Portfolio Size Effect in Retirement Accounts: What Does It Imply for Lifecycle Asset Allocation Funds

Anup K. Basu
School of Economics and Finance
Queensland University of Technology
Brisbane 4001
Australia
Phone + 61 (0)7 31388377
Fax + 61 (0)7 31381500
E-mail: a.basu@qut.edu.au

Michael E. Drew
Griffith Business School
Griffith University
Brisbane 4111
Australia
Phone +61 (0)7 37355311
Fax +61 (0)7 37353719
E-mail: michael.drew@griffith.edu.au

Lifecycle funds have gained great popularity in recent years. Sponsors of defined contribution (DC) plans offer more and more of these funds as investment options to their participants. In many cases, these funds serve as default investment vehicles for plan participants who do not make any choice about investment of their plan contributions. As reported by Vanguard [2006], one of the largest pension plan managers in USA, two thirds of their plans offered lifecycle options in 2005, up from one-third in 2000. Assets in lifecycle funds amounted to $160 billion in 2005 compared to below $10 billion in 1996 (Gordon & Stockton [2006]). The rapid growth of lifecycle invest programs within DC plans is often attributed to the fact that they simplify asset allocation choice for millions of ordinary investors who supposedly lack the knowledge or inclination to adjust their portfolios over time.[1] For them, the lifecycle fund offers an automatic 'set it and forget it' solution by modifying the asset allocation of retirement investments periodically in tune with the investors' changing capacity to bear risk.

The central theme of the lifecycle model of investing is that one's portfolio should become increasingly conservative with age (See, for example, Malkiel [2003]). In retirement plans, this is done by switching investments from more volatile assets (like stocks) to less volatile assets (fixed interest securities like bonds and cash) as the participant approaches retirement. For example, the Vanguard Target Retirement Funds prospectus states '*It is also important to realize that the asset allocation strategy you use today may not be appropriate as you move closer to retirement. The Target Retirement Funds are designed to provide you with a single Fund whose asset allocation changes over time as your investment horizon changes. Each Fund's asset allocation becomes more conservative as you approach retirement.*' While lifecycle funds offered by different providers differ from one another with respect to how and when they switch assets, there is total unanimity about the overall direction of the switch – from stocks to bonds and cash.

The practitioners' belief that one's exposure to risky assets should decrease with age (and consequent shortening of investment horizon) has been theoretically refuted by Samuelson [1963] and more recently by Bodie [1995] among others. However, there is no dearth of published theoretical work that lends support to this popular view (see, for example, Merrill and Thorley [1996] and Levy and Cohen [1998]). The relationship between horizons and investment risk has also been examined by empirical researchers with different conclusions.[2] Much of the empirical work considers the case of a multi-period investor who invests in a portfolio of assets at the beginning of the first period and reinvests the original sum and the accumulated returns over several periods in the investment horizon.[3] The situation of retirement plan participants, however, is more complex because they make fresh additional investments in every period until retirement in the form of plan contributions. As a result, the retirement plan participant's terminal wealth is not only determined by the strategic asset allocation governing investment returns but also by the contribution amounts that go into the retirement account every period since these alter the size of the portfolio at different points on the horizon.

A recent observation by Robert Shiller [2005a] harps on this issue and questions the intuitive foundation of conventional lifecycle switching for retirement investors. Shiller argues "a *lifecycle plan that makes the percent allocated to stocks something akin to the privately- offered lifecycle plans may do much worse than a 100% stocks portfolio since young people have relatively little income when compared to older workers….. The lifecycle portfolio would be heavily in the stock market (in the early years) only for a relatively small amount of money, and would pull most of the portfolio out of the stock market in the very years when earnings are highest.*" The statement is remarkable in asserting that the portfolio size of plan participants at different points of time is significant from the asset allocation perspective. If the above is

true, then lifecycle funds may be missing a trick by ignoring the growing size of the participant's portfolio over time while switching assets.

The size of the participant's retirement portfolio is likely to grow over time, not only because of possible growth in earnings and size of contributions as Shiller indicates, but also due to regular accumulation of plan contributions and investment returns. In such case, it would make little sense for the investor to follow the prescriptions of conventional lifecycle asset allocation. By moving away from stocks to low return asset classes as the size of their funds grow larger, the investor in effect would be foregoing the opportunity to earn higher returns on a larger sum of money invested.

But there is another side to this story. Advocates of lifecycle strategies point out that a severe downturn in the stock market at later stages of working life can have dangerous consequences for the financial health of a participant holding a stock-heavy retirement portfolio, not only because it can significantly erode the value of the nest egg but also because it leaves the participant with very little time to recover from the bad investment results. Lifecycle funds, on the other hand, are specifically designed to preserve the nest egg of the greying investor. By gradually switching investments from stocks to less volatile assets over time, they aim to lessen the chance of confronting very adverse investment outcome as one nears retirement.

In this paper we examine whether by reducing the allocation to stocks as the participant approaches retirement, the lifecycle investment strategy benefits or works against the retirement plan participant's wealth accumulation goal. We are particularly interested in testing whether the growing size of the accumulation portfolio in later years indeed calls for a higher allocation to stocks to produce better outcomes despite the lurking danger of facing a sharp decline in stock prices close to retirement. Since an

important objective of lifecycle strategy is to avoid the most disastrous outcomes at retirement, we assess its efficacy as the investment vehicle of choice for plan participants by examining various possible retirement wealth outcomes, particularly the most adverse ones that may be generated by following such a strategy.

Data and Methodology

We examine the case of a hypothetical retirement plan participant with starting salary of $25,000 and contribution rate of 9%. The growth in salary is taken as 4% per year. The participant's employment life is assumed to be 41 years during which regular contributions are made into the retirement plan account. For the sake of simplicity, we assume that the contributions are credited annually to the accumulation fund at the end of every year and the portfolio is also rebalanced at the same time to maintain the target asset allocation. Therefore, the first investment is made at the end of first year of employment followed by 39 more annual contributions to the account.

