisited

Summary

Most strategic asset allocations adopted by institutional investors are 'risk taking' (liability mismatching to varying degrees) in preference to the 'risk free' default (liability matching to the extent feasible). This is usually done to enhance long term returns and minimize capital requirements, but is accompanied by increased volatility in the solvency margin in the short term. Conventional wisdom is to rebalance a 'risk taking' strategic asset allocation systematically between its underlying asset classes as their respective investment returns vary over time. Value added from this automated, contrarian, 'buy low sell high' process is well established in the literature[1, 2, 3]. However, rebalancing is typically not undertaken between the risk taking and risk free strategic asset allocations. In effect, no rebalancing between assets and liabilities occurs. In this paper we examine with a simple model the hypothesis that such rebalancing leads to value added over time by enhancing long term investment returns and reducing volatility in the solvency margin. The concept has clear application in insurance and defined benefit superannuation, and can be adapted for member choice superannuation where managing downside risk is a key priority.

Key Messages

The optimal investment outcome is most likely obtained when a preset, reasonably achievable target is established and then periodic rebalancing is carried out with reference to this target.

For insurance companies and defined benefit superannuation funds, this target may be the ratio of assets to liabilities (or solvency ratio). For defined contribution superannuation funds, the target may be a long term investment return of say CPI plus 5% per annum.

When in surplus relative to target, rebalance by reducing exposure to risky assets. When in deficit the reverse.

We assert that rebalancing to target generally produces better investment outcomes than traditional rebalancing to a fixed strategic asset allocation in terms of:

- magnitude of drawdowns and subsequent rebounds in difficult periods,
- lower volatility of the target ratio, and
- higher and less volatile investment returns in the portfolio.

The investment outcomes are sensitive to starting level of assets, duration of the investment period and the timing of major adverse events.

If this approach had been utilized over the last decade then, risky assets such as equities would have been underweighted in the run up to the current financial crisis leading to significant outperformance in 2008. By the same token they would have moved to an overweight position by the beginning of 2009.

We observe that member choices in defined contribution superannuation funds tend to be in the opposite direction to target rebalancing, and we demonstrate that the investment outcome is poor.

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1 Perold, Andre F., and William F. Sharpe. 1988. "Dynamic Strategies for Asset Allocation," *Financial Analysts Journal* 44, 1 (January-February): 16-27.

2 Bernstein, William J. and Wilkinson, David J.,Diversification, Rebalancing, and the Geometric Mean Frontier(November 24, 1997). Available at SSRN: http://ssrn.com/abstract=53503 or DOI: 10.2139/ssrn.53503

3 The Benefits of Rebalancing
Jr. Buetow; Ronald Sellers; Donald Trotter; Elaine Hunt; Jr. Whipple
The Journal of Portfolio Management Winter 2002

Background

All institutional portfolios exist to support some underlying liabilities or future payments. These liabilities may be superannuation defined benefits, they may be life or general insurance policy liabilities, or they may simply be the 'liability' to meet the future living costs of retired people in the case of a defined contribution, or accumulation, superannuation fund.

In determining how to invest these portfolios it is normal to take account of such concepts as asset-liability modeling, efficient portfolio design, liability matching, and so forth. The result of all of this work is most often expressed as a strategic asset allocation of the available funds between available asset classes, and this strategic asset allocation often remains in place, unchanged and not reviewed until the next strategic review, perhaps in three years time. During this period, rebalancing rules will be followed to keep the portfolio within pre-specified limits of its design strategic asset allocation.

The process is tried and tested and works well. It is common knowledge that the choice of strategic asset allocation is generally the most important determinant of investment outcomes. Furthermore, the rebalancing process reduces exposure to asset classes that have outperformed and increases exposure to underperforming asset classes in a systematic, automated fashion. This provides the portfolio with a built in buy low, sell high discipline.

What the process generally does not do, is to take account of changes in the relationship between assets and liabilities during the period between strategic reviews. This kind of approach leads to better outcomes in terms of measures which include both assets and liabilities, such as solvency ratios and accounting surplus or deficit.

The purpose of this paper

The purpose of this paper is to construct a simple model of a rebalancing process that takes account of both assets and liabilities, then, using this model, to demonstrate the benefits of the approach.

The paper does not purport to present a model of adequate sophistication for implementation by institutional investors, however it is hoped that it will motivate further research taking into account actual asset and liability mixes, transaction costs and rebalancing more frequently than annually.

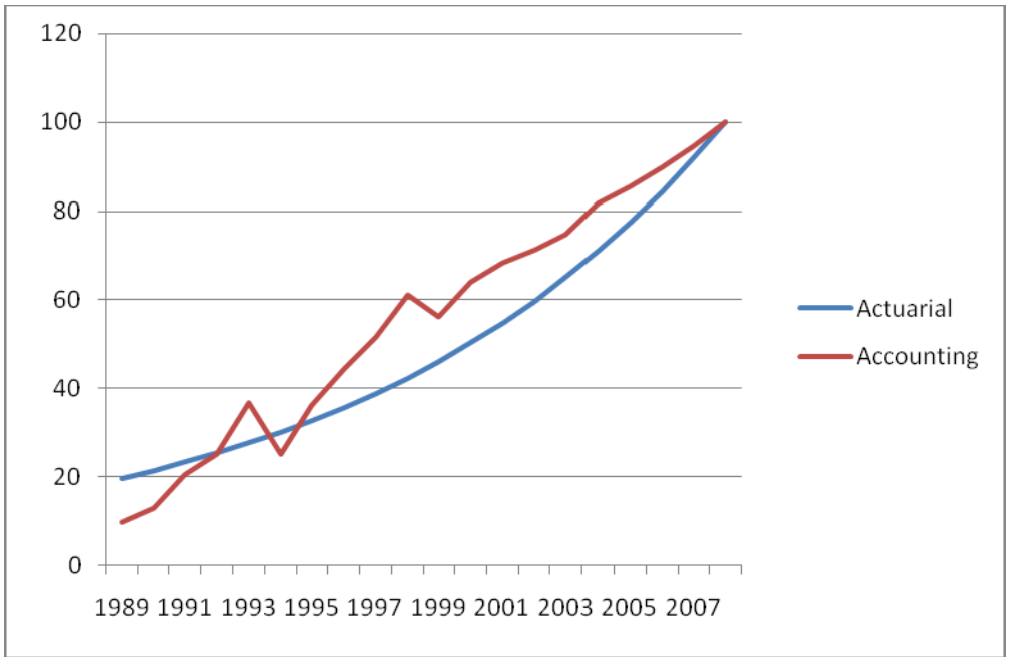
The model in outline

The approach that has been taken is to "backtest" the model rebalancing process, and to compare the results with what would have been achieved had the assets been invested in a conventionally rebalanced portfolio with 60% of the assets in Australian Equities and 40% in Australian Bonds.

The liability is taken as known to be $100 at 31 December 2008. Liabilities at previous dates are then determined in two different ways:

- From an "actuarial" standpoint the liability is discounted at 9% pa compound to determine the liability at earlier dates. 9% was chosen as typical of the long term discount rates used in actuarial valuations (5% above the long term rate of inflation); or
- From an "accounting" standpoint, the liability was discounted using the yield on Australian Government ten year bonds[4]. That is the liability at any previous date was taken as being the amount which, if invested at that bond yield at that date would have accumulated to $100 at 31 December 2008.

An example of this is depicted below:



The assets were taken as being invested in a mixture of a total return Australian Equity index[5] and a total return Australian bonds index[6].

It is obvious that this model is highly simplified; nonetheless, the model is adequate to demonstrate the benefits of the approach, as will be seen.

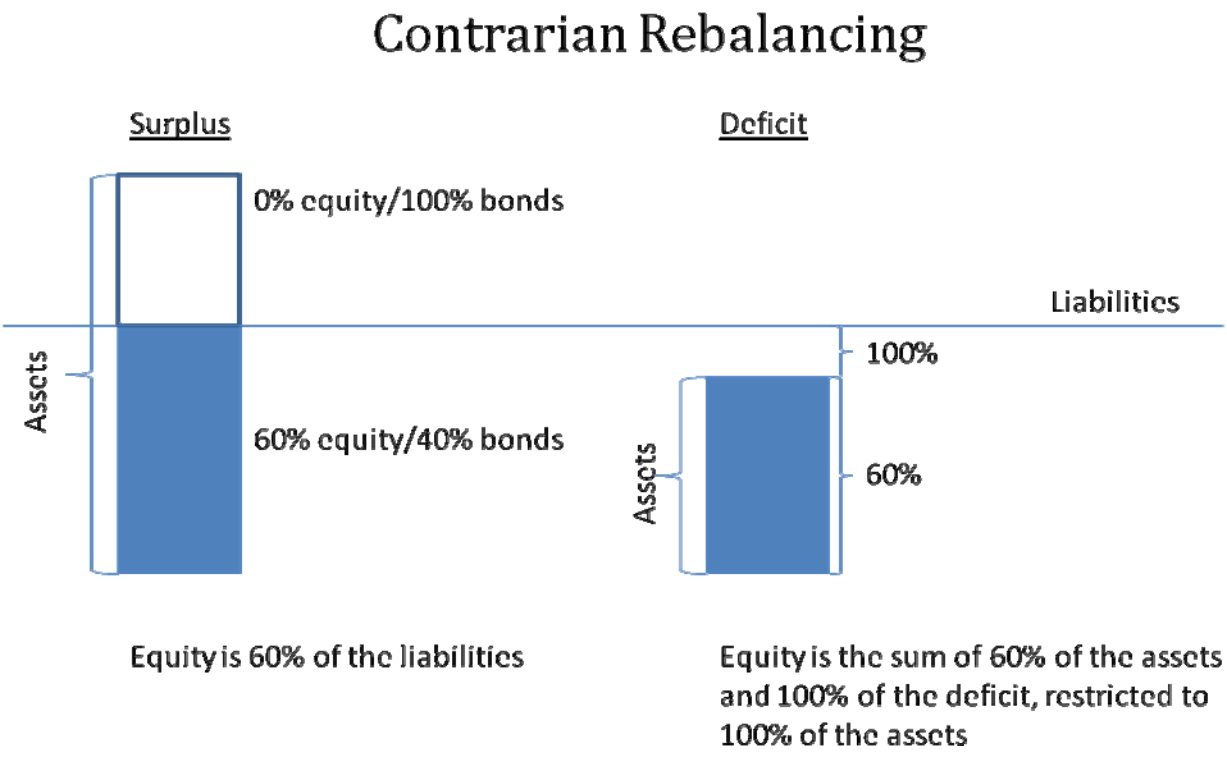
At time zero, the fund is taken as being of amount equal to its liabilities. The fund's assets are initially invested 60% in equities and 40% in bonds. At the end of each year the assets are rebalanced between equities and bonds, taking account not only of how equities and bonds have performed over the year, but also of how the liability has changed. We have labeled the approach used "contrarian rebalancing". It is explained more fully below.

For comparison purposes, the model is also run with a fixed strategic asset allocation of 60% in equities and 40% in bonds, also rebalanced annually.

[4] Source: RBA Capital Market Yields – Government Bonds
[5] Source: Australian Equity Total Return (Ibbotson DMS database 2006), extended to 31.12.08 using ASX All Ordinaries Total Return data
[6] Source: Australian Bond Total Return (Ibbotson DMS database 2006), extended to 31.12.08 using UBS Warburg Composite All Maturities, Bond Index, Total Return - Australia

A more rigorous mathematical approach would be to set up a statistical model and then to simulate future outcomes. This type of approach is applied by Leung in his forthcoming paper[7]. Leung's findings provide further support for the contrarian rebalancing approach adopted in this paper.

The rebalancing rule used to determine the allocation to equities



The rebalancing rule used is shown in diagrammatic form above. It is contrarian in nature, in that any surplus, relative to the liability, is invested 100% in bonds, whereas the amount of any shortfall, relative to the liability, is added to the equity allocation. This results in the equity proportion being less than 60% when in surplus, and more than 60% when in deficit.

A simple model explained simply

Assume a portfolio invested in a 60/40 mix of Australian equities and bonds. Over ten years to the end of 2008, equities returned 7.9% p.a., bonds 5.7%p.a. and remarkably a 60/40 mix 7.9% p.a. (reflecting the virtues of traditional rebalancing in volatile markets). A particularly sound result overall given CPI at 2.9% p.a. over this period, so the portfolio was roughly in line with a reasonable long term target of CPI +5% p.a. The one blemish was a -19% return in the difficult 2008 calendar year.

We could have done better.

Had we followed the proposed contrarian investment strategy for the 10 year period, rebalancing relative to the actuarial liability, we would have earned 8.5% p.a. compound and incurred less volatility in the asset to liability ratio

[7] Reactive investment strategies, A.P. Leung

Some results

We start by considering periods of ten and twenty years up to 31 December 2008. Whether we rebalance relative to the "actuarial" liability or to the "accounting" liability, the outcome is for the surplus/deficit (or solvency margin) relative to the liability measure to follow a smoother path than is achieved by a static rebalancing approach. Furthermore, there seems to be scope for some alpha generation, again measured relative to the fixed rebalancing approach, although this is affected by the starting level of assets. In particular, 2008 stands out in this regard.

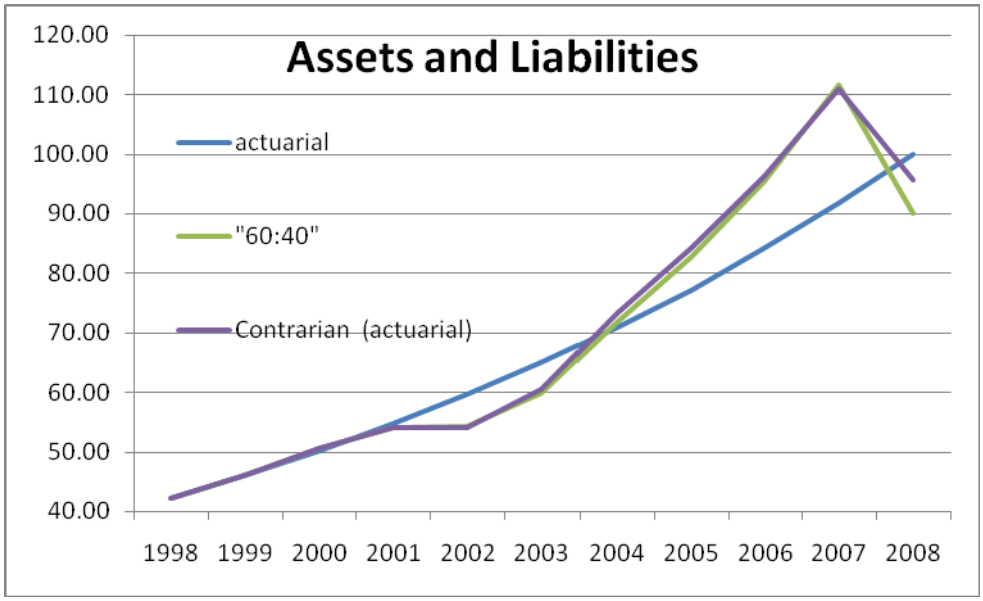
Then, to stress test the approach, we consider twenty year periods up to 31 December 1988 and up to 31 December 1938. Despite the different and dramatic market events to be found in these time periods, the overall effect of the contrarian rebalancing approach remains the same.

