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Is diversification always optimal?

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Abstract

Finance theory and recent literature suggest that investors should diversify their retirement savings across a number of funds. However, the Australian government encourages investors to consolidate retirement savings into just one fund. Using a number of optimization techniques, we investigate which of these two actions would result in the best outcome for investors in terms of risk and return. We find that in the majority of cases investors would be better off *not* diversifying their holdings; mainly because superannuation funds cannot be short sold. Consolidation therefore does appear to be the optimal strategy for the average superannuation investor.

Key words: Retirement funds; superannuation; diversification

JEL classifications: G11; G28

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Abstract

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1. Introduction

Diversification is one of the fundamental principles of finance. Modern portfolio theory states that, as long as the correlation between pairs of assets is less than one, investors should hold at least some of their wealth in multiple assets. This strategy will reduce the risk of their portfolio for a given level of expected return (Markowitz, 1952).

A number of studies have examined the question of how many securities need to be included to achieve a diversified portfolio, (see for example Evan and Archer, 1968 and Campbell, 2001), and Benjelloun (2010) shows a well-diversified portfolio can be achieved with 40 to 50 assets. For the average investor, a relatively simple and low-cost way of accessing a portfolio of such a size would seem to be to invest in a mutual fund. However, research suggests that even holding one mutual fund may not sufficiently diversify investment risk, particularly for retirement savings. Elton et al. (2007) and Moorman (2009) suggest that investors who do not diversify their fund holdings across multiple funds will suffer increased portfolio risk, and therefore reduced overall utility.

In this paper, we ask a more fundamental question. Namely, are investors better off diversifying their holdings across multiple funds, or should they concentrate their holdings into just one fund? While the answer to this question would seem to be a mathematical tautology – investors should always diversify if pairwise correlations are lower than one – investors do not face perfect capital markets, and frictions such as short-selling constraints and fees could alter the answer to the question.

We examine funds held for retirement savings purposes, not only because this market comprises an enormous amount of money, but also because most nations now have ageing populations, and therefore it is critical for governments and other stakeholders to ensure policy in this arena is made in investors' best interests. Our paper is motivated by a seeming disconnect between government policy and findings from the academic literature.

Specifically, there has been a drive by the Australian government to strongly encourage investors to consolidate their retirement savings into just one fund. However, implications from current research (Elton et al., 2007; Moorman, 2009) and traditional finance theory suggest that encouraging investors to consolidate savings into one fund is not optimal: consolidation may not minimize investors' risk (hence increase risk-adjusted return) and therefore does not appear to be in investors' best interests. The aim of this study is to contribute to the debate by determining whether retirement savings should be diversified across funds, or consolidated into just one fund.

Our setting is Australian retirement savings funds.[1] The Australian retirement savings (known as "superannuation") landscape is interesting for a number of reasons. Unlike the USA, retirement saving is compulsory for anyone who is employed in Australia. Further, for the most part, employees can choose to invest in *any* superannuation fund. This is in stark contrast to, for example, American 401(K) plans, where the trustee pre-selects a number of funds from which an employee may choose. In Australia, employers typically suggest a few funds from which employees can choose, but employees are not limited to these choices. The ability to invest one's superannuation in any fund gives Australian investors saving for retirement an apparent advantage over US investors. More specific detail about the Australian superannuation industry is provided in the next section.

Superannuation constitutes an extremely large proportion of Australia's investment pool: superannuation funds under management are estimated at A$1.6 trillion, nearly the same size as Australia's GDP.[2] The Australian government, consequently, takes an active

[1] These funds are regulated by the Australian Prudential Regulation Authority (APRA) and are distinct from Australian managed funds – equivalent to mutual funds – which are regulated under Corporations Law.

[2]http://www.apra.gov.au/Super/Publications/Documents/Revised%202013%20Annual%20Superannuation%20 Bulletin%2005-02-14.pdf – date accessed 14/10/2014.

interest in the oversight and regulation of the superannuation industry, and it is critical to ensure policy changes in this domain will benefit investors. Examining the Australian market also provides out-of-sample testing for Elton et al.'s (2007) and Moorman's (2009) findings.

We begin the study by using Elton et al.'s (2007) and Moorman's (2009) methodology to investigate whether their findings apply in the Australian setting. We then move to the fundamental part of our analysis. We directly investigate if investors benefit from holding more than one superannuation fund by examining how combinations of funds are optimized, using actual fund data. We look at maximizing the Sharpe ratio (mean-variance optimization) and also minimizing variances and, in robustness tests, expected shortfall. We use superannuation funds' actual returns and risks, which is an improvement over Elton et al. (2007) and Moorman (2009), who both use extremely restrictive and unrealistic assumptions about funds' characteristics.

Our results show that, using Elton et al.'s (2007) and Moorman's (2009) methodologies, Australian superannuation investors should indeed hold a number of superannuation funds. However, when we relax their restrictive assumptions and examine actual fund returns, mean-variance (minimum variance) optimization suggests that in more than 80% (about half) of cases would investors be better off investing in one fund rather than diversifying across two. This result is primarily driven by the fact that investors are not able to short-sell superannuation funds.

For investors with sufficient financial literacy and skill, our results indicate that it may be worthwhile to hold more than one fund. These investors would have to correctly identify, out of more than 600 equity fund options, those funds with which to combine their current holdings, and invest the correct weights in the funds. This is not an easy task. Further, the average superannuation fund's Sharpe ratio is 0.2, and the improvement in Sharpe ratio from diversifying is on average between 0.001 and 0.008, before fees. Given the high level of superannuation investor disengagement and financial illiteracy (Fear and Pace, 2009), it is possible that such a low chance of improved risk/return outcomes, and such a small potential improvement in Sharpe ratio, may not be sufficient incentive for the average superannuation investor to expend the effort and resources required to diversify into a second fund. It would appear that the Australian government's push to encourage investors to consolidate their superannuation holdings into just one fund may in fact be the rational strategy for the majority of investors.