A number of studies in recent years including Hickman et al. [2001] and Shiller [2005b] compare terminal wealth outcomes of 100% stock portfolios with those of lifecycle portfolios and find little reason for investors to choose lifecycle strategies for investing retirement plan contributions. But these studies are not specifically designed to test whether the allocation towards stocks should be favoured during the later stages of the investment horizon because of the growth in size of one's portfolio. This is because the competing strategies invest in different asset classes for different lengths of time and therefore they are bound to result in different outcomes simply because of the return differentials between the asset classes. For example, one may argue that a 100% stock portfolio may dominate a lifecycle portfolio purely because the former holds stocks for longer duration. The role played by the growing size of the portfolio

over time and its interplay with the asset allocation in influencing the final wealth outcome is not very clear from this result.

To find out whether the growth in size of contributions and overall portfolio with the investor's age renders the conventional lifecycle asset allocation model counter-productive, as Shiller conjectures, we push the envelope a bit further. We consider hypothetical strategies which invest in less volatile assets like bonds and cash when the participants are younger and switch to stocks as they get older i.e. strategies that reverse the direction of asset switching of conventional lifecycle models. These strategies, which we call *contrarian* strategies in the remainder of this paper, are well placed to exploit the high returns offered by the stock market as the participants accumulation fund grow larger during the later part of their career. Moreover, we design these strategies in such a manner that they hold different asset classes for identical lengths of time as corresponding lifecycle strategies. This is necessary to ensure that we are not comparing apples to oranges as would be the case if we compare the outcomes of any lifecycle strategy with a fixed weight strategy like one holding 100% stock throughout the horizon or even with another lifecycle strategy which holds stocks (and other asset classes) for unequal lengths of time.[4]

Initially, we construct four lifecycle strategies all of which initially invest in a 100% stock portfolio but start switching assets from stocks to less volatile assets (bonds and cash) at different points in time - after 20, 25, 30, and 35 years of commencement of investment respectively. We make a simplified assumption that the switching of assets takes place annually in a linear fashion in such a manner that in the final year before retirement all four lifecycle strategies are invested in bonds and cash only. The proportion of assets switched from stocks every year is equally allocated between bonds and cash.[5]

Next we pair each lifecycle strategy with a contrarian strategy that is actually its mirror image in terms of asset allocation. In other words, they replicate the asset allocation of lifecycle portfolios in the reverse order. All four contrarian strategies invest in a portfolio comprising only bonds and cash in the beginning and then switch to stocks linearly every year in proportions which mirror the asset switching for corresponding lifecycle strategies. The four pairs of lifecycle and contrarian strategies are individually described below.

Pair A. The lifecycle strategy (20, 20) invests only in stocks for the first 20 years and then linearly switches assets towards bonds and cash over the remaining period. At the end of the 40 years, all assets are held in bonds and cash. The corresponding contrarian strategy (20, 20) invests only in bonds and cash in the initial year of investment. It linearly switches assets towards stocks over the first 20 years at the end of which the resultant portfolio comprises only of stocks. This allocation remains unchanged for the next 20 years.

Pair B. The lifecycle strategy (25, 15) invests only in stocks for the first 25 years and then linearly switches assets towards bonds and cash over the remaining period. At the end of the 40 years, all assets are held in bonds and cash. The corresponding contrarian strategy (15, 25) invests only in bonds and cash in the initial year of investment. It then linearly switches assets towards stocks over the first 15 years at the end of which the resultant portfolio comprises only of stocks. This allocation remains unchanged for the remaining 25 years.

Pair C. The lifecycle strategy (30, 10) invests only in stocks for the first 30 years and then linearly switches assets towards bonds and cash over the remaining period. At the end of the 40 years, all assets

are held in bonds and cash. The corresponding contrarian strategy (10, 30) invests only in bonds and cash in the initial year of investment. It linearly switches assets towards stocks over the first 10 years at the end of which the resultant portfolio comprises only of stocks. This allocation remains unchanged for the remaining 30 years.

Pair D. The lifecycle strategy (35, 5) invests only in stocks for the first 35 years and then linearly switches assets towards bonds and cash over the remaining period. At the end of the 40 years, all assets are held in bonds and cash. The corresponding contrarian strategy (5, 35) is initially invested 100% in bonds and cash. It linearly switches assets towards stocks over the first 5 years at the end of which the resultant portfolio comprises only of stocks. This allocation remains unchanged for the remaining 35 years.

The above test formulation allows us to directly compare wealth outcomes for a lifecycle strategy to those of a contrarian strategy that invest in stocks (and conservative assets) for the same duration but at different points on the investment horizon. The allocation of any lifecycle strategy is identical to that of the paired contrarian strategy in terms of length of time they invest in stocks (and conservative assets). They only differ in terms of *when* they invest in stocks (and conservative assets) - early or late in the investment horizon. For example, in the case of pair A, both lifecycle (20, 20) strategy and contrarian (20, 20) strategy invests in a 100% stocks portfolio for 20 years and allocate assets between stocks, bonds, and cash for the remaining 20 years in identical proportions. However, the former holds a 100% stocks portfolio during the first 20 years of the horizon in contrast to the latter which holds a 100% stocks portfolio during the last 20 years of the horizon. The same is graphically demonstrated in Exhibit 1.

To generate investment returns under every strategy, we randomly draw with replacement from the empirical distribution of asset class returns. The historical annual return data for the asset classes over several years is randomly resampled with replacement to generate asset class return vectors for each year of the 40 year investment horizon of the DC plan participant. Thus we retain the cross-correlation between the asset class returns as given by the historical data series while assuming that returns for individual asset classes are independently distributed over time. The asset class return vectors are then combined with the weights accorded to the asset classes in the portfolio (which is governed by the asset allocation strategy) to generate portfolio returns for each year in the 40 year horizon. The simulated investment returns are applied to the retirement account balance at the end of every year to arrive at the terminal wealth in the account. For each lifecycle and contrarian strategy the simulation is iterated 10,000 times. Thus, for each of the eight strategies, we have 10,000 investment return paths that result in 10,000 wealth outcomes at the end of the 40-year horizon.

To resample returns, this paper uses an updated version of the dataset of nominal returns for US stocks, bonds, and bills originally compiled by Dimson, Marsh, and Staunton [2002] and commercially available through Ibbotson Associates. This annual return data series covers a period of 105 years between 1900 and 2004. Since the dataset spans several decades, we are able to capture the wide-ranging effects of favourable and unfavourable events of history on returns of individual asset classes within our test. The returns include reinvested income and capital gains.