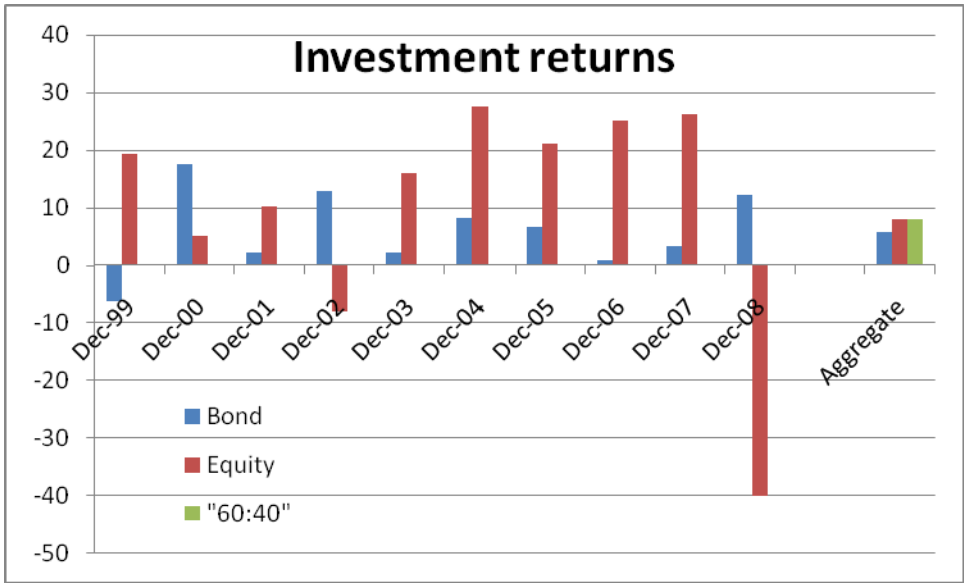
These outcomes are depicted below.

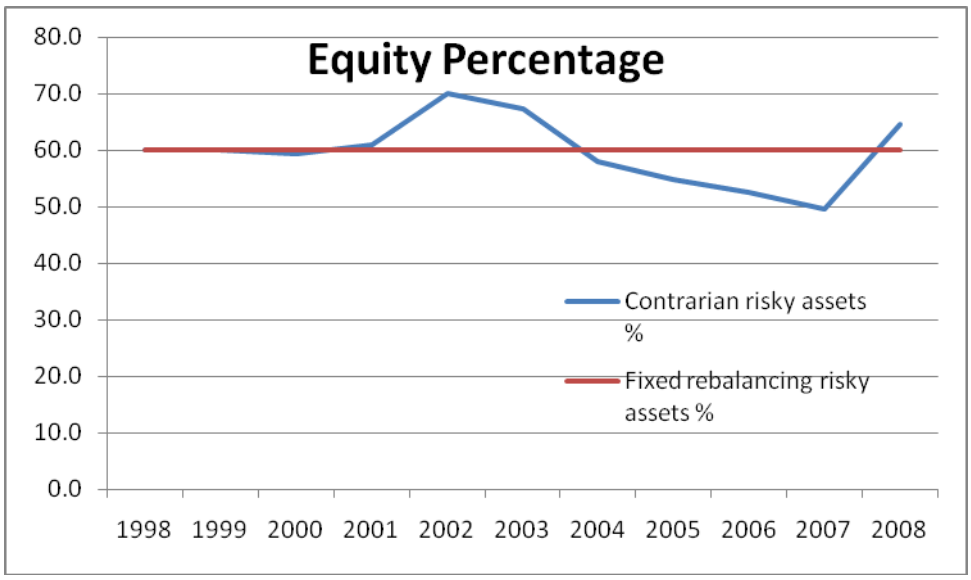
First for periods up to 31 December 2008:

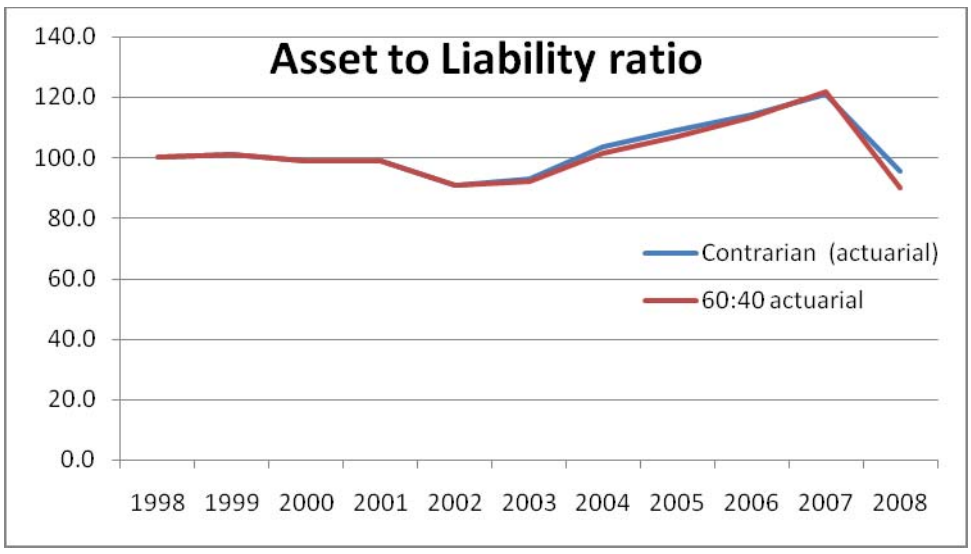
Relative to actuarial liability

Ten years



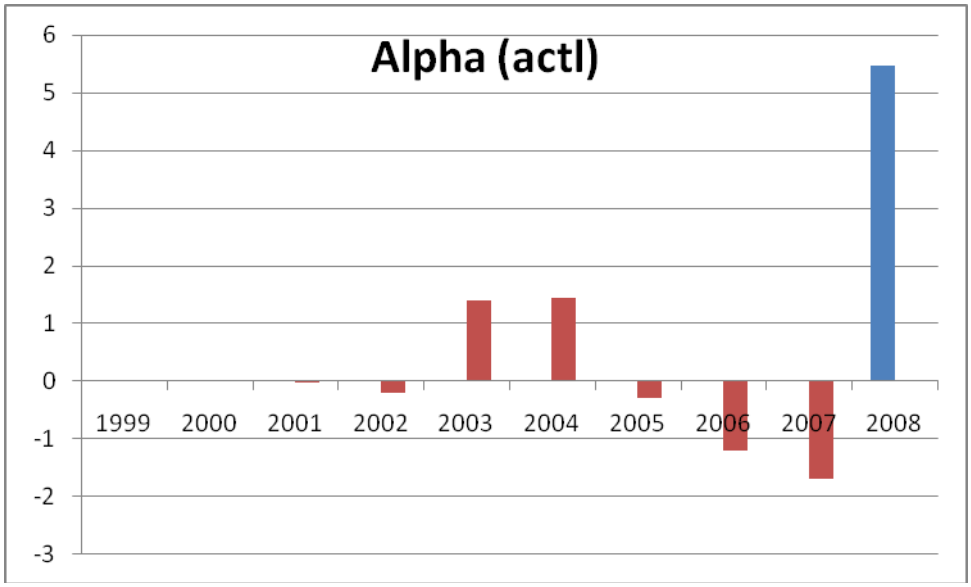

Investment returns
40
30
20
10
0
-10
-20
-30
-40
-50
Dec-99
Dec-00
Dec-01
Dec-02
Dec-03
Dec-04
Dec-05
Dec-06
Dec-07
Dec-08
Aggregate
Bond
Equity
"60:40"


Equity Percentage
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
Contrarian risky assets %
Fixed rebalancing risky assets %


Asset to Liability ratio
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
Contrarian (actuarial)
60:40 actuarial

Alpha

By alpha we mean the excess return achieved by the contrarian rebalancing strategy over that which would have resulted from holding the fixed rebalancing portfolio. In the charts below we have distinguished years in which the fixed rebalancing portfolio achieved a negative absolute return by colouring the bars for those years blue.

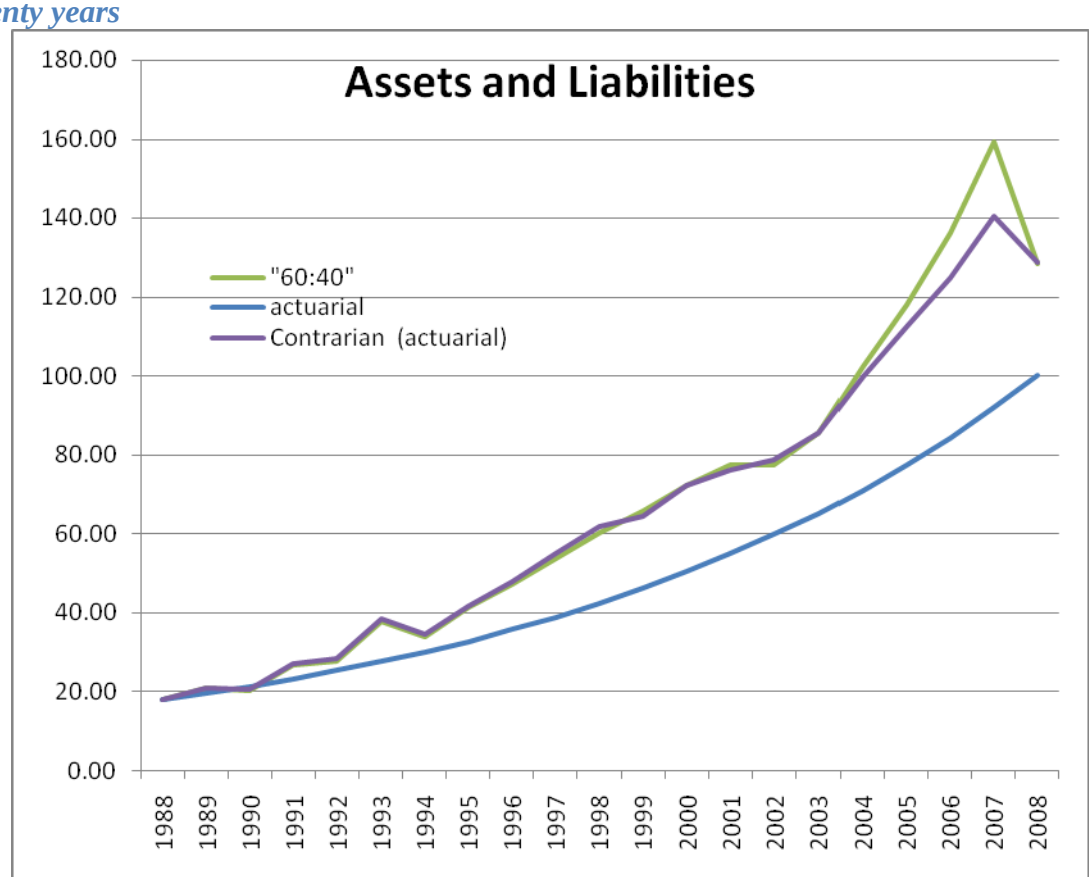


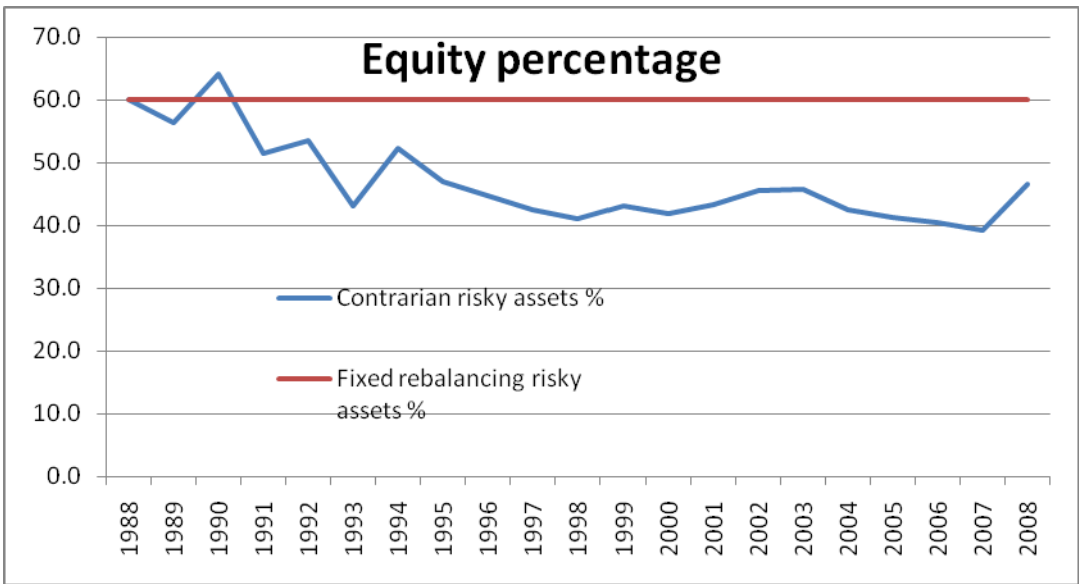
Some statistics:

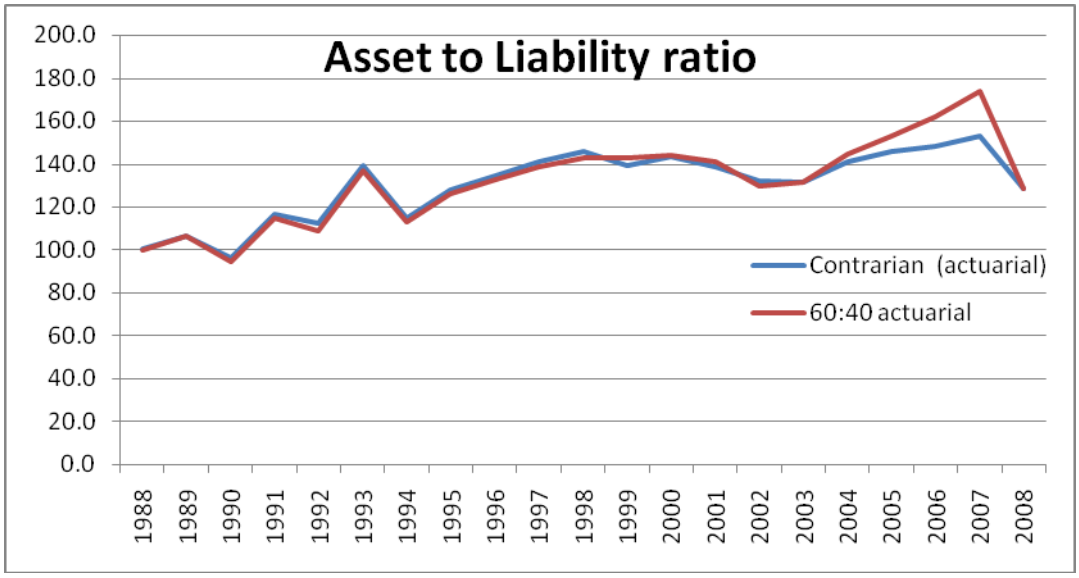
		Fixed rebalancing		Contrarian rebalancing
Returns				
	Average[8]	8.5		8.9
	Standard deviation	11.3		9.8
Asset to Liability ratio				
	Average	101.5		102.5
	Standard deviation	9.6		9.1
	Maximum drawdown	-31.6		-25.4
Alpha				
	Average			0.5
	Information ratio			0.2

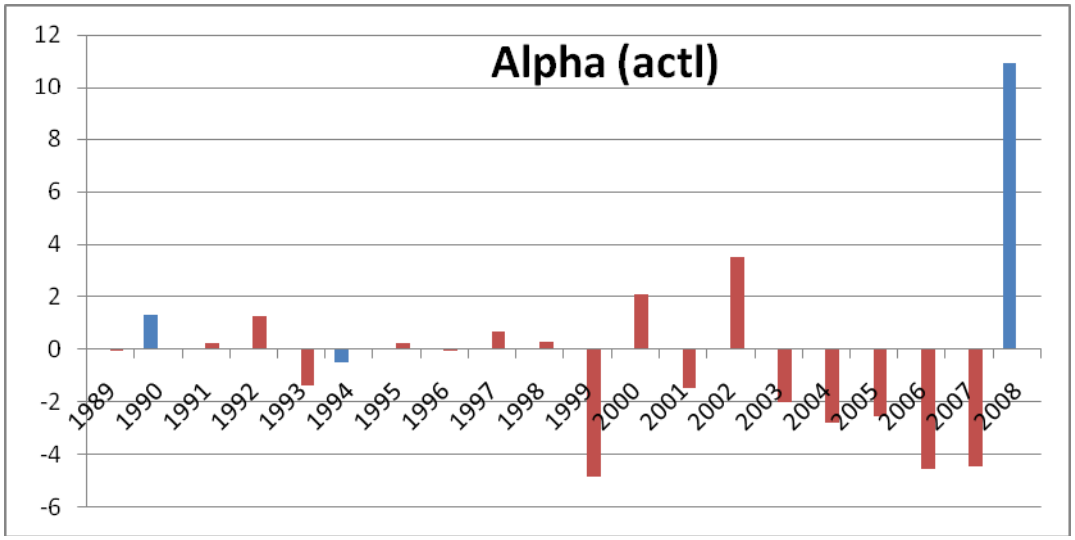
[8] This is the arithmetic average as opposed to the geometric average reported in Appendix B.