The rest of this paper proceeds as follows. We provide some background information on Australian superannuation in Section 2. Data are described in Section 3 and methods in Section 4. Results are in Section 5, and Section 6 concludes.

2. Background

Compulsory superannuation contribution was introduced in 1992, and the regulations at that time required employers to contribute 3% of employees' salaries to a superannuation scheme. Since then, the mandated superannuation contribution percentage has been slowly increased to the current 9.5%. This rate is to be incrementally increased to 12% by 2019.

Since its introduction, there have been many legislative changes, but we review only those most relevant to our study. In 1993, the Superannuation Industry (Supervision) Act allowed trustees to offer members a choice of two or more investment strategies. This gave employees some flexibility in terms of which funds they could invest in, but choice was limited to those funds pre-selected by a trustee. Major reform came in 2004, when the Australian government introduced the Choice of Fund policy,[3] giving the majority of

[3] More specifically, this was achieved when the *Superannuation Legislation Amendment (Choice of Superannuation Funds) Act 2004* was passed.

Australian workers the option to choose any fund(s) for their superannuation contributions from 1 July 2005.

However, perhaps somewhat surprisingly, survey evidence suggests that few investors seized the opportunity to alter their superannuation investments. After the introduction of choice, only 3% to 6% of investors changed superannuation fund, approximately half of which arose from investors changing jobs, rather than from active choice (Fear and Pace, 2009). Currently, 42.9% of funds are held in the default investment strategy.[4] These two facts suggest that many investors do not take an active interest in their retirement savings. The preference for the default strategy may also possibly indicate poor financial literacy (Fear and Pace, 2009). Further evidence of superannuation disengagement is the fact that there are more than six million accounts – worth over A$19 billion – on the "Lost Member Register".[5]

A large-scale review of the superannuation system, colloquially known as the "Cooper Review", was undertaken in 2009. From the committee's report, a series of policies was developed that aimed to simplify superannuation for employees, ensure appropriate management and regulation of the industry, and make processing easier.[6] The most significant change was the establishment of a "low cost default superannuation product" – referred to as MySuper – that was to become the default option. Since 1 July 2013 all superannuation funds can, but do not have to, offer a MySuper product.

The MySuper product offers a single diversified investment strategy with low fees. Employees still have the option to choose any superannuation fund and may direct their

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[4] http://www.apra.gov.au/Super/Publications/Documents/Revised%202013%20Annual%20Superannuation%20 Bulletin%2005-02-14.pdf– date accessed 17/11/2014.

[5]http://annualreport.ato.gov.au/Part-02-Performance-reporting/Securing-retirement-income/Lost-and-ATO-held-superannuation/ – date accessed 14/10/2014.

[6] The report is available at http://www.supersystemreview.gov.au/content/content.aspx?doc=html/final_ report.htm – date accessed 14/10/2014.

employer to pay their superannuation contributions into the chosen fund. These funds are referred to as Choice funds, and are not limited in the types of fees they can charge. For those who prefer not to be actively involved in their retirement investments, the MySuper product delivers a cost-effective investment plan. With lower fees, this should ideally result in higher income for the retiree. However, the low fee structure may impact the type of products and the level of active management that the fund manager can pursue. The government proposed that one key benefit of the MySuper product is that it allows investors to consolidate their superannuation accounts, the assumption being that holding multiple superannuation funds is sub-optimal.[7]

Recently, the Australian Securities Investment Commission (ASIC) has also been encouraging investors to consolidate their retirement savings into one fund to minimize fees, reduce paperwork and "be in control" of their investments.[8] Academic literature also provides a number of good reasons why investors might consider consolidating their superannuation into just one fund. Sirri and Tufano (1998) and Huang et al. (2007) note that investors face costs in terms of identifying, investigating and investing in a new fund. Elton et al. (2007) suggest that investors may restrict their attention to a single family due to fee exemptions, narrowing the search process and simplifying record keeping. These reasons, coupled with high investor disengagement, suggest that consolidation may be a rational strategy.

On the other hand, there are also reasons to suggest investors may benefit from diversifying across funds, and therefore this push to consolidate may not be in investors' best interests. The evidence on whether Australian fund managers in general can outperform

[7] See the Stronger Super, Information Pack, available at: http://strongersuper.treasury.gov.au/content/publications/information_pack/downloads/information_pack.pdf – date accessed 14/10/2014.

[8] https://www.moneysmart.gov.au/superannuation-and-retirement/keeping-track-and-lost-super/consolidating-super-funds – date accessed 14/10/2014.

broad market indexes after fees is at best mixed, and any outperformance does not seem to persist (Sawicki and Ong, 2000; Gallagher, 2001; Faff, et al., 2005; Humphrey and O'Brien, 2010; Kim, et al., 2014; Bennett, et al., 2014). Diversifying across funds will give investors exposure not only to different asset mixes, but also to different fund managers, potentially reducing the variance of their portfolios. Results from Elton et al. (2007) and Moorman (2009) indicate that portfolios of a number of funds have better Sharpe ratios than portfolios of just one fund.

We might also look to the fund of funds literature to determine whether diversification across funds is beneficial.[9] However, results from these studies are also mixed. Larsen and Resnick (2012) combine US sector funds to achieve enhanced risk adjusted performance. Chen et al. (2009) show it is only the skilled "active-alpha seeking" manager who can improve performance in a fund-of-fund environment. A passive combination of funds does not enhance performance. In the Australian context Brands and Gallagher (2005) show that improved diversification benefits can be achieved by combining approximately six active funds.

Inconclusive results in the literature on whether there are benefits from diversifying across funds indicates that a case can be made for either diversification across funds or consolidation of investment into one fund. Our study seeks to resolve this question in the context of Australian Superannuation, as the answer has important implications for policy makers.