Results and Discussion

Comparing various parameters of the terminal wealth distribution for the lifecycle strategies and their contrarian counterparts provide us a fair view of their relative appeal to the retirement investor. In

particular, we look at the mean, the median, and the quartiles of the terminal wealth distribution for the different asset allocation strategies. These are given in Exhibit 2. As even a cursory glance reveals that there are significant differences in these numbers.

For each of the four pairs, we observe that the contrarian strategies result in much higher expected value (mean) than the lifecycle strategies. The difference is most striking for pair A and pair B as the mean wealth at retirement for the contrarian strategies exceed those for the corresponding lifecycle strategies by more than half a million dollars. While the differences between expected values for the other two lifecycle and contrarian pairs (C and D) are less eye-popping, they are still very large.

However, it is important to note that the mean is not the most likely outcome or even the average likely outcome for any of the strategies. This is apparent from the skewness of the terminal wealth distributions. The means of the distributions are much higher than the medians indicating the probability of achieving the mean outcome is much less than 50%. In other words, the participants should have 'better than average' luck to come up with the mean outcome at retirement. The average outcome in this case is, therefore, much more accurately represented by the median of all outcomes.

But even when one looks at the median estimates, the story does not change at all. For all pairs, the contrarian portfolios beat the lifecycle portfolios hands down. For example, the contrarian (20, 20) strategy in pair A results in a median final wealth of $1,425,387. The corresponding lifecycle (20, 20) strategy manages only $1,160,225 thus falling short by a whopping $265,162. The same margins for pairs B, C, and D, are $270,763, $176,531, and $121,584 respectively.

We also compare the 75th percentile and 25th percentile estimates which represent the mid-point of the above average and the below average outcomes respectively. For the 75th percentile estimates, which are practically the medians of the 'above average' outcomes, the differences between the lifecycle and the corresponding contrarian portfolios grow even wider than those for median estimates. For pair A, the 75th percentile outcome for the contrarian portfolio is about 41% larger than the lifecycle portfolio which translates a wealth difference of more than $700,000. Even for pair D, where the results for the two strategies are the closest, the contrarian portfolio is still better off by more than a quarter million dollars.

For 25th percentile estimates, which represents the medians of the 'below average' outcomes, one would normally expect the lifecycle strategies to perform better given they are specifically designed to protect the retirement portfolio against the adverse market movements in the final years. Well, they certainly do better in terms of closing the gap but are still not able to outperform contrarian strategies for any of the pairs. Even for pair C, where the two estimates are the closest, the result for the contrarian strategy is almost 4% ($32,000) higher than that for the corresponding lifecycle strategy.

Although the dominance of contrarian strategies over their lifecycle counterparts is clearly visible for all pairs, the difference between the outcomes of the two strategies gets monotonically smaller as we move from pair A to pair D. This is expected as each subsequent pair of strategies has greater overlap in terms of holding the same asset class at the same point on the horizon (i.e. identical allocation) than the previous pair. For example, at no point of time do the lifecycle (20, 20) strategy and the contrarian (20, 20) strategy in pair A have identical allocation to the asset classes. In stark contrast, the lifecycle (35, 5) and the contrarian (5, 35) strategies in pair D have identical allocation for 30 years (between 6th and 36th Year), during which both are invested in 100% stock portfolio, thus resulting in final wealth outcomes that are

closer to one another than those produced by other pairs where the lifecycle and contrarian strategies have shorter overlapping periods of identical allocation.

The above results indicate that if the plan participant's objective is to maximise wealth at the end of the horizon, lifecycle strategies vastly underperform relative to the contrarian strategies. Shiller's emphasis on exposing the portfolio in later years to higher returns of stock market seems to be a possible candidate in explaining the superior 40-year performance of the contrarian strategies. But to have proper understanding of the interaction between portfolio size and asset allocation, it is necessary to track the accumulation paths of the lifecycle and corresponding contrarian strategies in the early, middle, and final years. In other words, to obtain more compelling evidence of the size effect, we need to plot the simulated portfolios over the entire 40 year period. Exhibit 3 depicts the accumulation paths over 40 years for each pair of lifecycle and contrarian strategies. Since showing all the 10,000 simulated accumulation paths for every strategy would make the plots visually unappealing and difficult to study, we display every 100^{th} simulation result in these graphs. Thus, for every strategy, we effectively plot 100 simulated accumulation paths for visual comparison with those of its counterpart.[6]

For every lifecycle and contrarian strategy, the slopes of the accumulation curves generally steepen as they move along the horizon.[7] This seems to indicate that the potential for rapid growth in the retirement account balance comes only in the later years. What is striking in this respect is that every lifecycle strategy and its paired contrarian strategy display quite similar accumulation outcomes in the initial years (despite the contrast in their asset allocation structures). In fact, till half way through the horizon (20 years), there is very little to choose between the accumulation patterns of the lifecycle strategies and the contrarian strategies although lifecycle strategies which share shorter overlapping periods of identical

asset allocation with their contrarian competitors (for example, lifecycle strategies in pair A and pair B) seem to do slightly better. It is only when the accumulation plots move well beyond the half-way mark on the horizon they start to look strikingly different. This seems to suggest that accumulation balance in the retirement account during the initial years may not be very sensitive to the asset allocation strategy chosen by the participant.

The above finding confirms the importance of growing portfolio size along the investment horizon from the perspective of asset allocation. In the initial years the size of the contributions are relatively smaller resulting in a smaller portfolio size. The return differentials between different asset allocation strategies during this period do not create large differences in the dollar value of the retirement portfolio. As the participant moves further along the investment horizon and the portfolio size grows larger, asset allocation assumes a more dominant role as small differences in returns can result in large differences in accumulated wealth. The sensitivity of the absolute growth in accumulated wealth to asset allocation becomes more and more pronounced in the final years before retirement when the size of the portfolio is larger than that in the previous periods.