Twenty years







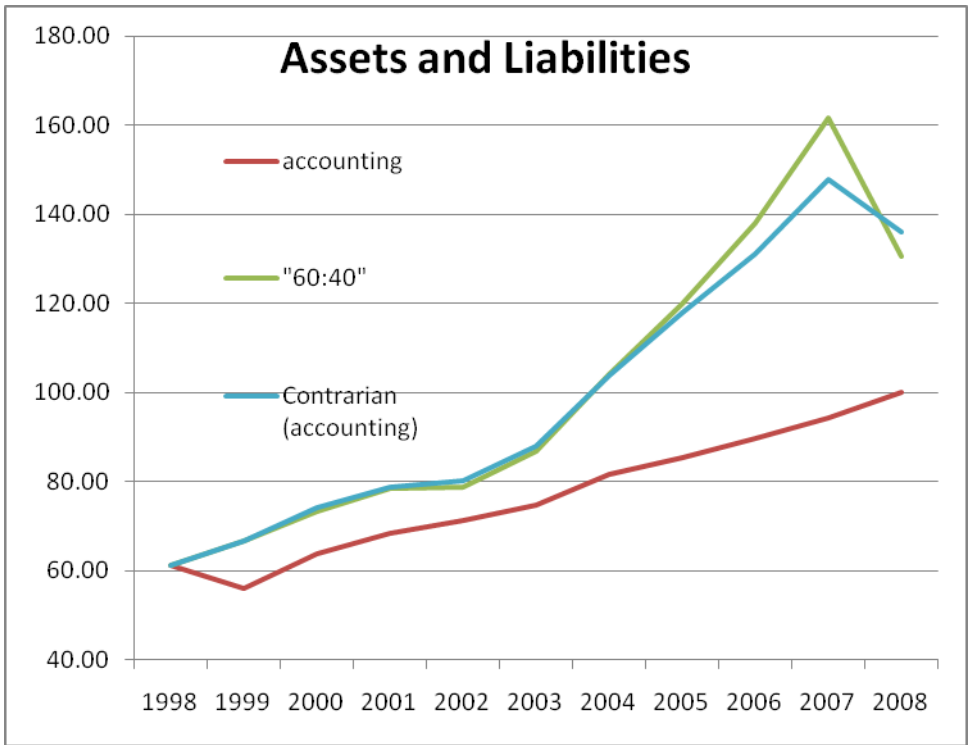


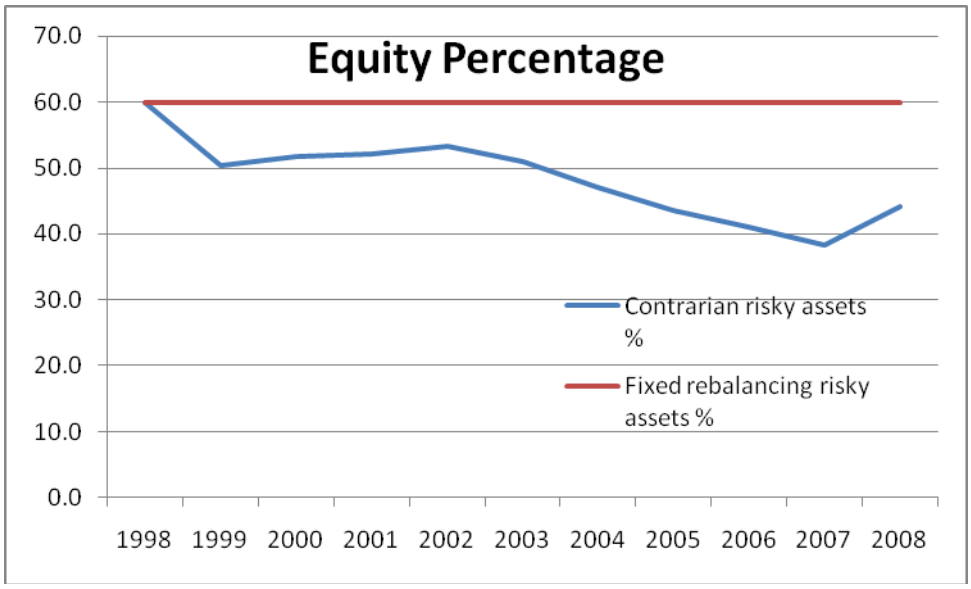
And here are the statistics:

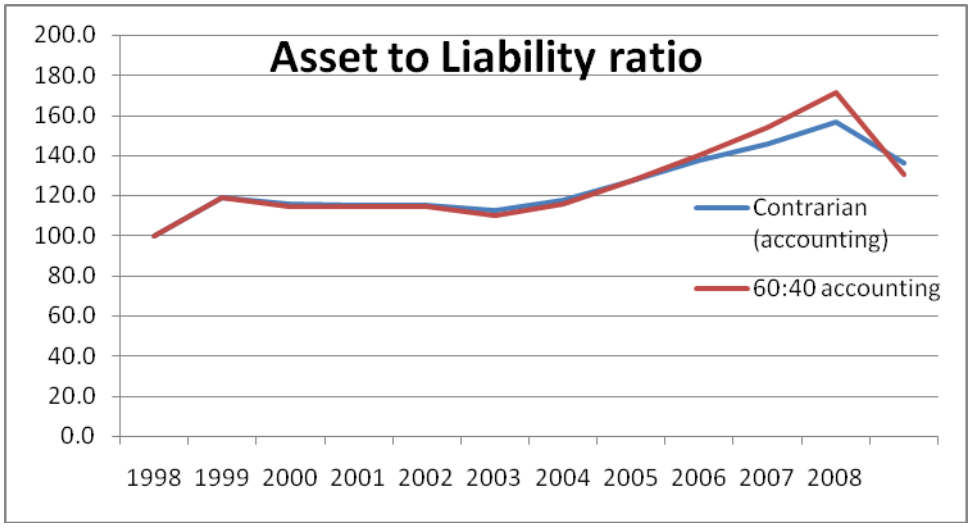
		Fixed rebalancing		Contrarian rebalancing
Returns				
	Average	11.1		10.9
	Standard deviation	12.9		11.3
Asset to Liability ratio				
	Average	131.7		130.2
	Standard deviation	20.1		16.4
	Maximum drawdown	-45.1		-24.8
Alpha				
	Average			-0.2
	Information ratio			-0.1

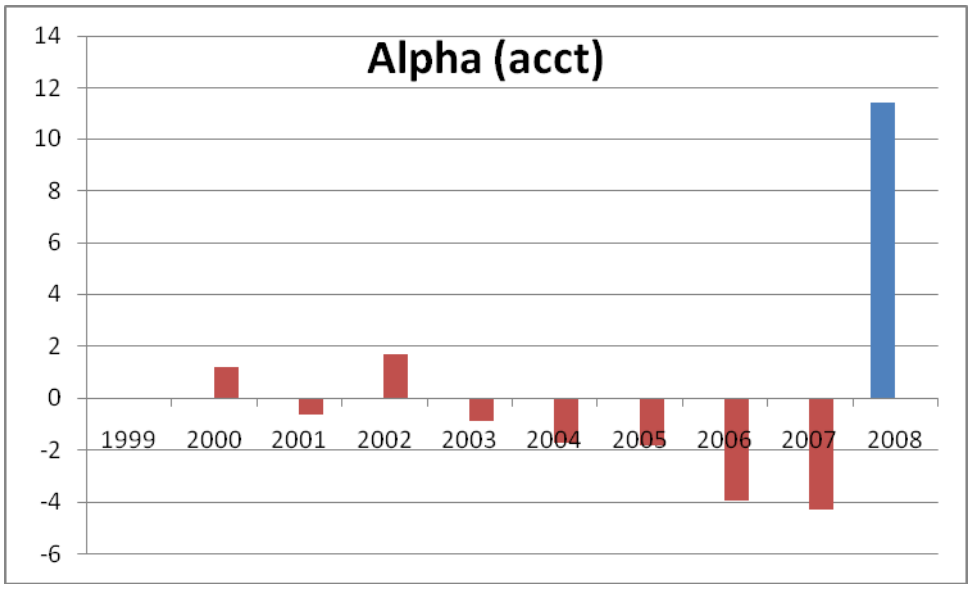
Relative to accounting liability

Ten years





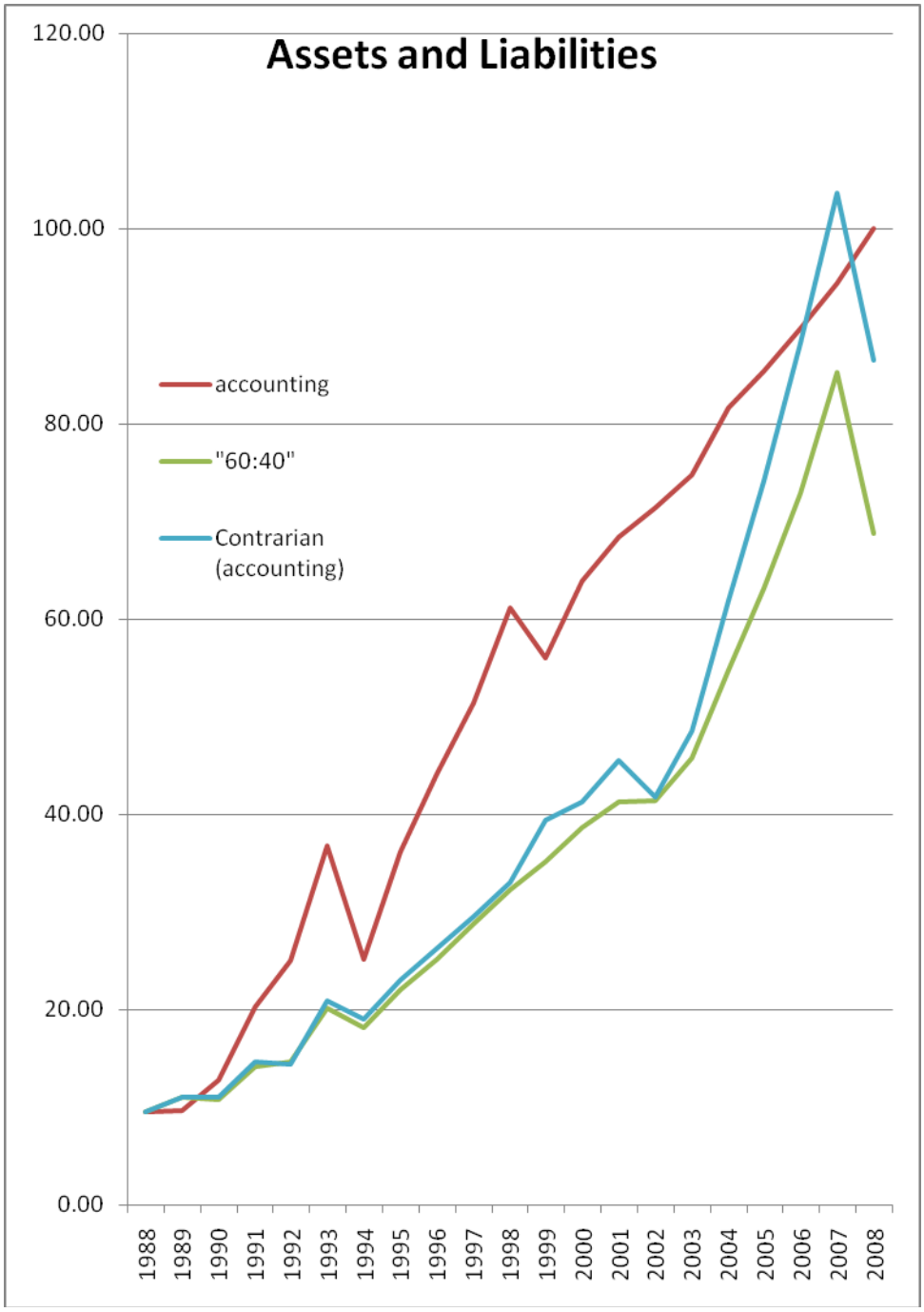




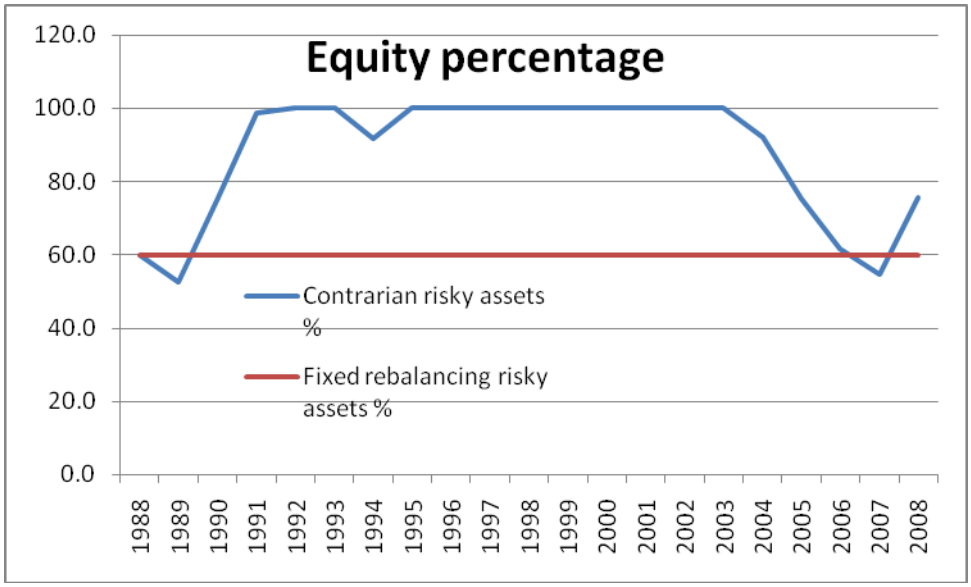
The statistics:

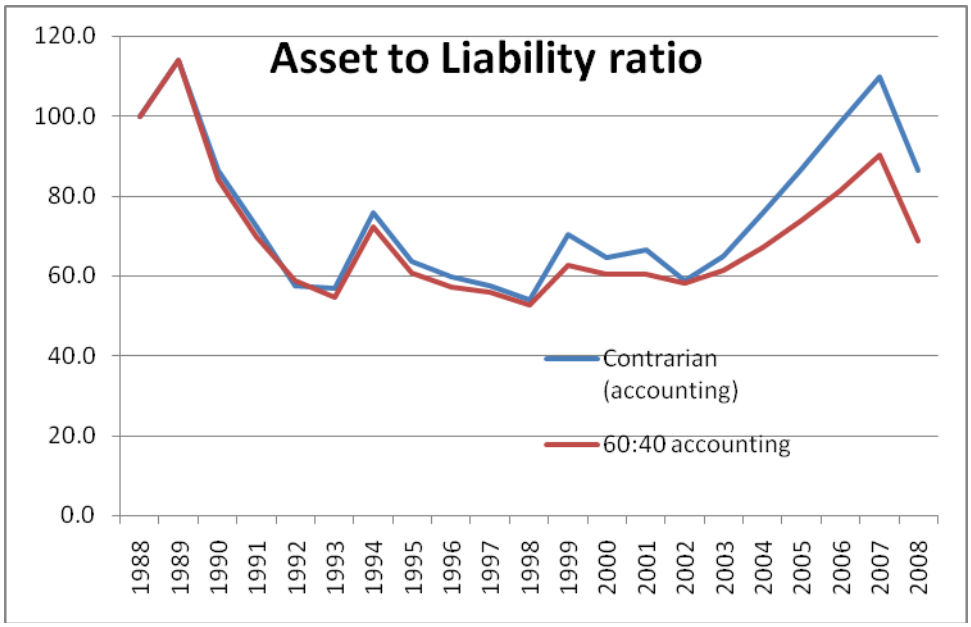
		Fixed rebalancing		Contrarian rebalancing
Returns				
	Average	8.5		8.5
	Standard deviation	11.3		7.2
Asset to Liability ratio				
	Average	127.1		125.8
	Standard deviation	21.0		16.6
	Maximum drawdown	-40.9		-20.6
Alpha				
	Average			0.1
	Information ratio			0.0

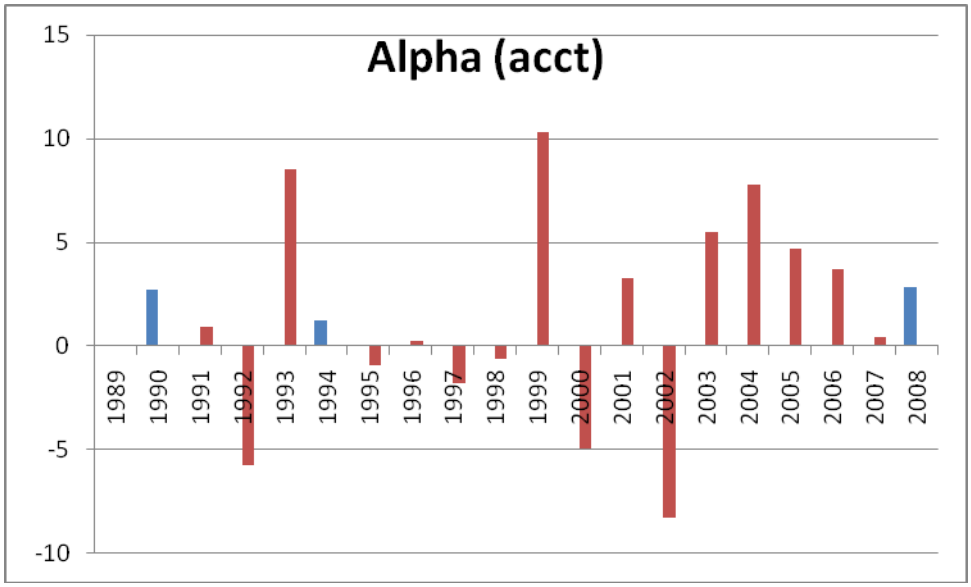
Twenty years



Note the very low level of the initial liability which results from the unusually high level of bond yields in 1988. Since we start with assets equal to this initial liability it is, perhaps, not surprising that the asset allocations considered fall short of the ultimate liability in 2008. Where it not for the extreme market conditions of the last year, however, it is interesting that the aggressive asset allocation selected by the contrarian approach would have succeeded here where the fixed rebalancing strategy would not.


Equity percentage
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Contrarian risky assets %
Fixed rebalancing risky assets %
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

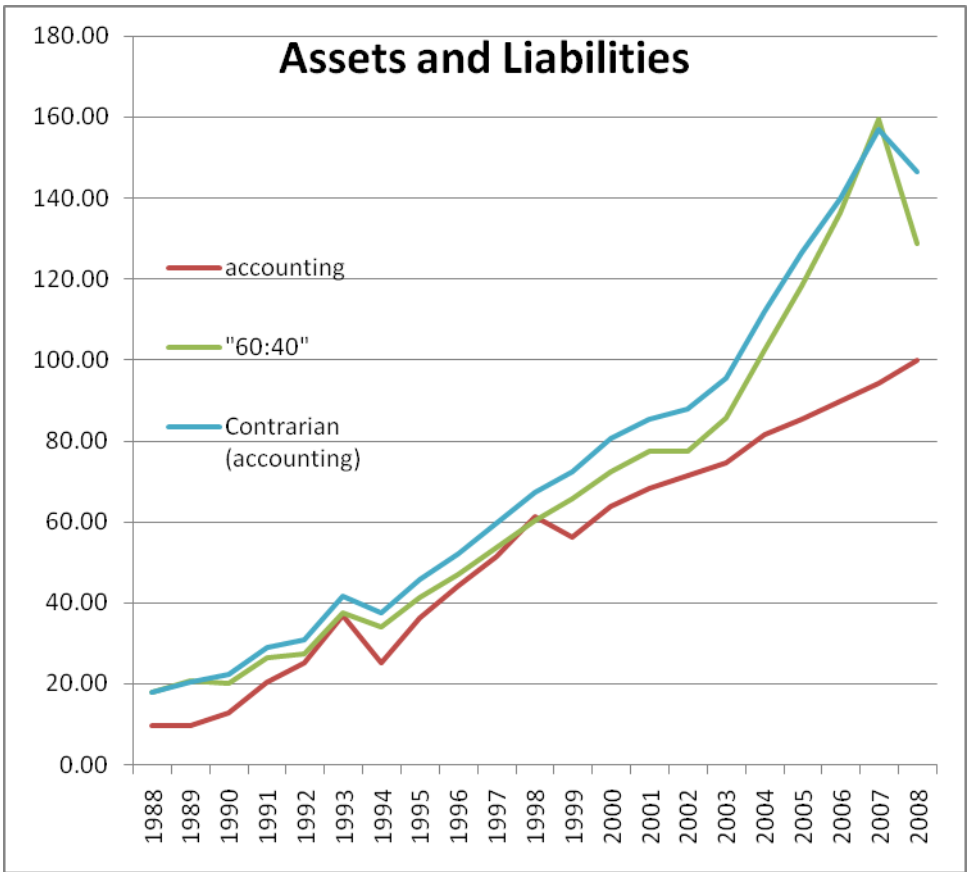

Asset to Liability ratio
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Contrarian (accounting)
60:40 accounting
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008



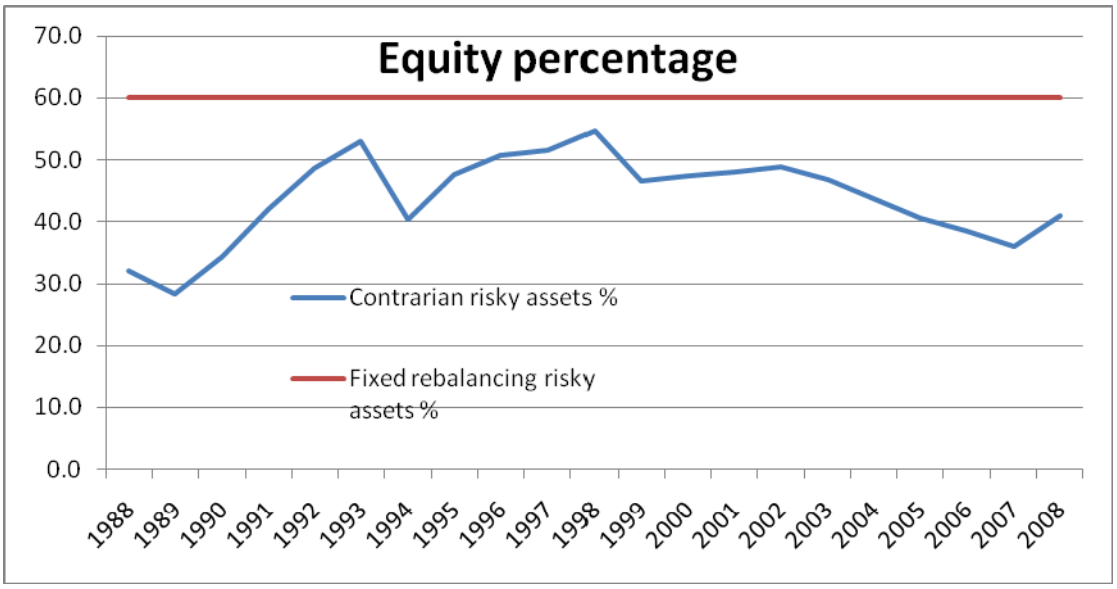
The statistics:

		Fixed rebalancing		Contrarian rebalancing
Returns				
	Average	11.1		12.6
	Standard deviation	12.9		14.7
Asset to Liability ratio				
	Average	69.8		75.2
	Standard deviation	16.1		18.2
	Maximum drawdown	-30.0		-27.6
Alpha				
	Average			1.5
	Information ratio			0.3

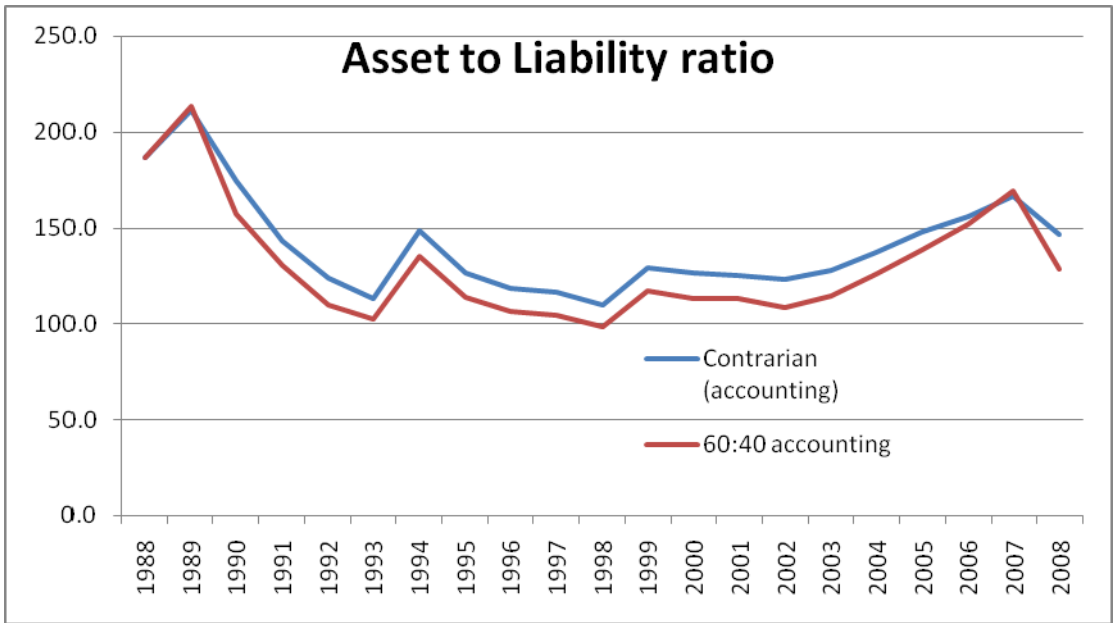
Twenty years (but starting with assets equal to actuarial liabilities rather than accounting liabilities)



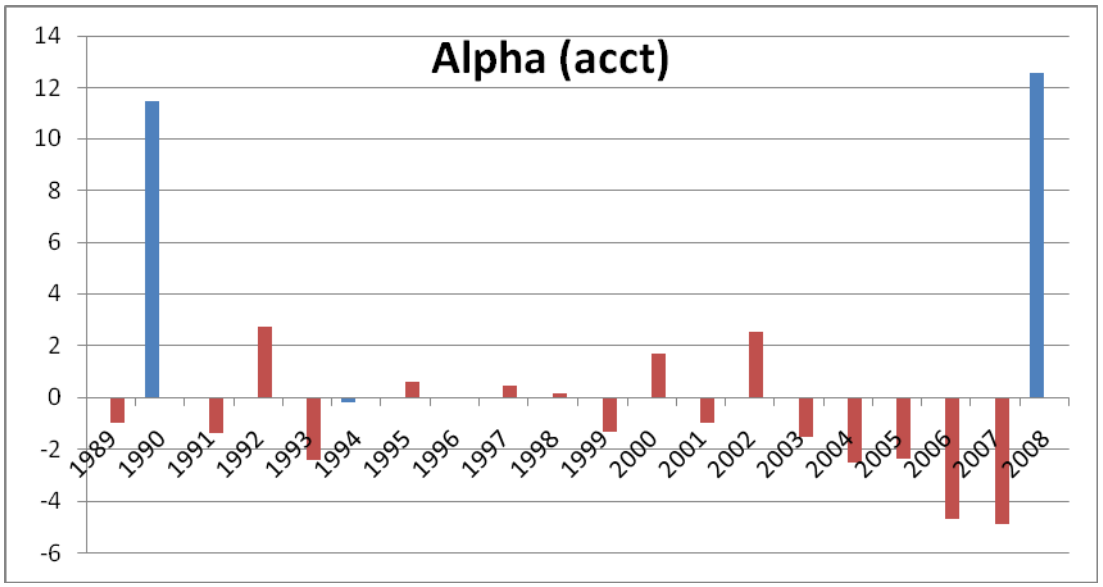
The higher starting level of assets here makes all the difference. Both fixed rebalancing and contrarian rebalancing, relative to the accounting liability measure, have little difficulty in achieving solvency.



As would be expected the higher level of assets gives rise to a lower level of investment in the risky asset and to higher asset to liability ratios.



The changed asset allocation gives rise to a completely different pattern of alpha generation.