3. Data and sample selection

Our superannuation fund data are primarily sourced from Morningstar Direct. Following Moorman (2009), we select equity funds and delete index funds, fund of funds and sector

[9] We thank an anonymous referee for this suggestion.

funds. Funds with less than 12 months of returns are removed from the sample to allow computation of the correlations, giving a sample of 908 superannuation funds.

A fund may offer the same portfolio to a number of different investor classes; for example, a fund may have a retail and an institutional version of the same fund. As investors are unlikely to want to (or indeed, in many cases, be able to) “diversify” into an identical fund to the one they already hold, we delete funds that have the same holdings. To operationalize this, we examine funds that have a correlation of 0.9995 or higher and delete the fund with the lowest return. This results in 304 funds being eliminated, leaving us with a sample of 604 funds. In the robust tests section, we reduce the correlation to 0.99.

Risk-free rate and market return data are from the Australian Graduate School of Management Centre for Research in Finance database (AGSM-CRIF). We use the return on the S&P/ASX 100 as our large capitalization index and the S&P/ASX Small Ordinaries as our small capitalization index. The returns on these indexes are from Morningstar Direct. Family is the fund’s management company as reported by Morningstar. Fund style is the fund’s Morningstar category.[10] The sample period is January 1992 to December 2012.

4. Methods

We first calculate pair-wise correlations between all possible pairs of funds in the sample. The funds must have at least 12 overlapping observations to be included in the sample. These correlations are then placed into one of four series: funds of the same family and same style (SFSS), same family and different style (SFDS), different family and same style (DFSS), and different family and different style (DFDS).

[10] We use the most recent Morningstar Classification as the fund’s style. Note that this may have changed over time.

4.1. Using Elton et al.'s (2007) and Moorman's (2009) method

We begin by examining the diversification question using Elton et al.'s (2007) and Moorman's (2009) methodology. This process involves starting with a fund, or a portfolio of up to five funds of the same family and style. A fund is then added and the Sharpe ratio of the new portfolio calculated. The added fund can either be a large or small capitalization fund. This process is performed twice: the added fund is of the same family (style) or a different family (style). The Sharpe ratios of the new portfolios are compared to determine how much higher the return on the first portfolio would need to have been for it to produce the same Sharpe ratio as the second portfolio. Moorman (2009) calls this the "extra return required to maintain the Sharpe ratio". Elton et al. (2007) and Moorman (2009) calculate the extra return required in slightly different ways, and these are documented in the Appendix. Note that when investigating family or style, we follow Moorman in that we control for reduced correlation in the other dimension (see Table 2 of Moorman, 2009). For example, if we are investigating style, the added fund is of the same style but from a different family versus an added fund of a different style and a different family. We investigate the following scenarios:

1) adding a fund with the same style and from the same family, rather than from a different family and with a different style
2) adding a fund from the same family, rather than a different family
3) adding a fund with the same style, rather than a different style.

Elton et al. (2007) and Moorman (2009) make some very strong assumptions about portfolio characteristics, which become inputs into their calculations. We maintain their assumptions in this section of our analysis. The assumptions are:

- Equal amounts are invested in each fund.

- All funds have the same variance – the average variance of all funds in the sample.
- Pairs of funds of the same type (i.e. SFSS, SFDS, DFSS and DFDS) all have the same correlation – the average correlation of funds of that type.
- Funds' returns are assumed to be 13% or 17.3% for large or small capitalization stocks, respectively, which is from the Ibbotson 2004 Yearbook. We use Australian equivalents, as outlined in the data section above.

4.2. Using actual returns

We then move to the more fundamental question of whether investors are better off holding one fund or diversifying across funds, using actual fund returns data. To do this, we take each fund in our sample and combine it sequentially with every other fund to form two-fund portfolios. We apply mean-variance optimization (MV), minimum variance (MIN) and, in robustness tests, minimizing expected shortfall (ES) to investigate how investors should optimally weight their investment portfolios on an ex-post basis.

MV optimization is applied to calculate the weight that must be invested in each of the two funds to obtain the optimal Sharpe ratio (Markowitz, 1952). We follow DeMiguel et al (2009) and assume gamma, the level of risk-aversion, is one. We alter this assumption in robustness tests. The MV optimization calculation is as follows:

$$\max_{\boldsymbol{w}} \boldsymbol{w}^T\boldsymbol{\mu} - \frac{\gamma}{2}\boldsymbol{w}^T \textstyle\sum \boldsymbol{w} \quad s.t. \quad \mathbf{1}_N^T\boldsymbol{w} = 1 \tag{1}$$

where: μ denotes the vector of mean returns of the assets within the portfolio,

$\sum$ is the variance-covariance matrix of portfolio returns,

γ is the level of the investor's risk-aversion,

w is the vector of portfolio weights that will produce the optimal weights in the mean-variance optimization exercise,

$\mathbf{1}_N$ is an *N*-dimensional vector of ones where *N* is the number of assets in the portfolio.

All portfolio returns are calculated in excess of the risk-free rate.

To assess the statistical significance of our results, we compare the confidence intervals of the Sharpe ratios of the optimized portfolio of two funds to those of the two underlying individual funds. In our calculation of the Sharpe Ratio confidence intervals, in line with Fletcher (2011), we use Newey and West's (1994) adjustment to produce heteroskedasticity and autocorrelation consistent estimators. Where 95% of the distribution of the two-fund portfolio lies to the right of the distribution from the single fund with the highest Sharpe ratio, we conclude that the Sharpe ratio is optimized by diversifying across two funds.