The slopes of the accumulation plots for lifecycle strategies and those for the corresponding contrarian strategies become conspicuously different during the later years. In general, the lifecycle portfolios gradually climb as they move along the horizon while the contrarian portfolios display a far steeper ascent. This clearly demonstrates the effect of portfolio size on the terminal wealth outcome. By allowing exposure of large portfolios to stock market in later years, the contrarian strategies create opportunities for higher absolute growth in accumulation balance. A closer examination of the plots would reveal that in many cases the contrarian portfolio values leapfrog over the lifecycle portfolios only at very late stages in

the investment horizon but still manage to result in huge differences in terminal portfolio value. For example, accumulation balances for the contrarian (20, 20) strategy in pair A generally lags behind those of the lifecycle (20, 20) strategy for the best part of 40 years. However, in most cases, not only do they manage to catch up the lifecycle portfolios in the final years before retirement but actually leave them way behind by the time the investors reach the finishing line.[8]

Yet one cannot ignore that contrarian strategies are exposed to the possibility of serious market downturns close to the investor's retirement. It is quite possible that higher volatility of stock returns can result in large losses for contrarian strategies in the later years and very poor terminal accumulations at least in some cases. This is certainly evident from the sharp ups and downs in the accumulation plots for the contrarian strategies later in the horizon. Lifecycle accumulation plots, in contrast, generally seem to enjoy a relatively smoother ride during this period. But does this suggest lower risk for lifecycle strategies?

A possible approach to compare the riskiness of the competing strategies would be to look at the lower tail of the distribution which comprises the adverse wealth outcomes. If lifecycle strategies are less risky, they may generate better outcomes at the lower tail of the terminal wealth distribution compared to contrarian strategies. From Exhibit 2, we have already observed that the first quartile outcomes of contrarian strategies dominate those for lifecycle strategies in every case. Now we compare various percentiles of distribution within the first quartile range which may be considered as the zone of most adverse outcomes for the plan participant. Exhibit 4 tabulates the estimates for 1^{st}, 5^{th}, 10^{th}, 15^{th} , and 20^{th} percentiles of the terminal wealth distributions under all strategies.

It is evident from the estimates that lifecycle strategies do produce better outcomes than their contrarian counterparts when we consider only the outcomes in the lowest decile (10^{th} percentile or below) of the distribution. However this is not without exception as we observe that the 10^{th} percentile outcome for the lifecycle (35, 5) strategy in pair D is lower than that of the corresponding contrarian strategy. The difference between the outcomes for every pair is highest for the 1^{st} percentile outcomes and reduces gradually as we consider higher percentiles of the distribution. But what is remarkable is that the final wealth under the contrarian strategies in the worst case scenarios falls short of the corresponding lifecycle strategies by a margin which is far less than alarming when one considers the size of the overall accumulation. For 1^{st} (and 5^{th}) percentile measures, this ranges from a little more than $100,000 (and $75,000) for pair A to about $37,000 (and $8,000) for pair D. The difference between the outcomes seems to become less significant around the 15^{th} percentile level with the contrarian strategies resulting in slightly higher estimates for pairs B and D. For 20^{th} percentile outcomes, the dominance of the contrarian strategies is clearly visible for all four pairs.

The above results show that lifecycle strategies do not always fare better than the contrarian strategies even in terms of reducing the risk of adverse outcomes. Only when we compare the 10^{th} percentile (and below) outcomes, a chance of which occurring is 1 in 10, lifecycle strategies fare slightly better. However, it is very unlikely that investors in reality would select a lifecycle asset allocation model with the sole objective of minimizing the severity of these extremely adverse outcomes, should they occur, because the cost of such action is substantial in terms of foregone wealth. For example, if the 10^{th} percentile outcome is confronted at retirement, one could be better off only by about 8% by following the lifecycle (20, 20) strategy rather than the contrarian (20, 20) strategy. But for the 90^{th} percentile outcome, which is equally likely to happen, one would be 55% better off by following the contrarian (20, 20) strategy instead of the

lifecycle (20, 20) strategy.[9] Choosing one strategy over the other in this case may decide whether the retirement years are spent watching travel shows on television or actually holidaying in exotic destinations around the world.

The opportunity for risk reduction varies considerably between various lifecycle strategies. These are more visible for lifecycle strategies that start changing their asset allocation relatively earlier in the investment horizon than those that do so later. For example, the 5th percentile outcome for lifecycle (20, 20) strategy is almost 19% higher than the contrarian (20, 20) strategy. The same estimate for lifecycle (25, 15), (30, 10), and (35, 5) strategies, which switch to conservative assets relatively later, vis-à-vis corresponding contrarian strategies shows 10%, 8%, and 2% better outcomes respectively indicating a declining risk reduction advantage for lifecycle strategies that delay switching to conservative assets. Ironically, reducing the risk of extreme outcomes by switching early to conservative assets involves a very heavy penalty in terms of foregone accumulation of wealth. This becomes apparent from the variation in terminal wealth outcomes for the four lifecycle strategies in question.

Summary and Conclusion

The apparently naïve contrarian strategies which, defying conventional wisdom, switch to *risky* stocks from conservative assets produce far superior wealth outcomes relative to conventional lifecycle strategies in all but the most extreme cases. This demonstrates that the size of the portfolio at different stages of the lifecycle exerts substantial influence on the investment outcomes and therefore should be carefully considered while making asset allocation decisions. The evidence presented in this paper lends support to Shiller's view that the growing size of the participants' contributions in the later years calls for aggressive asset allocation which is quite the opposite of what is currently done by lifecycle asset allocation funds.

It is important to emphasize here that we are clearly not suggesting that one should follow any of the contrarian asset allocation strategies to allocate retirement plan assets. We have formulated and used them in this paper only to conduct a fair test of the hypothesis that by investing conservatively in middle and later years lifecycle funds work against the participant's investment objectives. Our results show that, in most cases, the growth in portfolio size experienced in the later years of employment seems to justify holding a portfolio which is at least as aggressive as that held in the early years. For some participants, this may well mean holding 100% stocks throughout the horizon.

By their own admission, financial advisors recommending lifecycle asset allocation strategies focus on two objectives: maximizing growth in the initial years of investing and reducing volatility of returns in the later years. Our findings suggest that the bulk of the growth in value of accumulated wealth actually takes place in the later years. The first objective, therefore, has little relevance to the overarching investment goal of augmenting the terminal value of plan assets. We do find some support for pursuing the second objective of reducing volatility in later years to lessen the impact of severe market downturns but this comes at the high cost of giving up significant upside potential. In other words, the effect of portfolio size on wealth outcomes over long horizons is so large that it outweighs the volatility reduction benefit of lifecycle strategies in most cases. Therefore, switching to less volatile assets a few years before retirement can only be rationalized if the employee participants have already accumulated wealth which equals or exceeds their target accumulation at retirement.