The statistics:

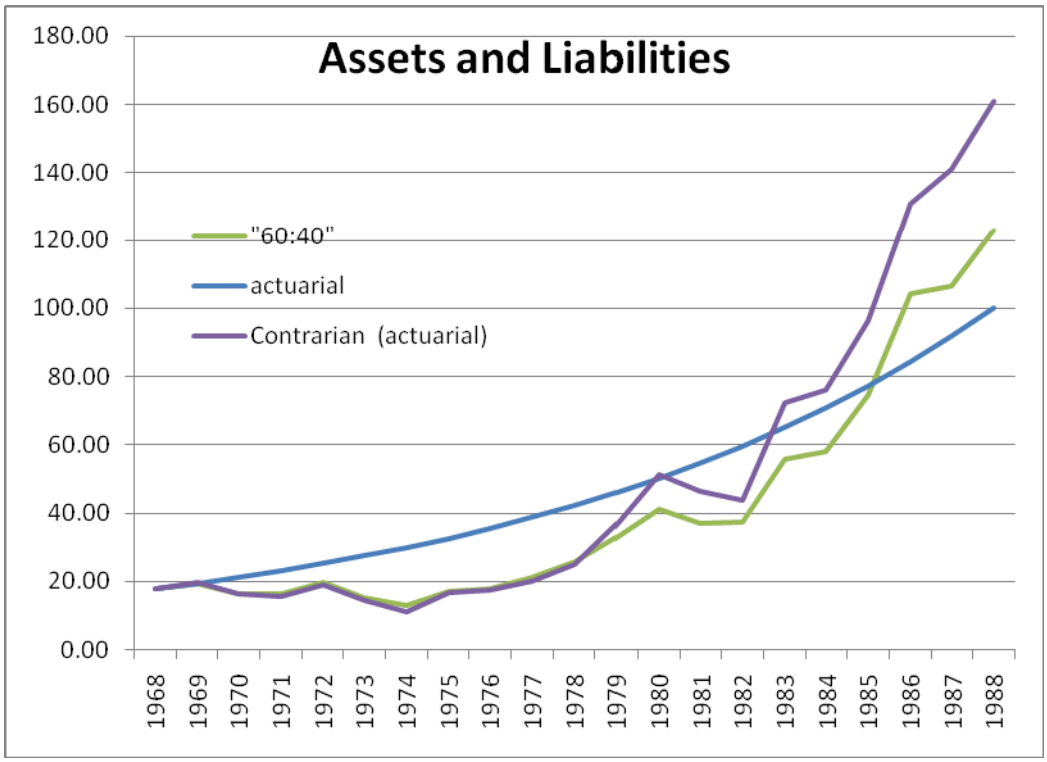
		Fixed rebalancing		Contrarian rebalancing
Returns				
	Average	11.1		11.6
	Standard deviation	12.9		10.3
Asset to Liability ratio				
	Average	130.3		140.8
	Standard deviation	30.0		26.2
	Maximum drawdown	-56.0		-37.1
Alpha				
	Average			0.4
	Information ratio			0.1

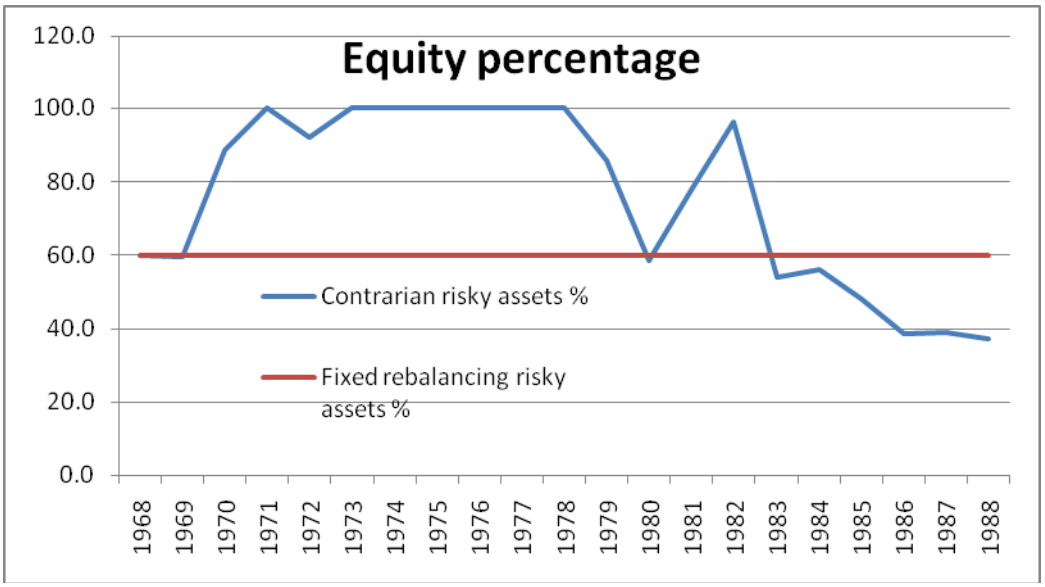
Comparing this with the previous example, it is clear that the starting level of assets is important to the success of the strategy. If the starting level of assets is very low then contrarian rebalancing will, unsurprisingly, not save the situation.

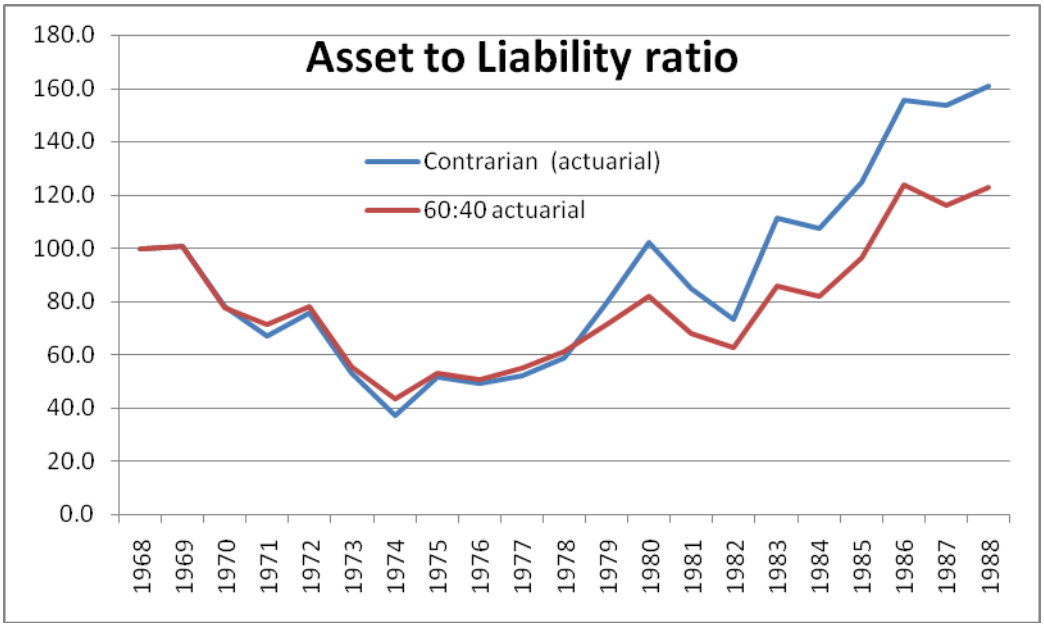
Stress testing contrarian rebalancing

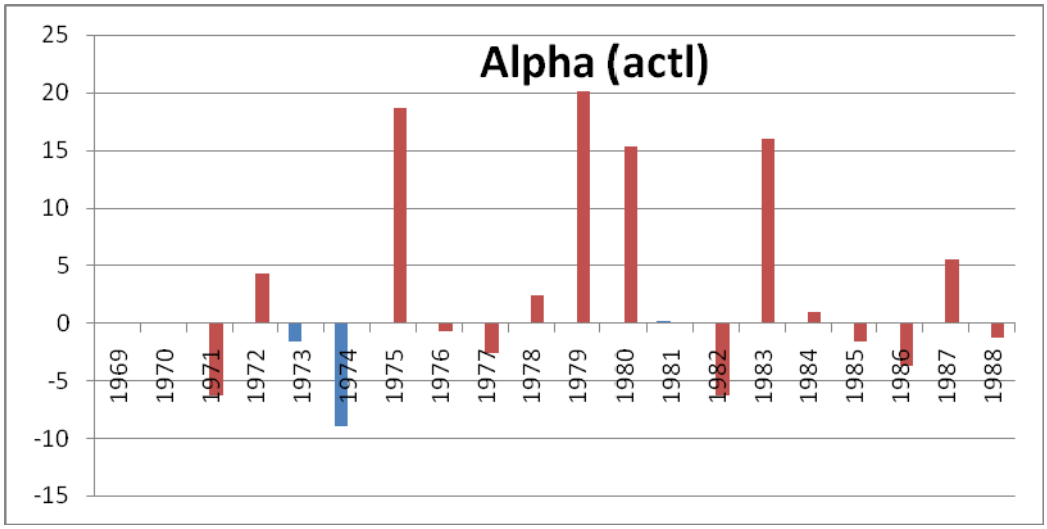
Inflation

Having considered how the proposed rebalancing approach would have worked out over current periods, next we consider a twenty year period ending on 31 December 1988, a time of unusually high inflation:









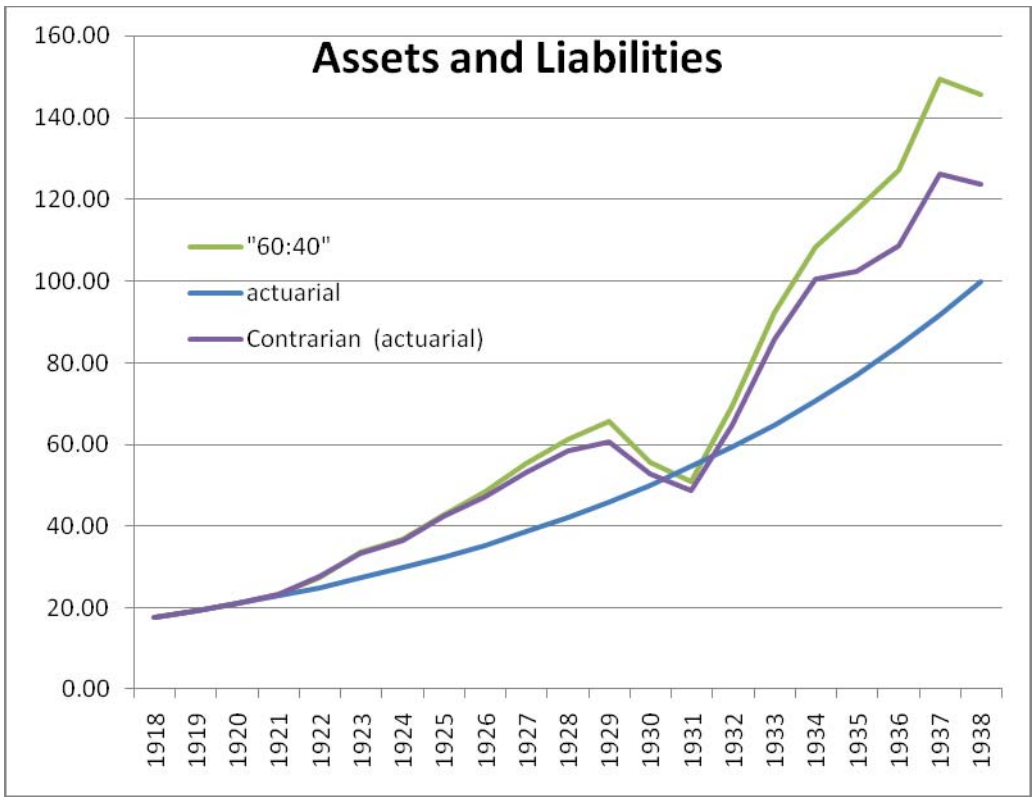
The statistics:

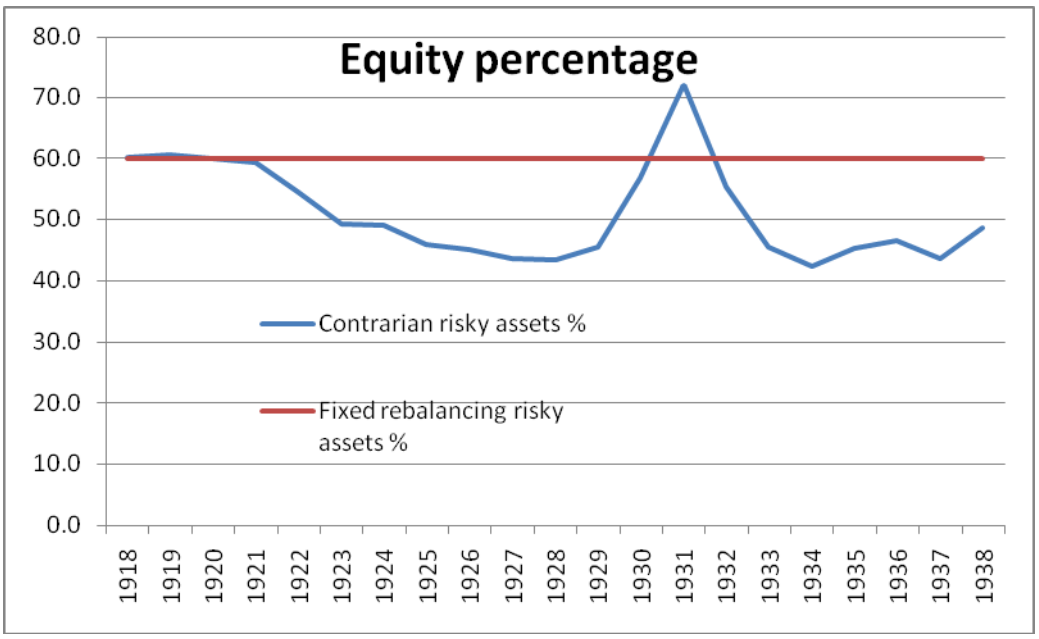
		Fixed rebalancing		Contrarian rebalancing
Returns				
	Average	11.7		14.2
	Standard deviation	19.3		25.1
Asset to Liability ratio				
	Average	79.0		89.4
	Standard deviation	23.7		36.6
		-23.0		-22.9
Alpha				
	Average			2.5
	Information ratio			0.3