MV optimization is the foundation of modern portfolio theory and is central in both static and dynamic models of asset prices. However, the practical application of MV optimization remains problematic. Michaud (1989) and Black and Litterman (1992) argue that mean-variance optimizers have little practical use, as the resulting portfolio distributions are unintuitive and are "estimation-error maximizers" that result in extreme weights. DeMiguel et al. (2009) perform a comprehensive study investigating the out-of-sample performance of a range of MV optimization techniques that are designed to be robust to estimation error. They find that none are able to consistently outperform the equally-weighted portfolio (1/N). However, in defence of portfolio optimization, Green and Hollifield (1992) find that eliminating estimation errors does not reduce the extreme weighting in MV optimization and recommend that investors abandon their intuition about the features of desirable portfolios and accept optimized MV portfolios. They show that the extreme weights are a result of a dominant single factor in equity returns, and to reduce exposure to significant factor risk in investment portfolios requires investors to take extreme positions.

From a practitioner's perspective, Fisher and Statman (1997) and Kritzman (2010) propose that if investors find that the resulting portfolios produced by MV optimization are unintuitive, they should focus on optimizing utility functions that are a reflection of their true preferences. They state that optimization techniques should fit the goals of investors, rather than dictate goals to investors. Such a statement is consistent with the objectives outlined in the Super System Review Final Report (2010) that explicitly states that "the super system should work for its members, not vice versa".[11] Thus, our study also includes the MIN and ES optimization portfolios that are intuitive objectives for long-term, risk-averse individuals, as they focus on minimizing volatility and left tail risk in the investment portfolio, respectively.

One of the findings of DeMiguel et al. (2009) is that the MIN strategy is able to produce similar, and sometimes higher, Sharpe Ratios than the 1/N strategy, thus outperforming other MV optimization variants. They find that by ignoring mean returns and purely exploiting the information from correlations within the investment portfolio, the MIN strategy produces weights that are much more reasonable than the MV strategy. As superannuation investors are concerned about the long-term performance of their fund, they may be concerned about minimizing volatility. Thus, our investigation also explores the outcomes of portfolio optimization by minimising the portfolio's variance as follows:

$$\min_{\boldsymbol{w}} \boldsymbol{w}^T \sum \boldsymbol{w} \quad s.t. \quad \mathbf{1}_N^T \boldsymbol{w} = 1 \tag{2}$$

We also optimize our portfolios to minimize the 5% expected shortfall (ES – also known as Conditional Value-at-Risk). Expected shortfall can be thought of as a measure of extreme underperformance – an issue that superannuation investors might reasonably be concerned about (Basu and Drew, 2010). Although Value-at-Risk is a well-known risk measure due to its prevalence in the Basel II accord, it violates the sub-additivity property

[11] http://www.supersystemreview.gov.au/ – date accessed 18/11/2014.

and is not a coherent risk measure. Thus, academics have proposed the use of ES as a coherent risk measure (Uryasev, 2000), which is ideal for reporting and minimizing left tail risk in investment portfolios (Low et al., 2013). Intuitively, minimizing ES reflects the requirements of investors who are focused on minimizing extreme downside exposure on their investments, and are indifferent to upside variance. Furthermore, it generates an efficient frontier that incorporates non-normality in asset returns. Generating optimal portfolios to minimize ES is a linear programming exercise of the following equation, as given by Rockafellar and Uryasev (2000):

$$\min_{(\boldsymbol{w},\alpha)} F_{\alpha}\,(\boldsymbol{w},\beta) = \alpha + \frac{1}{(1-\beta)} \int_{y\in\mathbb{R}} [-\boldsymbol{w}^{\boldsymbol{T}}\boldsymbol{r} - \alpha]^{+}\, p(\boldsymbol{r}) d\boldsymbol{r} \tag{3}$$

where

$$\mu(\boldsymbol{w}) \leq -R \tag{3.1}$$

$$\mathbf{1}_N^T \boldsymbol{w} = 1 \tag{3.2}$$

α represents Value at Risk, β is the threshold value that we set to 95%,

$\boldsymbol{r}$ is the sample of portfolio returns.

The vector of portfolio weights, $\boldsymbol{w}$, is extracted from the optimization procedure to generate the portfolio that minimizes ES for a given portfolio return, R, that is set to the average return on the value-weighted market portfolio.

In all of our tests, we use funds' actual returns and variances. This is an improvement over Elton et al. (2007) and Moorman (2009), who use a number of strong, unrealistic assumptions (listed above) in their analysis. The assumptions used in those two papers may be appropriate for large portfolios, but are unlikely to apply to small portfolios of a few funds. First, an optimal portfolio is unlikely to have equal amounts invested in each fund. In our analysis, we find the actual weights that optimize the portfolios. Second, all funds do not have the same variance, and funds of the same type do not all have the same correlation (see Table 1). Finally, the return on portfolios of funds will not all be the same.

We form the portfolios within each of our SFSS, SFDS, DFSS and DFDS groups, to maintain consistency with the Elton et al. (2007) and Moorman (2009) methodology. We impose a no short-selling constraint because investors cannot short superannuation funds. We then count the number of portfolios for which the optimal outcome is obtained using a two-fund portfolio and the number of portfolios that are optimized with 100% invested in just one of the funds.[12]

5. Results

Descriptive statistics are reported in Table 1. Panel A displays descriptive statistics on the inputs used to apply Elton et al.'s (2007) and Moorman's (2009) method. We need to use the annualized mean values, but display other descriptive statistics for completeness. Panel B displays the descriptive statistics on correlations of pairs of funds in each of the four style and family classifications. As is to be expected, funds from the same family and of the same style have the highest correlations (a mean of 0.9029), and the lowest average correlations are between funds from different families and of different styles (mean of 0.8234). Diversifying across style only (SFDS) reduces the average correlation to 0.8439 and this correlation is lower than if the investor diversified across family only (DFSS). Whereas all the correlations

[12] In fact, we allow the cut-off to be above 99% for the portfolios that impose the short-selling constraint and between 99% and 101% for the portfolios that allow short selling. This is to capture situations where negligible weights are allocated to one fund. Results are qualitatively identical, but there are, of course, fewer combinations optimized with one fund if we impose a 100% constraint.

are high (>0.82), they are less than one, hence, in theory, there should be some benefit to diversification.