If lifecycle strategies aim to preserve accumulated wealth, then one has to first ensure sufficient accumulation in the retirement investor's account before recommending switch towards conservative investments. Unfortunately, this is not the case with lifecycle funds currently used in DC plans, where the

asset switching is done following a pre-determined mechanistic allocation rule and without giving any cognizance to the actual accumulation in the account. It seems that retirement investors would be better off by refraining from blindly adopting these age-based investment strategies that are keen on preservation even when there is not much to preserve.

ENDNOTES

This research was supported under the Australian Research Council's Discovery Grant (project number DP0452336). The authors are particularly grateful to Prof. Martin Gruber for valuable discussion during their visit to Stern School of Business, New York University. Comments from participants at 12th Melbourne Money and Finance Conference and 15th PBFEAM Conference are also acknowledged. The authors thank an anonymous reviewer for helpful comments on the paper

[1] Not all lifecycle funds change their asset allocation over time. Static allocation funds offered by various providers which have the same exposure to various asset classes throughout the investment horizon are also sometimes categorised as lifecycle or lifestyle funds. In contrast, the lifecycle funds, we discuss in this paper change their allocation over time and therefore are often referred to as age-based or target retirement funds. It is this type of age-based lifecycle fund that has witnessed the highest growth in the last few years (Mottola and Utkus [2005]).

[2] For example, McEnally [1985] and Butler and Domian [1991] examine the effect although they reach different conclusions. This is, however, a result of different measures of risk employed by these researchers. While the former views variability of terminal wealth as risk, the latter uses probability of stocks underperforming bonds and T-bills over long horizons as the risk measure.

[3] An exception to this is Hickman et al. [2001] who model the terminal value of a retirement investor's portfolio where contributions are made every month. However, they assume that contributions remain equal throughout the horizon.

[4] An exception would be the case where the average allocation of the lifecycle strategy to any asset class over the investment horizon exactly matches that of the fixed weight strategy it is compared with.

[5] Information about precise asset allocation of existing lifecycle funds at every point on the horizon is rarely made available in the providers' prospectus. Our formulation follows the general direction of the switch and does not try to consciously replicate the allocation of any of the existing funds.

[6] We have chosen to use a linear scale over a logarithmic scale in plotting the accumulation wealth along y-axis. This is motivated by our interest in absolute growth in the accumulation balance in actual dollars rather than percentage growth. Graphs using logarithmic scale for y-axis can be made available by the authors on request. It is also to be noted that a few extremely large accumulations for both lifecycle and contrarian strategies in pairs C and D do not completely fit in the graphs.

[7] This is not unexpected because of compounding of investment returns over multiple periods. Moreover, contributions are made to the retirement account every period and the size of the contributions get larger every period under our assumption of constant growth in salary.

[8] Obviously there are exceptions visible in the diagrams where an individual accumulation plot under lifecycle strategy is able to beat those under contrarian strategies.

[9] The 90th percentile terminal wealth estimates, although not provided in this paper, are available from the authors on request.

References

Bodie, Zvi. " On the Risk of Stocks in the Long Run." *Financial Analysts Journal*, May/June 1995, pp 18-22.

Butler, Kirt, and Dale Domian. "Risk, Diversification, and the Investment Horizon." *Journal of Portfolio Management*, 17 (1991), pp. 41-48.

Gordon, Catherine and Kimberley Stockton. "Funds for Retirement: The 'Life-cycle' Approach, Research Report, *Vanguard Investment Counselling & Research*, 2006.

Hickman, Kent, Hugh Hunter, John Byrd, John Beck, and Will Terpening. "Life Cycle Investing, Holding Periods, and Risk." *Journal of Portfolio Management*, 27 (2001), pp. 101-112.

Levy, Haim, and Allan Cohen. "On the Risk of Stocks in the Long Run: Revisited." *Journal of Portfolio Management*, 24 (1998), pp. 60-69.

Malkiel, Burton. *A Random Walk Down Wall Street: The Time Tested Strategy for Successful Investing*, New York: W.W.Norton & Co., 2003.

McEnally, Richard. "Time Diversification: Surest Route to Lower Risk?" *Journal of Portfolio Management*, 11 (1985), pp. 24-26.

Merrill, Craig, and Steven Thorley. "Time Diversification: Perspectives from Option Pricing Theory." *Financial Analysts Journal*, May/June 1996, pp. 13-19.

Mottola, Gary, and Stephen Utkus. "Life-cycle Funds Mature: Plan Sponsor and Participant Adoption." *Vanguard Centre for Retirement Research*, 20 (2005), pp. 1-14.

Samuelson, Paul. "Risk and Uncertainty: A Fallacy of Large Numbers." *Scientia*, 98 (1963), pp. 108-113.

Shiller, Robert. "Lifecycle Portfolios as Government Policy." *The Economists' Voice*, 2 (2005a), Article 14.

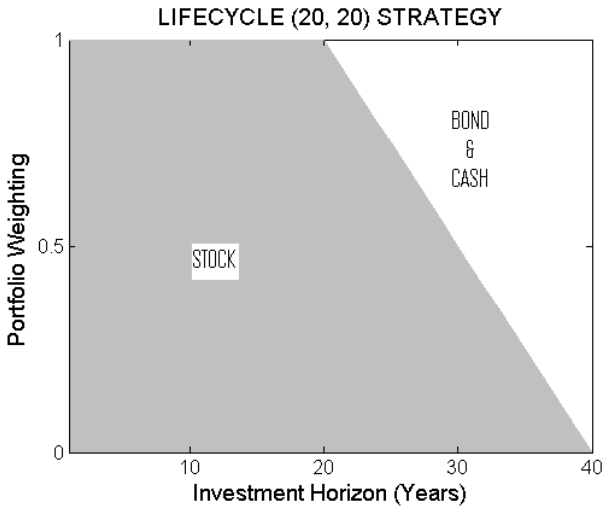
Shiller, Robert. "The Lifecycle Personal Accounts Proposal for Social Security: A Review." *National Bureau of Economic Research Working Paper No. 11300*, 2005b.