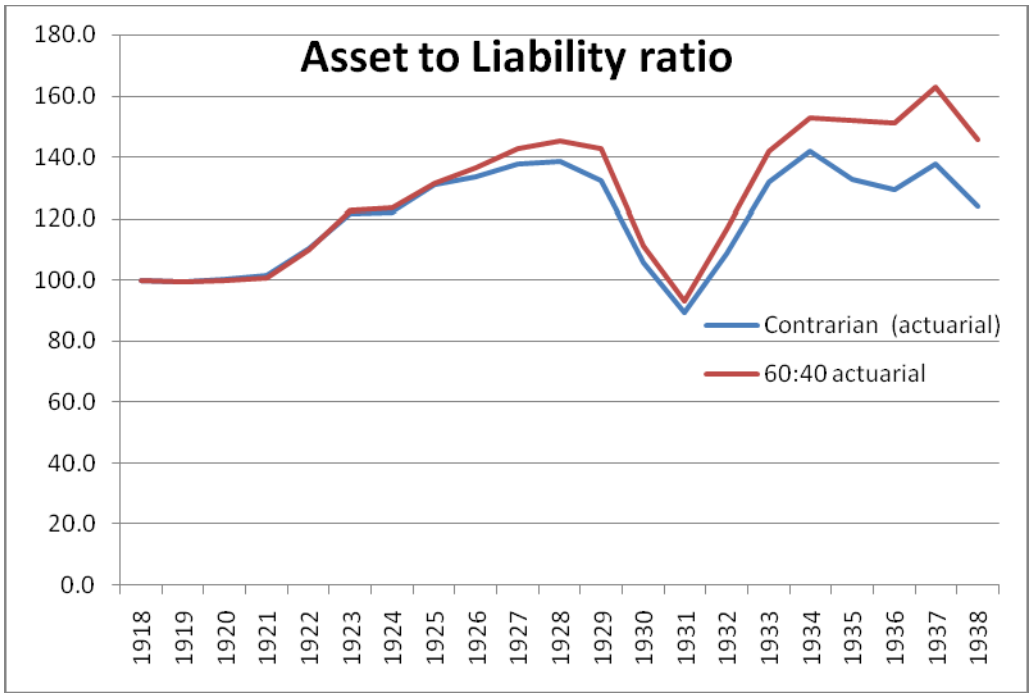
Deflation

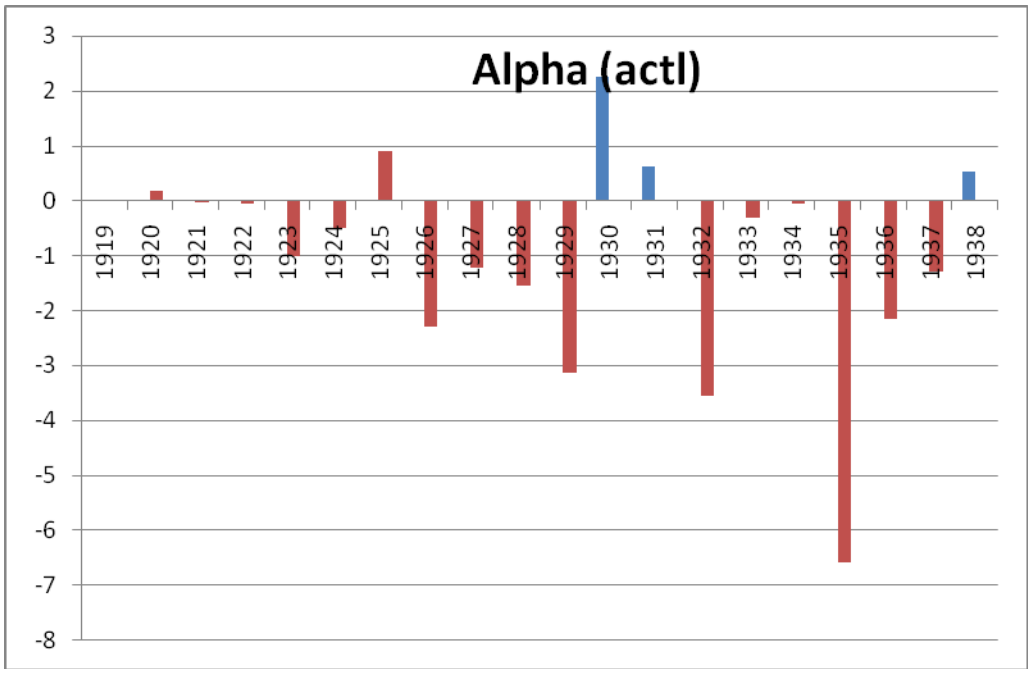
Finally we consider a twenty year period ending on 31 December 1938, a period of deflation and the "great depression":

Here are the corresponding charts, relative to the actuarial liability:









The inherent conservatism of the approach results in missing out on some of the strong returns available from equities towards the end of the period that we are looking at. The funds however are extremely solvent at that time and so are not heavily exposed to the equity market. Note the positive alpha in all of the "down" years.

The statistics are:

		Fixed rebalancing		Contrarian rebalancing
Returns				
	Average	11.7		10.7
	Standard deviation	11.9		11.3
Asset to Liability ratio				
	Average	127.8		120.4
	Standard deviation	21.6		16.2
		-31.6		-26.4
Alpha				
	Average			-1.0
	Information ratio			-0.5

Conclusions

If we manage an institution's assets without ongoing consideration of their relationship with its liabilities, we are more likely than not to leave something on the table.

This paper has illustrated, by the use of a highly simplified model, that benefits are often derived from the use of a systematic contrarian rebalancing policy taking into account a preset target reflective of liabilities.

The approach results in smoother outcomes, in terms of solvency margin, and tends to produce positive alpha in "down" cycle, relative to a fixed asset allocation rebalanced between asset classes only.

In practice, of course, matters are far more complicated; there are governance and regulatory constraints, ongoing cash flows to invest, multiple asset classes, liquidity issues and transaction and friction costs. Notwithstanding the omission of these multiple important considerations from the simple model, it is felt that the model results present a compelling case for the use of an approach with some of the features of those utilized in the model.

The practical difficulties of maintaining a contrarian target rebalancing approach should not be underestimated. The approach flies in the face of normal human behavior, which is to increase risk when ahead and to reduce risk when behind. For this reason, any real world application of this kind of contrarian approach is most likely to succeed if it is "automated", following a pre-agreed set of rules which do not envisage external review or override. It will also almost certainly be necessary to limit the extent to which the automatic implementation is permitted to diverge from the "base case" strategic asset allocation.

It is to be expected that institutions will develop and use highly sophisticated dynamic management approaches which will be sensitive to changes above predetermined threshold levels of many indicator variables, some specific to the assets, some to the liabilities and some to their interrelationship. This paper does support the view that there may often be value to be gained from doing this.

The concepts modeled in this paper relate most closely to such entities as insurance companies and defined benefit superannuation funds. There is also some merit in considering this type of investment approach for defined contribution superannuation funds. It is normal for these funds to offer members a choice of fixed asset allocations, to which the investments are regularly rebalanced. The modeling carried out in Appendix A of this paper adopts the contrarian to a target of a long term investment return of, say CPI + 5%. The results suggest target rebalancing would produce less alarm on the downside, and much the same upside, as the conventional approach.

Appendix A – Member Choice

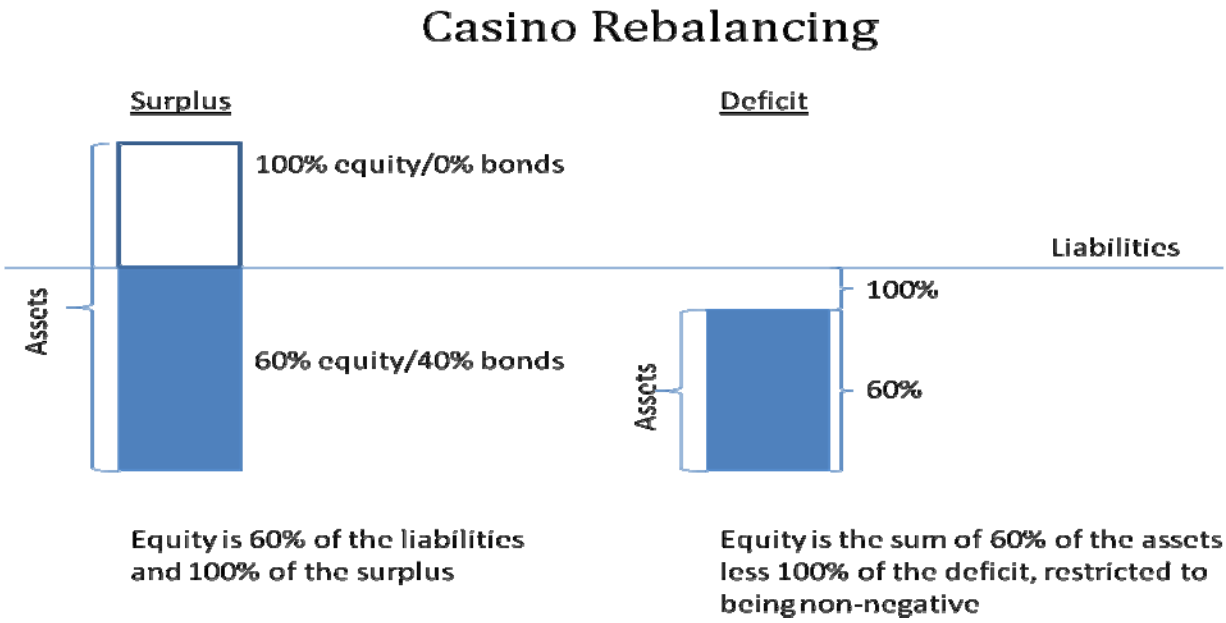
When an individual is investing for their own retirement, or indeed for any other long term purpose, it is arguable that what they really would like to achieve is:

- Keeping pace with price inflation, perhaps with salary inflation (or preferably a bit more than this).
- Not too much excitement along the way. Smooth and steady growth is preferred to snakes and ladders.
- In particular, some protection from the worst ravages of the market in down years.
- Not too much in the way of "big bets". An investor who puts money into a "conservative growth" fund would not be happy to find it all in equities at any time, for example.

The contrarian rebalancing approach described in this paper can be adapted to these circumstances. We effectively treat the liability in this case as the achievement of a real return of 5% p.a. The approach taken has thus been to target asset growth at 5% pa above CPI[9], to have a default asset allocation of 60% to equities, but to allow this to be adjusted within the range 40% to 80% using the contrarian rebalancing approach previously described.

Casino rebalancing

It is, of course, only human nature to increase your bets when ahead and to reduce them when behind. This approach could form the basis of yet another investment approach, which we have termed "casino rebalancing" (although it does have some defensive characterics). It is depicted diagrammatically below:



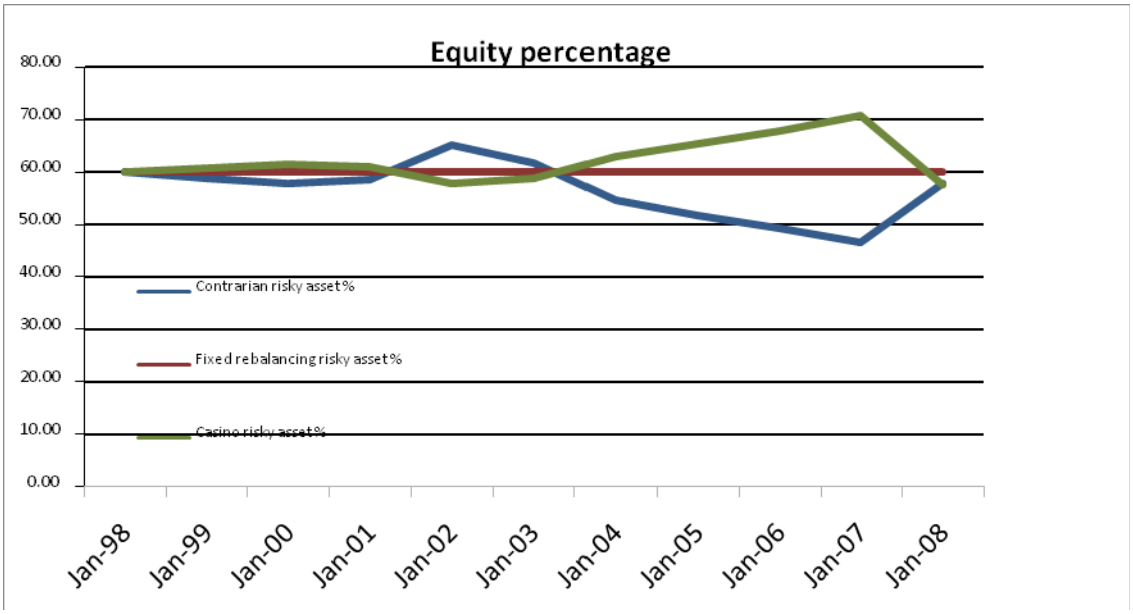
As one might suspect, this common approach does not work out very well. It can lead to significant negative alpha in down years. Overall we demonstrate it is usually inferior to both fixed rebalancing and to contrarian rebalancing. Regrettably it appears to be similar to the investment "switching" approach adopted by many individual investors.

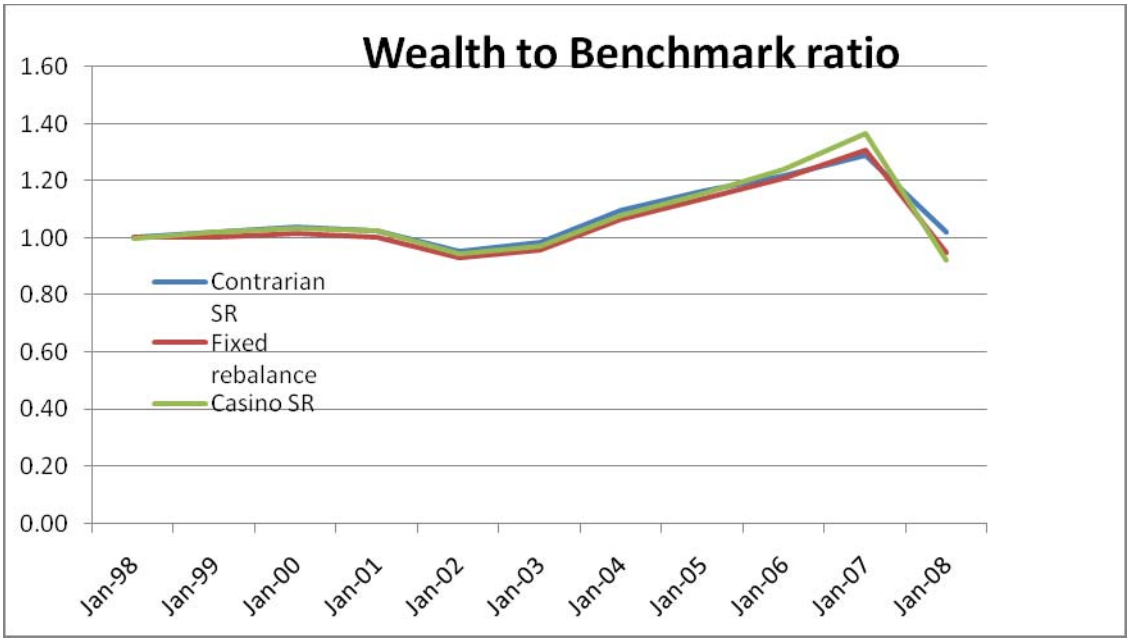
[9] Source: Australia Inflation (%Price Return) (Ibbotson DMS database 2006), extended to 31.12.08 using CPI all groups data from the ABS

These differences become clearer the longer the period of investment.