5.1 Results using Elton et al.'s (2007) and Moorman's (2009) method

Our analysis begins with using Elton et al.'s (2007) and Moorman's (2009) method, and results are in Table 2. We see that as the number of funds held increases, the variance decreases. The decrease in variance occurs irrespective of whether the additional funds held are from the same family (style) or different families (styles). These preliminary results are consistent with a benefit from diversifying across funds. However, the decreases in variance are simply a function of increasing portfolio size, as the analysis does not consider actual fund weights, returns or variances.

The figures presented in Panel A, columns (5) and (6) show the additional return required from adding a fund from the same family and of the same style versus a fund from a different family and different style. If the investor currently holds one (five) fund(s) then adds a large cap fund from the same family and same style, using the Elton et al. (2007) methodology, this fund would need to earn an extra 25bp (43bp) in order to provide the same Sharpe ratio that would be earned if a fund was added from a different family and of a different style. In other words, an investor would be better off holding more funds and adding funds of a different style and different family. As the number of starting funds increases, more basis points are required from the SFSS fund. Similar results are found using the Moorman (2009) method.[13]

Panel B shows the results of the analysis when diversifying across family. If an investor holds one (five) fund(s) and adds a large cap fund from the same family, only 7bp (11bp) are

[13] Mean correlations have been used in the analysis. We also repeated the analysis using median correlations. The results are qualitatively the same.

required from the additional fund (see column 5, Panel B) to earn the same Sharpe ratio as adding a fund from a different family.

The impact of style is shown in Panel C. In this case, if the investor holds one (five) fund(s) and adds a large cap fund of the same style, then 19bp (32bp) are required from the additional fund to obtain the same Sharpe ratio as if the added fund was of a different style.

These results are consistent with Elton et al. (2007) and Moorman (2009) and show that there are economically significant benefits from diversifying across funds. The analysis shows the most benefit is obtained by adding a fund from a different family and of a different style. However, there are also diversification benefits from adding a fund of the same family (style) if it has a different style (family), although this benefit is less than diversifying across both criteria at 7bp (19bp).

These results suggest that perhaps the Australian government should not be encouraging superannuation investors to consolidate their retirement savings into just one fund. It seems that there are benefits to diversifying across funds. We now turn to a more comprehensive analysis of this issue using actual fund returns and variance data.

5.2. Results using actual fund data

Having established that the results of Elton et al. (2007) and Moorman (2009) also apply in the Australian superannuation environment, we now relax their assumptions and investigate whether superannuation investors should diversify across funds using actual fund data.

We begin by mean-variance optimizing portfolios of two funds. The results presented in Table 3 show the summary of the analysis that combines all possible pairs of equity funds within each group: SFSS, SFDS, DFSS and DFDS. Panel A shows the analysis for the full sample period. For each pair of funds, we find the portfolio weights in each fund that maximize the Sharpe ratio and determine if the Sharpe ratio is maximized using one or two funds. We begin the analysis by not allowing for short selling because investors are not able to short-sell superannuation funds. This constraint reflects a “real-world” limitation that is imposed on investors’ portfolio construction options. Results show that the maximum Sharpe ratio is, in the majority of cases, achieved by holding just one fund. Indeed, in 82% or 83% of all possible combinations within every group, it is not possible to increase the Sharpe ratio by adding an additional fund. Interestingly, there is not a great amount of difference between the four family/style combinations of strategies in terms of how many portfolios are optimized by diversification.

These results suggest that, in fact, in the majority of cases, investors are *not* better off diversifying across funds, a result that is in stark contrast with those using Elton et al.’s (2007) and Moorman’s (2009) methodology.

We examine the Sharpe ratios’ confidence intervals to assess the statistical significance of our results. Where 95% of the distribution of the two-fund portfolio lies to the right of the distribution from the single underlying fund with the highest Sharpe ratio, we conclude that the Sharpe ratio is optimized by diversifying across two funds. Including the confidence intervals slightly reduces the number of instances in which it is optimal to diversify across two funds. Results (not displayed, available upon request) indicate that in 87% of all possible combinations within every group, it is not possible to increase the Sharpe ratio by adding an additional fund. We can therefore view our initial specification as an upper bound for the number of combinations for which it is preferable to diversify across two funds.

To assess economic significance, we examine differences in Sharpe ratios. Where the optimal portfolio was obtained by diversifying across two funds, we took the portfolio's Sharpe ratio and subtracted the Sharpe ratio of the best performing individual fund. The average increase in Sharpe ratio ranges from 0.001 for SFDS to 0.008 for DFDS. The average Sharpe ratio of our sample of funds is 0.2. On average, then, this increase would not appear to be economically meaningful.

As noted above, investors have not always been permitted to choose which superannuation funds they can invest in, so perhaps our initial analysis is not realistic, as it includes an extensive period in which investors did not have the option to choose. To this end, we repeat the analysis in just the post-Choice period – from July 2005 (Panel B). These results show that, in fact, there has been even less benefit to diversification since 2005. Correlations across all four classifications increase in the later part of the sample and, unsurprisingly, more pairs of funds are optimized with 100% allocation to one fund. This result suggests that a possible outcome of the Choice legislation has been an increase in homogeneity across funds. The increased competition to attract investors has not produced unique products.

Our results on mean-variance maximization are surprising in light of Elton et al. (2007) and Moorman (2009) and also traditional finance theory, which all suggest that investors would always be better off diversifying across two assets as long as they are less than perfectly positively correlated. We therefore investigate further to determine whether our results are due to the imposed short-selling restriction. We find that the short-selling constraint has serious implications for the discussion on whether to diversify or consolidate. When the restriction is lifted, results (in Panel C) show that the benefit of diversification becomes substantially clearer. Indeed, in this case, results show that 99% of combinations are optimized by diversifying across two funds. Consequently, investors *would* be better off diversifying across two funds if they were able to short sell one of the funds.[14] However, unfortunately this result is of little practical use as investors cannot short sell superannuation funds.