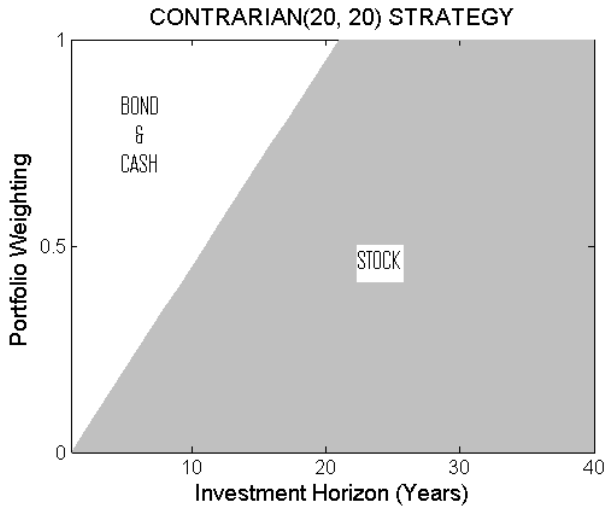
Vanguard Center for Retirement Research. "How America saves 2006: A report on Vanguard 2005 defined contribution plan data", 2006.

EXHIBIT 1

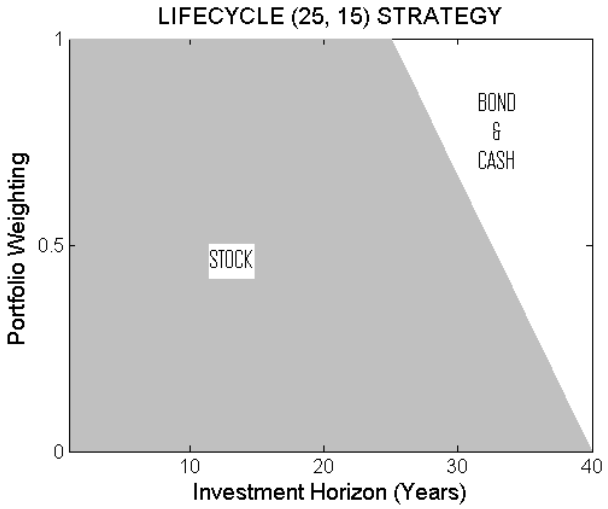
ASSET ALLOCATION AT DIFFERENT POINTS OF INVESTMENT HORIZON

PAIR A





PAIR B



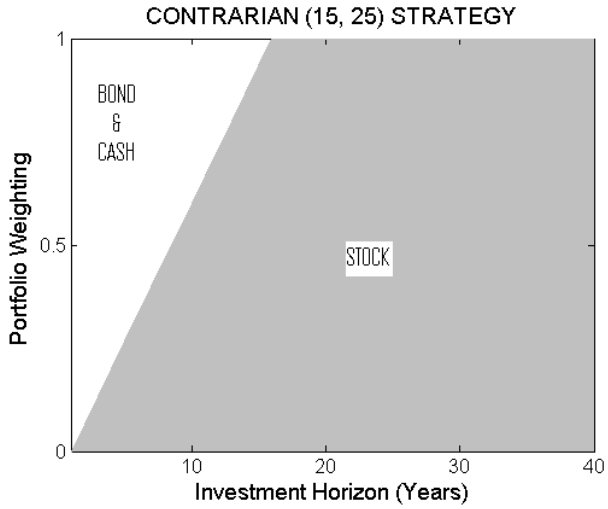
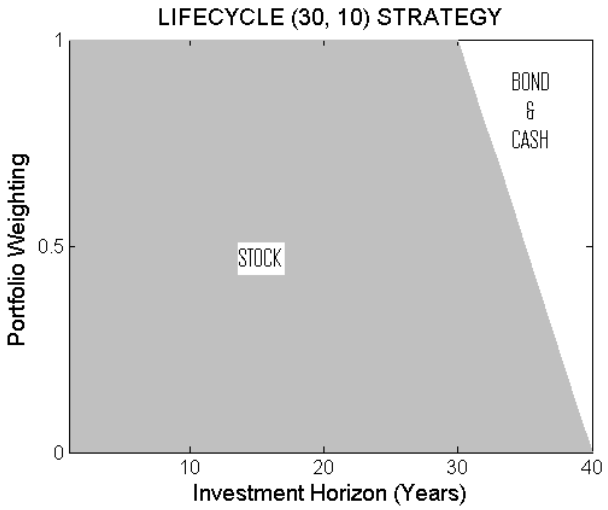
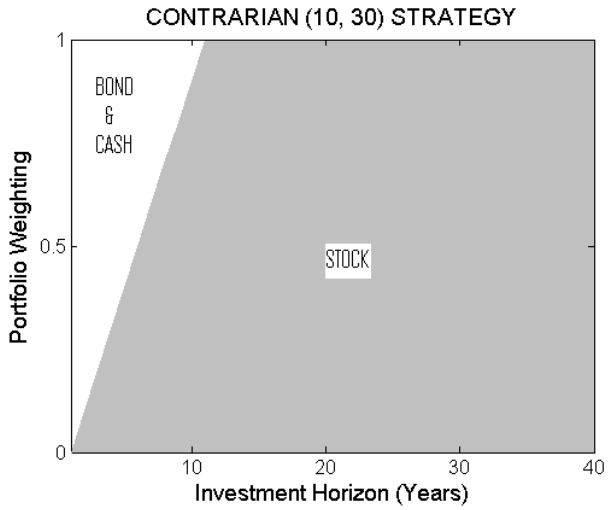


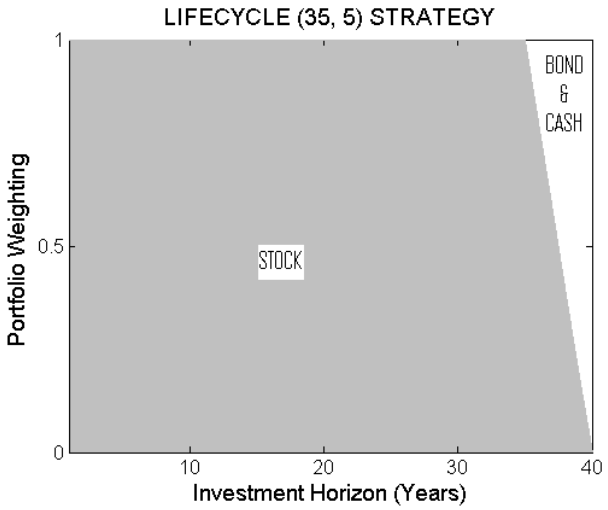
EXHIBIT 1 (CONTINUED)