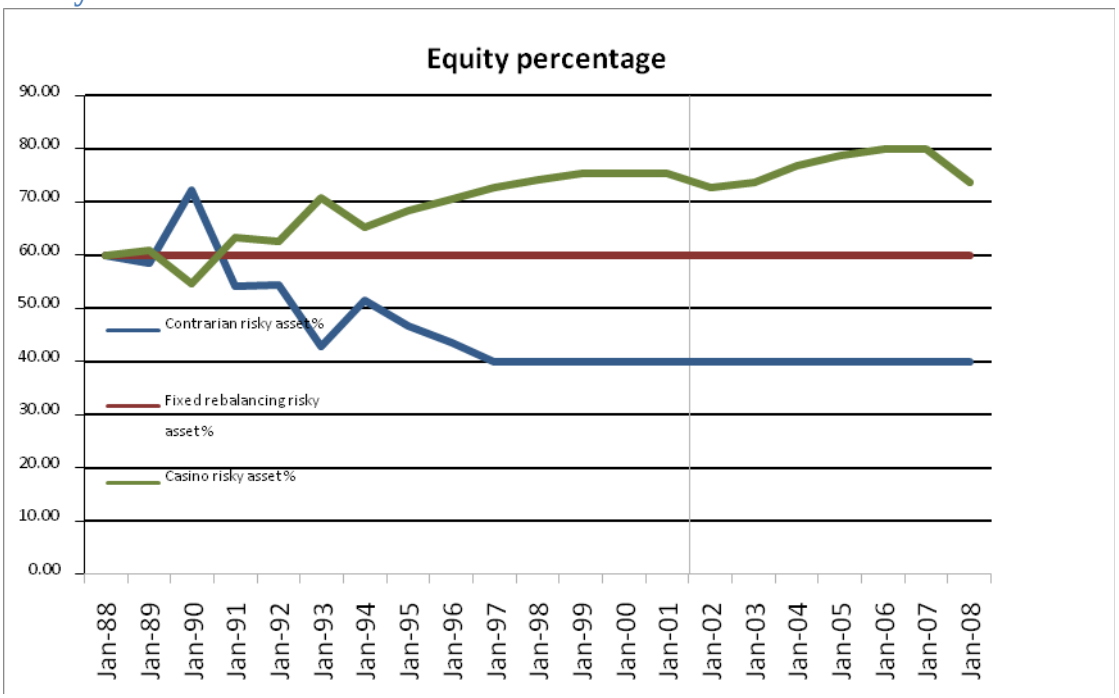
Here are some results, for periods ending 31 December 2008. It appears that the contrarian approach not only leads to smoother growth in wealth than does fixed rebalancing, it also outperforms, particularly in the longer term. Casino rebalancing is almost invariably wealth destructive.