As discussed previously, it is also possible that our results are driven by the tendency of mean-variance optimization to produce extreme weights (DeMiguel et al., 2009). We therefore repeat the analysis, but instead of maximizing the Sharpe ratio, we now minimize the variance of combinations of funds. Results are presented in Table 4. In Panel A we see that approximately half of our pairs of funds have their variances minimized with a two-asset portfolio, rather than being in a single fund. While these results are not as extreme as those from mean-variance optimization, the fact that only one in two portfolios is optimized by diversifying is not overwhelming evidence in support of diversification. Panel B displays the analysis in the post-Choice era. In line with the MV optimization, our post-Choice results show less benefit to diversification. It is interesting to note that the most benefit from diversification is from combining funds from a different family and of the same style. Further, combinations of SFSS and DFDS provide similar levels of diversification benefit. These results again raise questions about lack of heterogeneity across funds and across fund families. Again, lifting the short-selling constraint substantially alters the conclusion in that

[14] These results are consistent with Chen et al (2009) who also find short selling impacts performance results in the context of fund of funds.

almost all pairs' variances are minimized by diversifying across two funds (results are in Panel C).

5.2.1 Robustness tests

We perform a number of tests to investigate the robustness of our results. First, we investigate tail risk. Using variance to measure risk does not take into account the fact that investors are concerned about downside risk (losses), rather than upside risk (gain). We therefore use the 5% expected shortfall to investigate whether diversification across two funds is preferable to holding just one fund. Results, in Table 5, are in between the mean variance and minimum variance results. We again see most fund combinations (66% to 70%) being optimized with just one fund: in the majority of cases, diversification does not seem to be the optimal strategy. Similar to the results from the other two strategies, this appears to be driven by the short- selling constraint. Without the short-selling restriction, the optimal portfolios are formed by diversifying across two funds.

In our initial specification we removed duplicate funds by examining pairs of funds with correlation of 0.9995 or higher and deleting the fund with the lower returns. We re-run our analysis increasing the cut-off from 0.9995 to 0.99. Results (not displayed) for the full sample period are similar to our initial specification, although we find slightly less support for only holding one fund.[15] For the specification where we maximise the Sharpe ratio, in 75% to 79% of all possible combinations, it is not possible to increase the Sharpe ratio by adding an additional fund (compared with 82% or 83% for the original specification). Similarly, the minimum variance results for the full sample period suggest that for between 39% and 54% of all possible combinations, it is not possible to increase the Sharpe ratio by

[15] All results in this section are available upon request from the corresponding author. We thank an anonymous referee for suggesting these robustness tests.

adding an additional fund (compared with a range of 46% to 51% for the original specification). In line with initial results, diversification appears to provide less benefit post-Choice and the results appear to be driven by the short-selling constraint.

Initially, when performing the mean-variance tests, we assumed gamma, the level of investors' risk-aversion, was one, following DeMiguel et al (2009). For robustness, we alter gamma to equal five, following Kirby and Ostdiek (2012), but results are almost identical.

6. Conclusion

The Australian government strongly encourages investors to consolidate retirement savings into just one fund. However, results from prior research suggest the optimal policy may be exactly the opposite: investors may be better off if they diversified their retirement savings across a number of funds (Elton et al., 2007; Moorman, 2009). In this paper we investigate whether investors should diversify or consolidate their retirement savings.

We begin by using a methodology similar to Elton et al. (2007) and Moorman (2009) and find that their results hold in the Australian context. Specifically, diversifying across funds improves portfolios' Sharpe ratios. While diversifying across both family and style is best, there are diversification benefits even if diversifying across only one of these dimensions.

In our main analysis, we relax the strong assumptions of Elton et al. (2007) and Moorman (2009) and use actual fund returns to calculate optimal Sharpe ratios for portfolios of funds. We find that in more than 80% of cases, investors would be better off holding one superannuation fund rather than two. This proportion is higher in the post-Choice era (after July 2005). We also perform the analysis by minimizing portfolios' variances and find similar, but less extreme, results. In this case it is optimal to diversify in about half the cases. While, on the surface, these results seem at odds with current research and traditional finance theory, further investigation suggests that results are driven by the fact that investors cannot short sell superannuation funds. It is this market friction that drives the disjoint between our findings against diversification and what we might expect theoretically.

Note that our analysis has not taken into account the cost of altering a portfolio, and these costs may not be insignificant. Investors may face costs in the form of switching fees, initial set-up fees, or financial advisor fees, and these may be particularly onerous should investors choose to invest outside the current family. These costs will further erode any increase in the Sharpe ratio due to diversification. Investors also face costs in terms of the time and effort required to research and identify a new fund (Sirri and Tufano, 1998; Huang et al., 2007).

For engaged, financially literate investors, a less than one-in-five (one-in-two) chance of the resulting portfolio having a higher Sharpe ratio (lower variance) may be sufficient incentive to justify the required research and cost involved in diversifying across funds. However, for the majority of superannuation investors this is unlikely to be the case.

We conclude, then, that in theory investors should diversify across funds as this will lead to optimal portfolios in terms of risk and return. However, investors do not face perfect, theoretical, frictionless markets and the fact that investors cannot short sell superannuation funds profoundly impacts the results. For the majority of investors, consolidation would seem to be the logical investment strategy, and the Australian government has made the correct policy decision in encouraging investors to consolidate their retirement savings. However, one possible consequence of this action has been less innovation within the superannuation industry and less competition across fund families.

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Appendix. Calculating the extra return required to maintain the Sharpe ratio

A.1. Elton et al.'s (2007) method

In this approach, the investor starts with an equally-weighted portfolio of funds of the same family (style) whose return is *R* and then adds one fund to the portfolio. This additional fund can either be from the same family (style) or a different family (style). If the added fund is from a different family (style), this will not affect the return on the portfolio. However, if the added fund is of the same family (style), it is assumed to have a potentially different return.