PAIR C





PAIR D



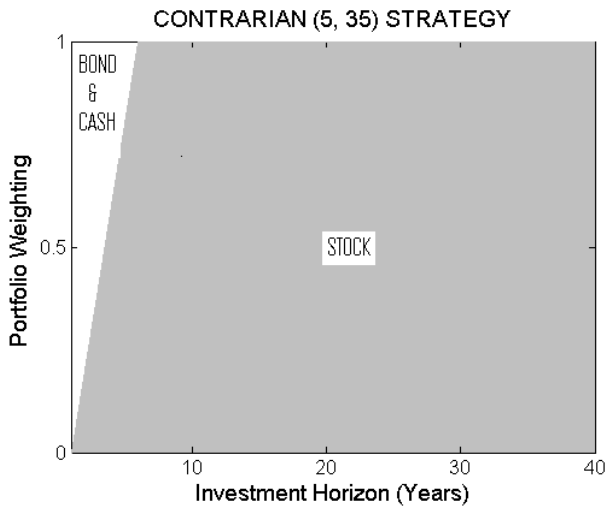


EXHIBIT 2

TERMINAL VALUE OF RETIREMENT PORTFOLIO IN NOMINAL DOLLARS

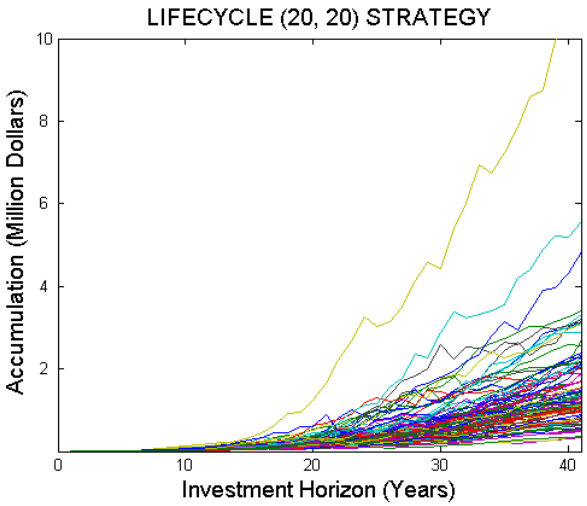
Strategy	Mean	Median	25th Percentile	75th Percentile
Pair A				
Lifecycle (20,20)	1,420,332	1,160,225	793,371	1,724,852
Contrarian (20,20)	1,959,490	1,425,387	838,796	2,435,856
CONT - LCYL (%)	38.0	22.9	5.7	41.2
Pair B				
Lifecycle (25,15)	1,645,154	1,275,577	825,149	2,004,439
Contrarian (15,25)	2,173,389	1,546,339	889,496	2,702,427
CONT - LCYL (%)	32.1	21.2	7.8	34.8
Pair C				
Lifecycle (30,10)	1,909,918	1,411,168	876,711	2,355,363
Contrarian (10, 30)	2,335,373	1,587,699	909,020	2,864,003
CONT - LCYL (%)	22.3	12.5	3.7	21.6
Pair D				
Lifecycle (35,5)	2,253,731	1,578,405	918,483	2,764,413
Contrarian (5,35)	2,491,247	1,699,990	964,222	3,032,984
CONT - LCYL (%)	10.5	7.7	5.0	9.7

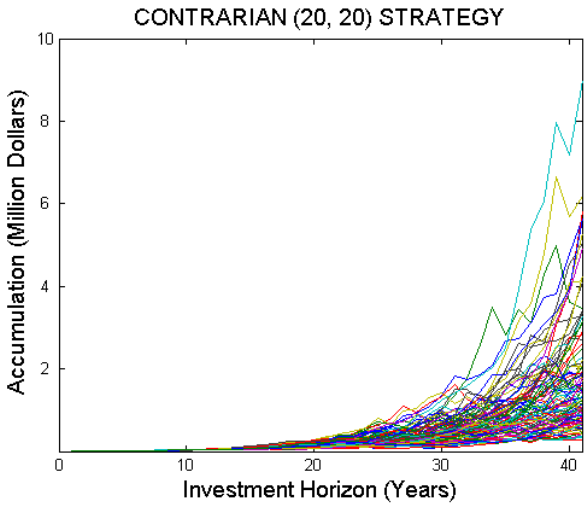
CONT – LYCL = Contrarian Strategy Terminal Value – Lifecycle Strategy Terminal Value
(Expressed as percentage of the lifecycle strategy terminal value)