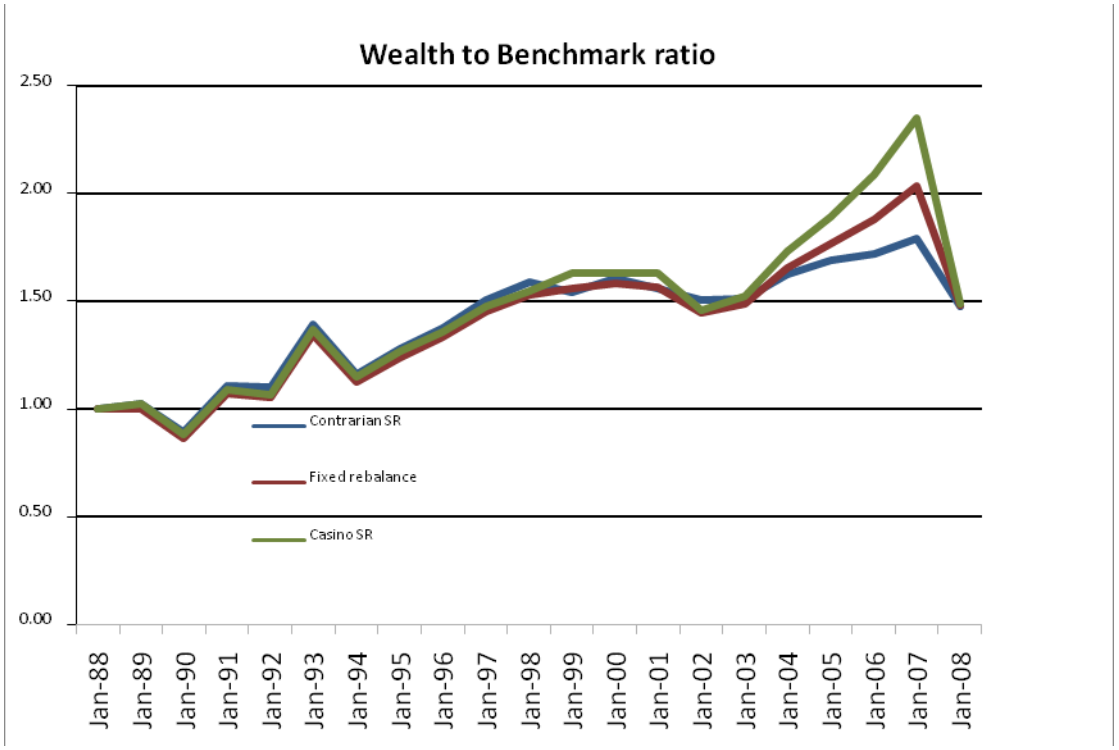
Last 10 years



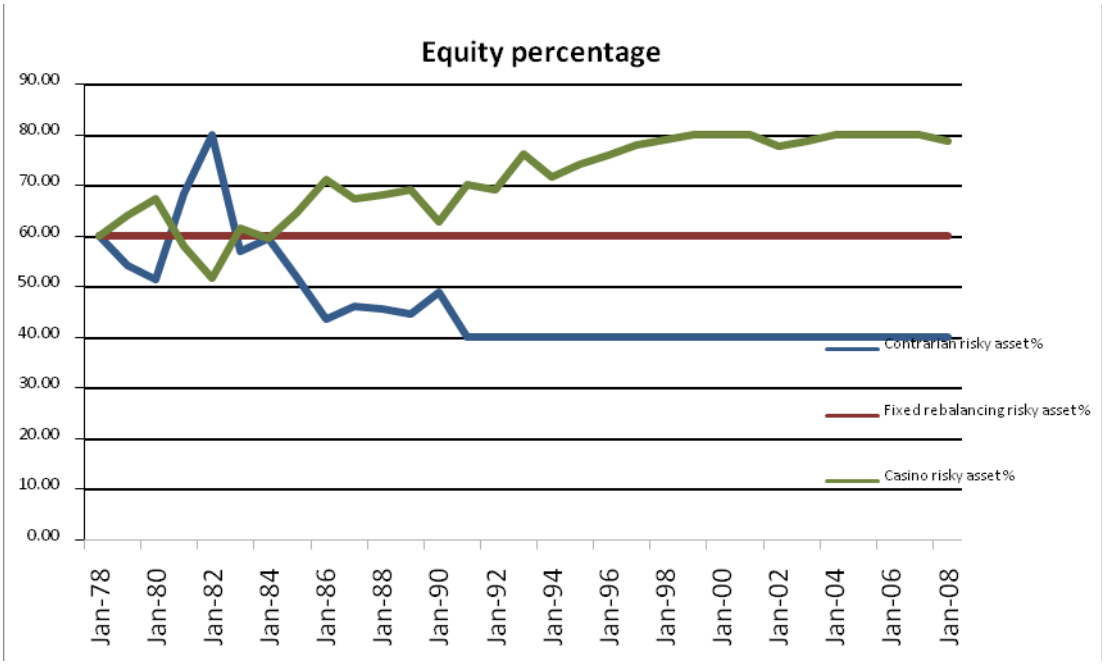


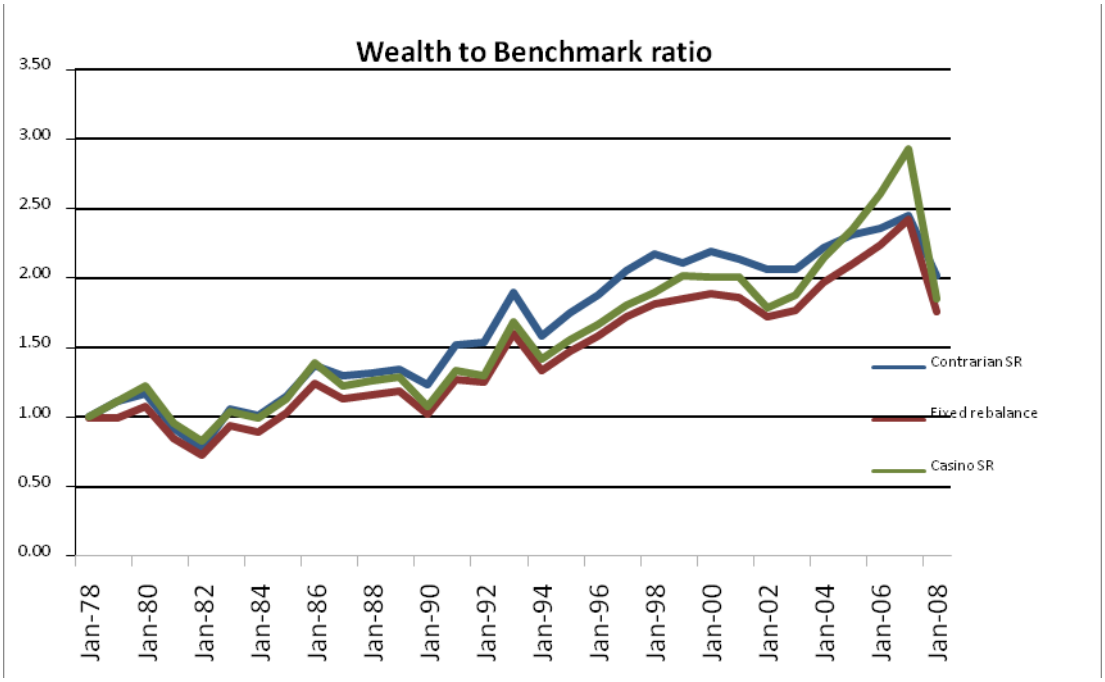
Last 20 years



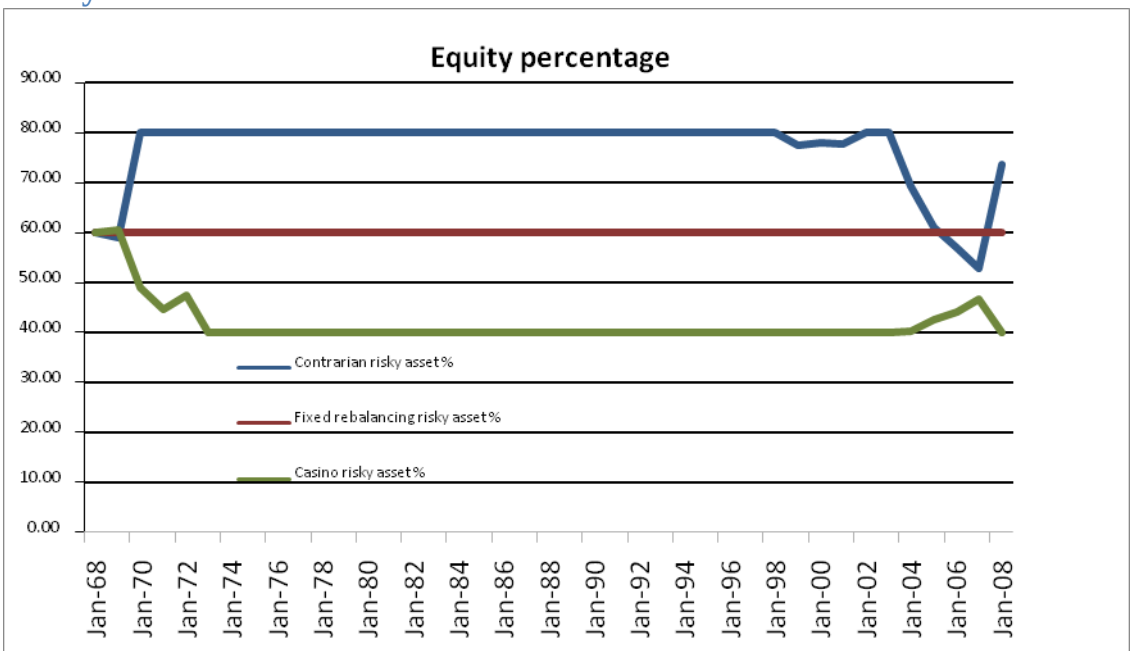


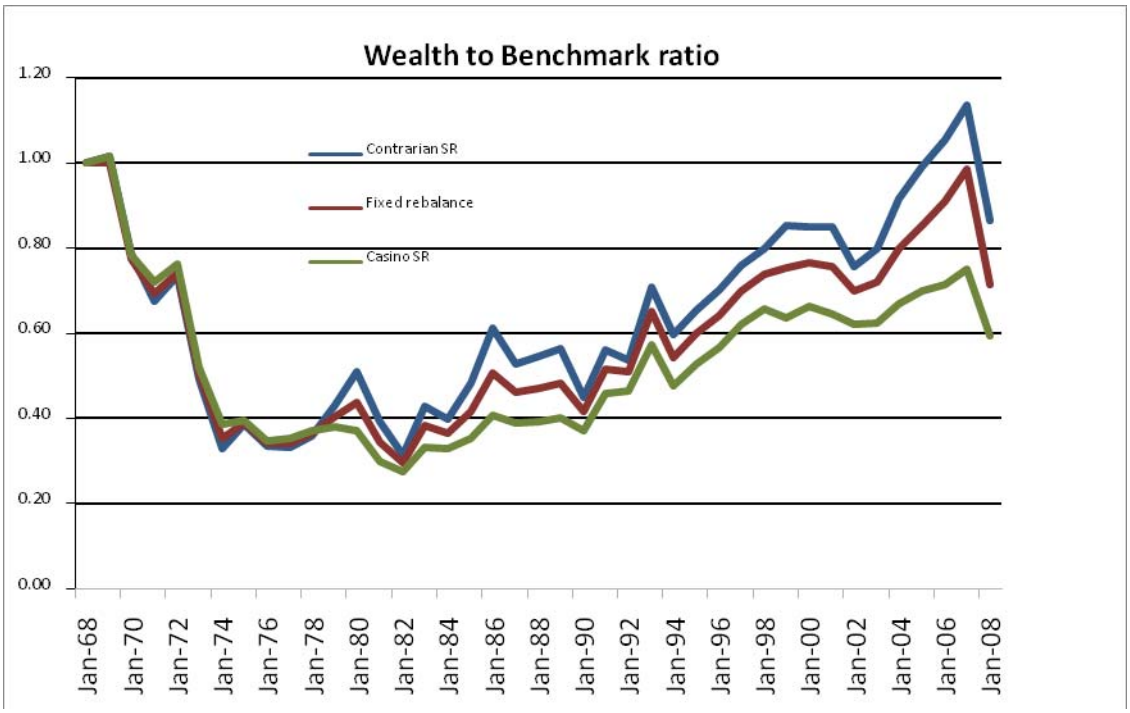
Last 30 years



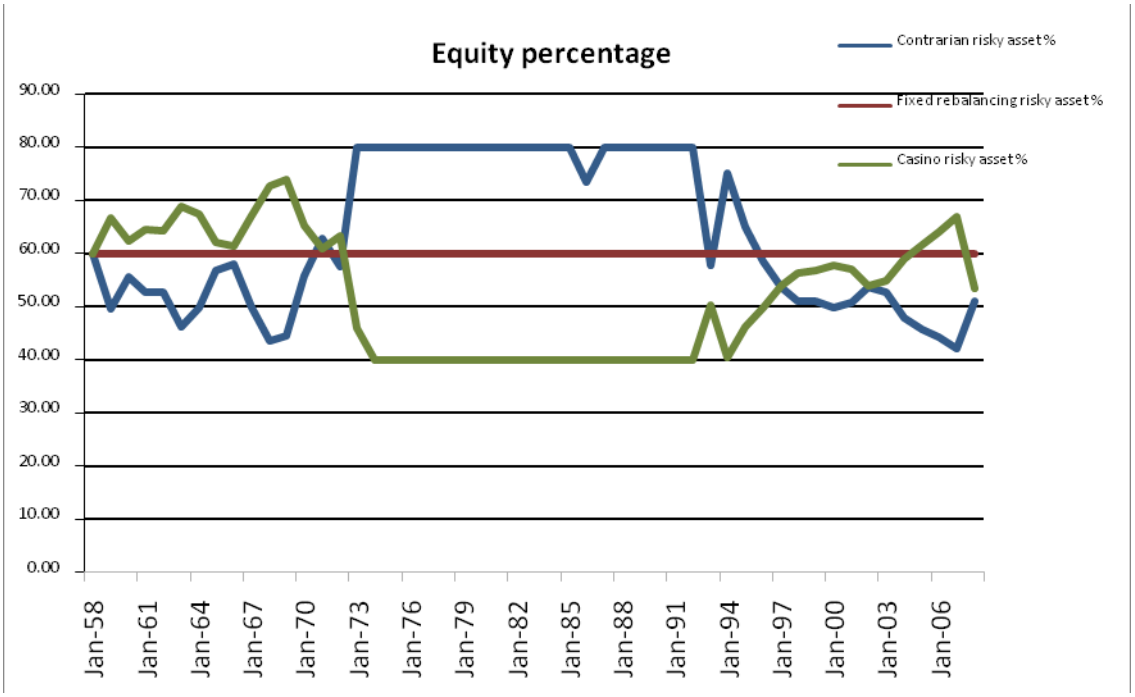


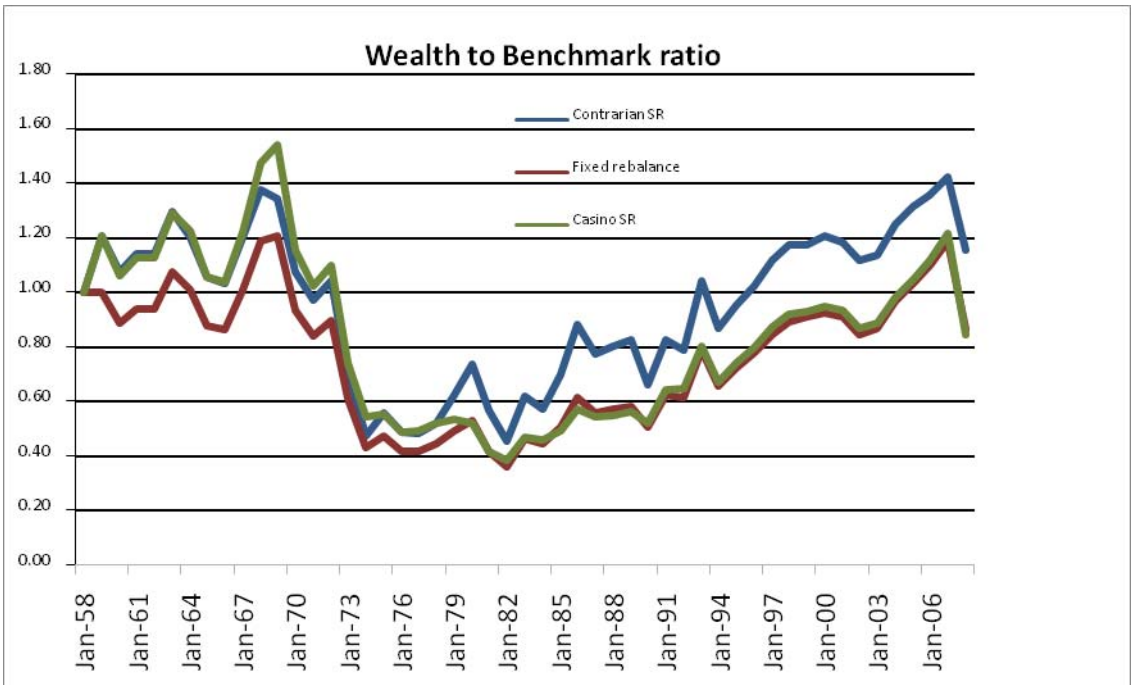
Last 40 years



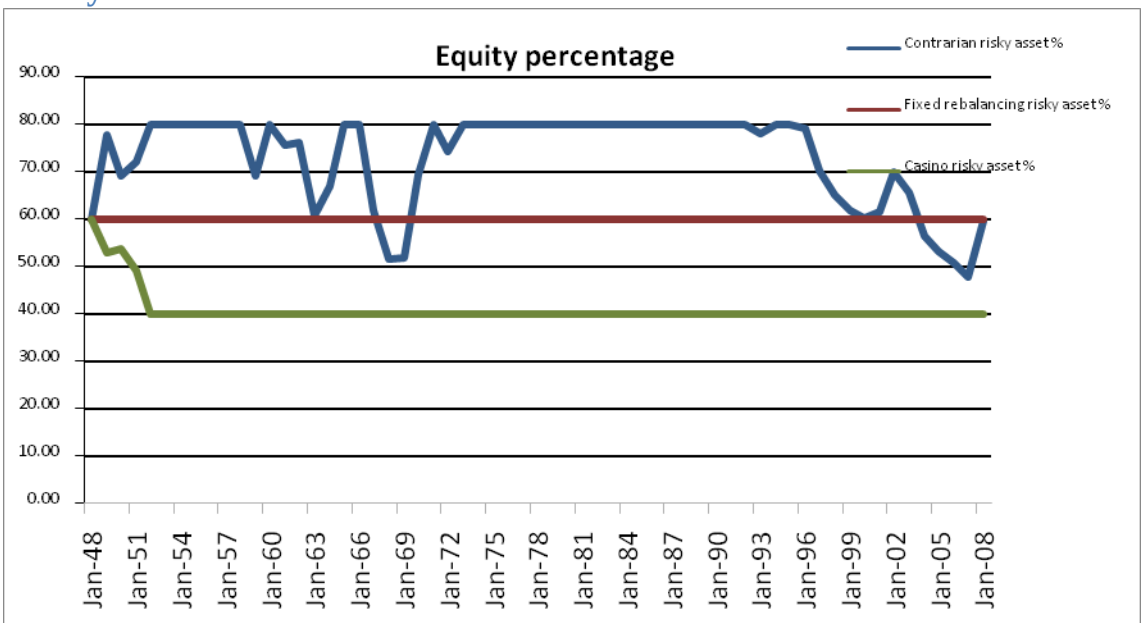


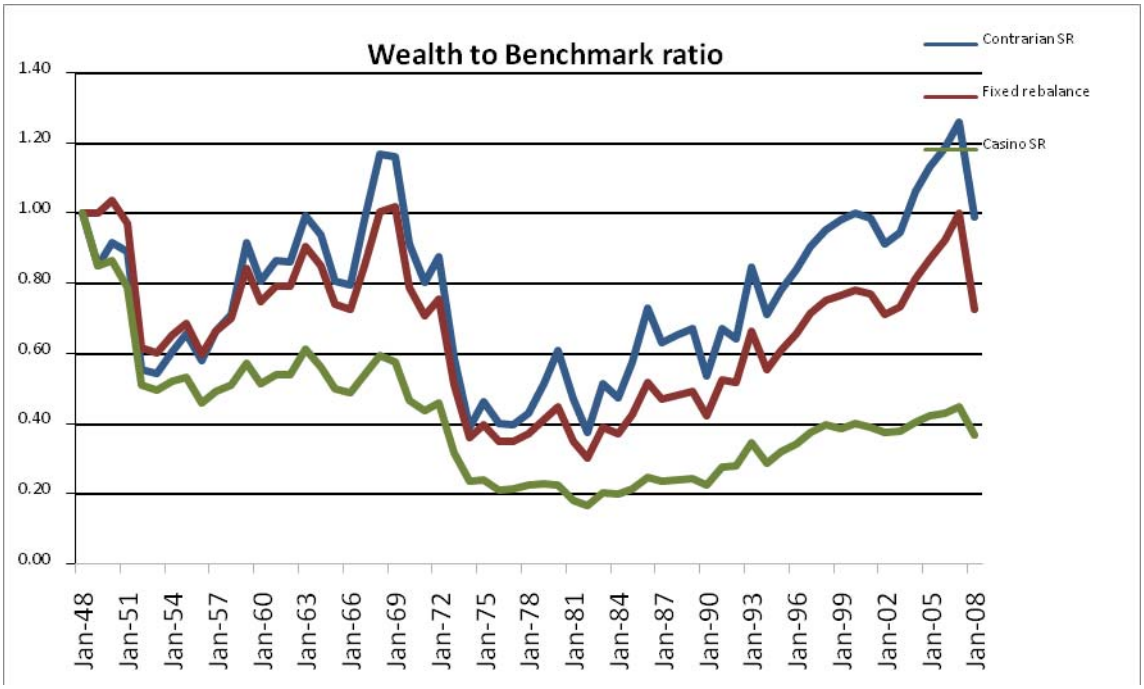
Last 50 years



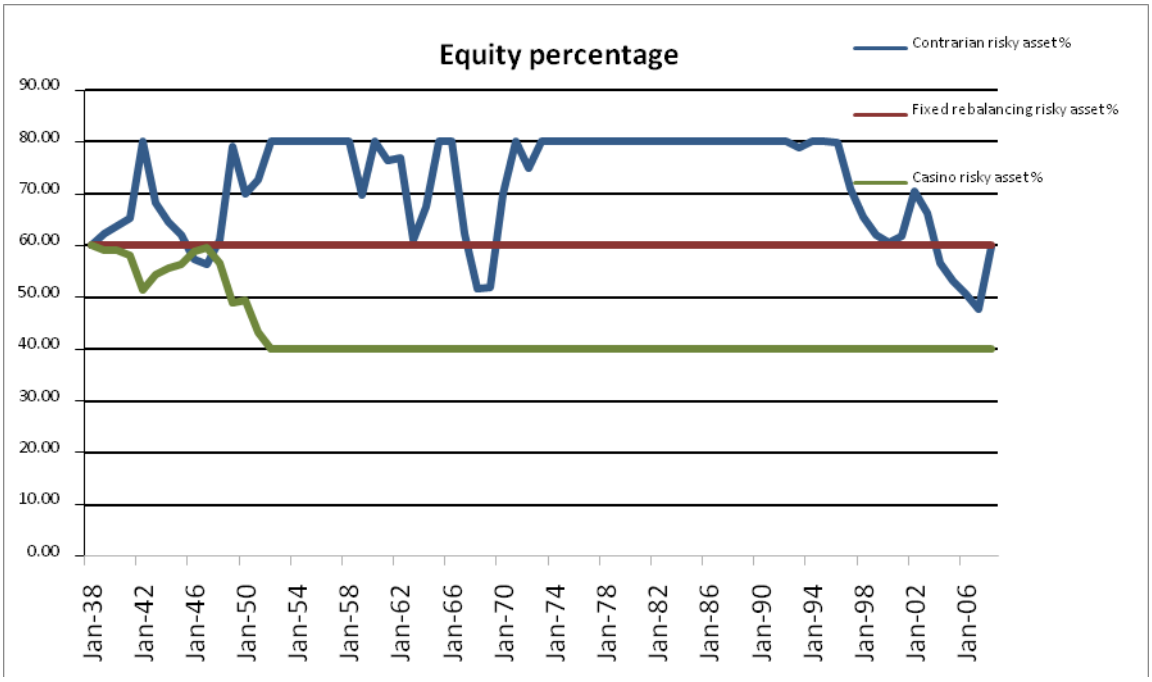


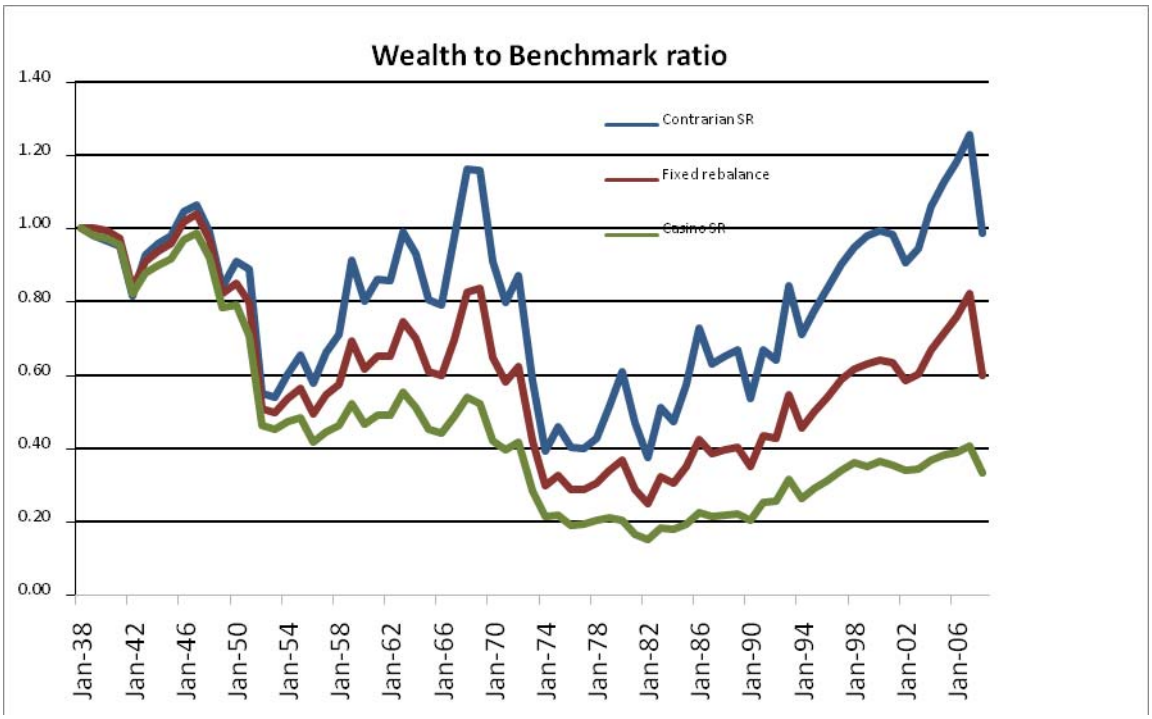
Last 60 years





Last 70 years





Appendix B – Data Summary

Periods ending 31 December 2008		CPI % p.a.	CPI + 5 % p.a.	Equities % p.a.	Bonds % p.a.	"60:40" % p.a.
Years						
	10	2.9	8.0	7.9	5.7	7.9
	20	2.9	8.0	9.6	10.2	10.4
	30	4.7	9.9	13.1	9.8	12.5
	40	5.8	11.1	10.4	8.2	10.3
	50	5.1	10.3	11.4	7.5	10.5
	60	5.4	10.7	11.4	6.1	9.9
	70	5.2	10.5	11.1	6.1	9.7
Periods ending 31 December 1988						
Years						
	20	8.8	14.3	11.3	6.3	10.1
Periods ending 31 December 1938						
Years						
	20	0.0	5.0	13.3	6.9	11.1

Equities: Australian Equity Total Return (Ibbotson DMS database 2006), extended to 31.12.08 using ASX All Ordinaries Total Return data

Bonds: Australian Bond Total Return (Ibbotson DMS database 2006), extended to 31.12.08 using UBS Warburg Composite All Maturities, Bond Index, Total Return – Australia

CPI: Australia Inflation (%Price Return) (Ibbotson DMS database 2006), extended to 31.12.08 using CPI all groups data from the ABS