The following equations are used to calculate the extra return required to maintain the Sharpe ratio ($(R - R_f)/\sigma$):

$$\frac{\frac{NR+x}{N} - R_f}{N\sigma_s} = \frac{\frac{NR}{N} - R_f}{N\sigma_D} \qquad \text{(A1)}$$

solving for *x*:

$$x = (R - R_f)\left(\frac{N\sigma_s - N\sigma_D}{N\sigma_D}\right)N \qquad \text{(A2)}$$

where:

R is the average return on funds in the initial portfolio comprising *N*-1 funds. This is also the return on the added fund if it comes from a different family and/or different style,

R_f is the risk-free rate,

x is the extra return required,

$N\sigma_D$ is the standard deviation of the portfolio that adds a fund from a different family (style) to form a portfolio of *N* superannuation funds,

$N\sigma_S$ is the standard deviation of the portfolio that adds a fund from the same family (style) to form a portfolio of *N* superannuation funds.

The additional return required, x, is the difference between the two fund returns, which will equate the Sharpe ratios of the new portfolios.

A.2. Moorman's (2009) method

The initially held funds are again assumed to be from the same family (style). Moorman (2009), however, assumes that all funds from the same family (style) will earn the same returns. Therefore, if the added fund is from the same family, the return on the new portfolio is equal to the return on the initial portfolio. However, if the added fund is from a different family (style) it has a different return. The additional return, x, is also defined slightly differently. This time, all funds in the portfolio comprising funds of the same family (style) need to earn an extra return, x, to equal the Sharpe ratio of the portfolio with an added fund from a different family. The relationship is defined as:

$$R_S = R_D + x = R + x \tag{A3}$$

where:

R is the return on the initial portfolio,

R_D is the return earned on the added fund if it comes from a different family (style),

R_S is the return earned on the added fund if it comes from the same family and/or same style,

x is the extra return required from all of the funds that are from the same family and/or of the same style to maintain the same Sharpe ratio as adding a fund from a different family and/or of a different style.

Again, the Sharpe ratio is rearranged to calculate the extra return x:

$$\frac{\frac{N(R+x)}{N}-R_f}{N\sigma_s}=\frac{\frac{(N-1)(R+x)+R}{N}-R_f}{N\sigma_D} \tag{A4}$$

The extra return is:

$$x=\frac{(R-R_f)\left(\frac{N\sigma_S-N\sigma_D}{N\sigma_D}\right)}{\frac{N\sigma_D-N\sigma_S}{N\sigma_S}+\frac{1}{N}} \tag{A5}$$

Table 1.

Descriptive statistics

This table shows the average value of the variables used in the analysis and the descriptive statistics on our four classifications of funds by family and style. There are 604 funds and the sample period is January 1992 to December 2012.

Panel A. Descriptive statistics on parameters used

Parameters	Proxy	Mean	Median	Max	Min	Std dev
Risk-free rate (Annual)	CRIF risk-free rate	5.33%	5.10%	8.33%	2.63%	1.12%
Large cap return (Annual)	S&P/ASX 100 total return index	11.14%	13.76%	43.50%	-37.21%	17.84%
Small cap return (Annual)	S&P/ASX Small Ords total return index	10.92%	14.60%	45.36	-38.92%	18.41%
Return std dev (Annual)	Sample funds standard deviation	13.21%	12.45%	64.46	-53.17%	26.49%

Panel B. Correlations of pairs of funds

Pairs of funds	Mean	Median	Max	Min	Std dev
Same family same style (SFSS)	0.9029	0.9205	0.9983	0.1454	0.0820
Same family different style (SFDS)	0.8439	0.8711	0.9949	0.0840	0.1110
Different family same style (DFSS)	0.8828	0.9039	0.9990	0.0121	0.0896
Different family different style (DFDS)	0.8234	0.8579	0.9977	-0.3121	0.1322

Table 2.

Additional return required to maintain the same Sharpe ratio when adding a fund to a portfolio of funds

Panel A. The impact of changing both family and style

The first column shows the number of funds that the investor starts with. Portfolios of two or more funds are equally weighted. Column 2 is the average standard deviation of the portfolio if one fund of the same family and same style is added to the original portfolio of funds. Column 3 is the average standard deviation if a fund from a different family and different style is added to the portfolio. Columns 5 and 6 show the extra annual return required from adding a fund, *from the same family*, *same style* in order to achieve the same Sharpe ratio as when adding a large cap or small cap fund from a *different family and different style*. Columns 7 and 8 show the extra annual return required if it is calculated from all funds in the portfolio rather than just the added fund.

				Extra annual return required from			
				The fund added to the portfolio (Elton method)		**All funds in the portfolio (Moorman method)**	
(1) Funds currently held	(2) Std dev of funds of the same family, same style	(3) Std dev of funds of a different family, different style	(4) = (2-3) Difference	(5) Large cap	(6) Small cap	(7) Large cap	(8) Small cap
1	13.14	12.86	0.28	0.25	0.24	0.26	0.25
2	13.03	12.78	0.25	0.34	0.33	0.35	0.34
3	12.97	12.76	0.21	0.38	0.37	0.40	0.39
4	12.94	12.76	0.18	0.41	0.39	0.43	0.42
5	12.91	12.76	0.16	0.43	0.41	0.45	0.44

Panel B. The impact of changing family

The first column shows the number of funds that the investor starts with. Column 2 is the average standard deviation if one fund from the same family is added to the original portfolio of funds. Column 3 is the average standard deviation if the added fund is of a different family. Columns 5 and 6 show the extra annual return required from adding the fund *from the same family* in order to achieve the same Sharpe ratio as when adding the fund from a *different family*. Columns 7 and 8 show the extra annual return required if it is calculated from all funds in the portfolio rather than just the added fund.