EXHIBIT 3

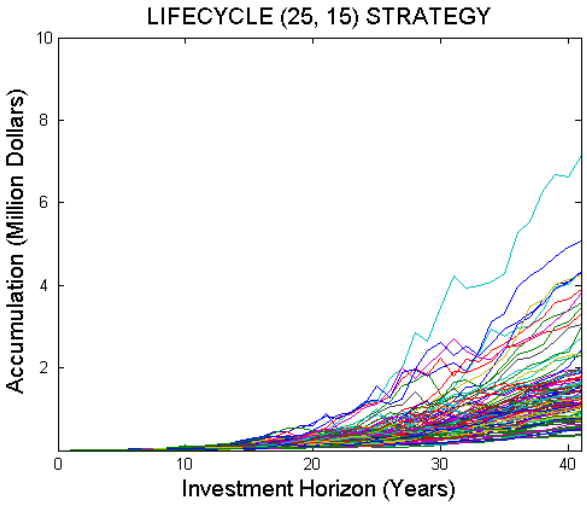
SIMULATED ACCUMULATION PATHS OVER INVESTMENT HORIZON

PAIR A





PAIR B



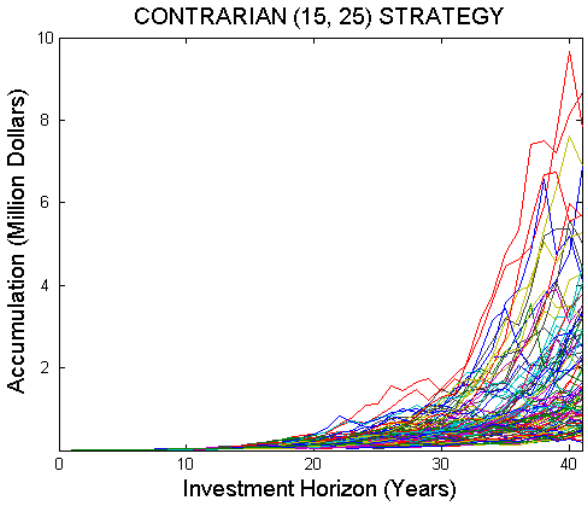
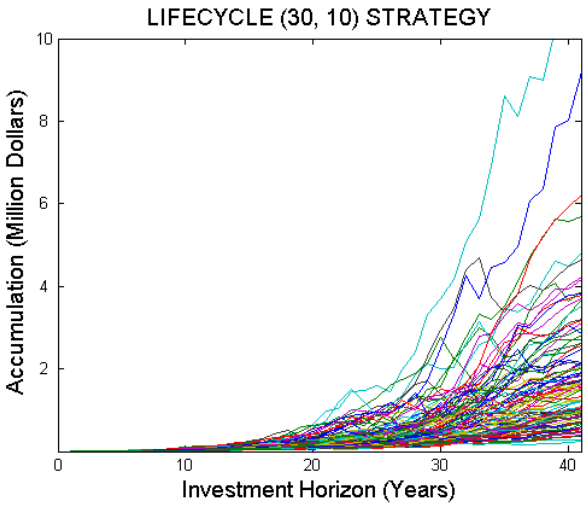
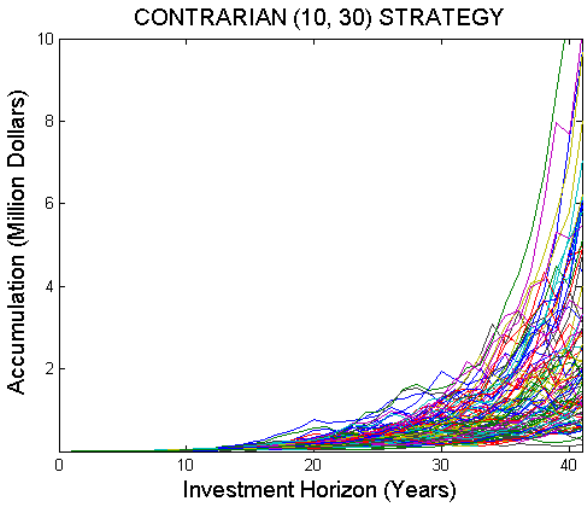


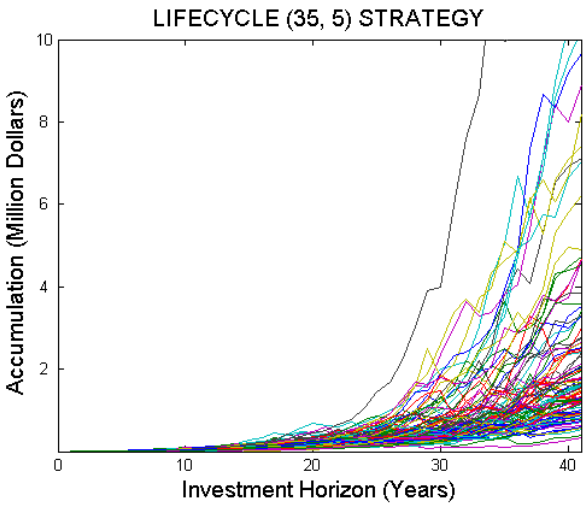
EXHIBIT 3 (CONTINUED)

PAIR C





PAIR D



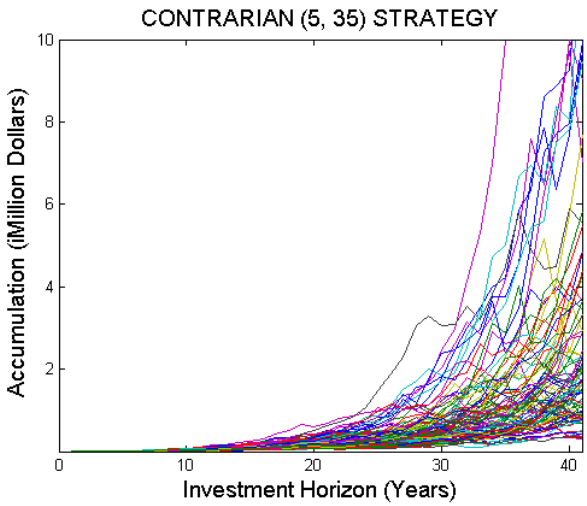


EXHIBIT 4

TERMINAL PORTFOLIO VALUES FOR ADVERSE OUTCOMES IN NOMINAL DOLLARS

Asset Allocation Strategy	Percentiles of Distribution				
	1	5	10	15	20
Pair A					
Lifecycle (20,20)	370,049	483,800	577,066	654,132	728,573
Contrarian (20,20)	258,637	407,053	532,291	639,031	738,534
LCYL – CONT (%)	43.08	18.85	8.41	2.36	-1.35
Pair B					
Lifecycle (25,15)	343,326	466,203	571,193	662,194	744,045
Contrarian (15,25)	259,630	424,103	557,240	673,115	778,744
LCYL – CONT (%)	32.24	9.93	2.50	-1.62	-4.46
Pair C					
Lifecycle (30,10)	318,211	470,271	585,107	685,409	781,134
Contrarian (10, 30)	249,829	434,660	567,613	682,174	803,828
LCYL – CONT (%)	27.37	8.19	3.08	0.47	-2.82
Pair D					
Lifecycle (35,5)	301,184	455,267	589,409	700,323	817,011
Contrarian (5,35)	264,326	446,592	600,863	719,279	843,420
LCYL – CONT (%)	13.94	1.94	-1.91	-2.64	-3.13

LYCL - CONT = Lifecycle Strategy Terminal Value - Contrarian Strategy Terminal Value
((Expressed as percentage of the contrarian strategy terminal value)