				Extra annual return required from			
				The fund added to the portfolio (Elton method)		**All funds in the portfolio (Moorman method)**	
(1) Funds currently held	(2) Std dev of funds of the same family	(3) Std dev of funds of different families	(4) Difference	(5) Large cap	(6) Small cap	(7) Large cap	(8) Small cap
1	12.68	12.61	0.07	0.07	0.06	0.07	0.06
2	12.50	12.44	0.06	0.09	0.09	0.09	0.09
3	12.41	12.36	0.05	0.10	0.10	0.10	0.10
4	12.36	12.31	0.05	0.11	0.11	0.11	0.11
5	12.32	12.28	0.04	0.11	0.11	0.12	0.11

Panel C. The impact of changing style

The first column shows the number of funds that the investor starts with. Column 2 is the average standard deviation of the funds if one fund of the same style is added to the portfolio of funds. Column 3 is the average standard deviation if the added fund is of a different style. Columns 5 and 6 show the extra annual return required from adding the fund of the *same style* in order to achieve the same Sharpe ratio as when adding the fund of a *different style*. Columns 7 and 8 show the extra annual return required if it is calculated from all funds in the portfolio rather than just the added fund.

				Extra annual return required from			
				The fund added to the portfolio (Elton method)		**All funds in the portfolio (Moorman method)**	
(1) Funds currently held	(2) Std dev of funds of the same style	(3) Std dev of funds of different style	(4) Difference	(5) Large cap	(6) Small cap	(7) Large cap	(8) Small cap
1	12.82	12.61	0.20	0.19	0.18	0.19	0.18
2	12.68	12.50	0.18	0.26	0.25	0.26	0.25
3	12.62	12.46	0.15	0.29	0.28	0.30	0.29
4	12.58	12.44	0.13	0.31	0.30	0.32	0.31
5	12.55	12.43	0.12	0.32	0.31	0.34	0.33

Table 3.

Mean-variance maximization

This table shows the results from mean-variance maximization. For each pair of funds the two-fund combination that gives the maximum Sharpe ratio is calculated. The number and percentage of combinations where the maximum Sharpe ratio is achieved investing 100% in just one fund is shown. Sample size is 604 and only funds where the correlation is less than 0.999 are included. Pairs of funds are classified as: same family and same style (SFSS – column 2), same family but different style (SFDS – column 3), different family, same style (DFSS – column 4) and different family, different style (DFDS – column 5). Panel A shows results for the full sample period. Panel B shows results for the post-Choice period only. In Panels A and B no short selling is allowed. Panel C repeats the analysis for the full period allowing short selling.

	Panel A. Full sample period 1992–2012				**Panel B: Post-Choice, July 2005 to Dec 2012**			
(1)	(2) SFSS	(3) SFDS	(4) DFSS	(5) DFDS	(6) SFSS	(7) SFDS	(8) DFSS	(9) DFDS
Average correlation	0.9029	0.8439	0.8828	0.8234	0.9156	0.8640	0.8947	0.8435
Combinations where investing in one fund maximizes the Sharpe ratio (percentage)	3938 (83%)	8388 (82%)	32253 (82%)	69292 (82%)	3422 (91%)	6678 (89%)	29853 (89%)	61158 (87%)
Total number of combinations	4762	10252	39367	84920	3758	7517	33499	70139

Panel C. Full sample period, allowing short selling

	SFSS	SFDS	DFSS	DFDS
Average correlation	0.9029	0.8439	0.8828	0.8234
Combinations where investing in one fund maximizes the Sharpe ratio	47 (1%)	67 (1%)	295 (1%)	624 (1%)
Total number of combinations	4762	10252	39367	84920

Table 4.

Minimum variance

This table shows the results from variance minimization. The number and percentage of combinations where the minimum variance is achieved investing 100% in just one fund is shown. Sample size is 604 and only funds where the correlation is less than 0.999 are included. Pairs of funds are classified as: same family and same style (SFSS – column 2), same family but different style (SFDS – column 3), different family, same style (DFSS – column 4) and different family, different style (DFDS – column 5). Panel A shows results for the full sample period. Panel B shows results for the post-Choice period only. In Panels A and B no short selling is allowed. Panel C repeats the analysis for the full period allowing short selling.

	Panel A. Full sample period 1992–2012				Panel B: Post-Choice, July 2005 to Dec 2012			
(1)	(2) SFSS	(3) SFDS	(4) DFSS	(5) DFDS	(6) SFSS	(7) SFDS	(8) DFSS	(9) DFDS
Average correlation	0.9029	0.8439	0.8828	0.8234	0.9156	0.8640	0.8947	0.8435
Combinations where investing in one fund maximizes the Sharpe ratio (percentage)	2417 (51%)	5719 (56%)	18184 (46%)	43222 (51%)	2199 (59%)	4729 (63%)	18160 (54%)	40203 (57%)
Total number of combinations	4762	10252	39367	84920	3758	7517	33499	70139

Panel C. Full sample period, allowing short selling

	SFSS	SFDS	DFSS	DFDS
Average correlation	0.9029	0.8439	0.8828	0.8234
Combinations where investing in one fund maximizes the Sharpe ratio	94 (2%)	177 (2%)	860 (2%)	1766 (2%)
Total number of combinations	4762	10252	39367	84920

Table 5.

Expected shortfall

This table shows the results from minimizing the 5% expected shortfall. The number and percentage of combinations where the minimum variance is achieved investing 100% in just one fund is shown. Sample size is 604 and only funds where the correlation is less than 0.999 are included. Pairs of funds are classified as: same family and same style (SFSS – column 2), same family but different style (SFDS – column 3), different family, same style (DFSS – column 4) and different family, different style (DFDS – column 5). Panel A shows results for the full sample period. Panel B shows results for the post-Choice period only. In Panels A and B no short selling is allowed. Panel C repeats the analysis for the full period allowing short selling.

	Panel A. Full sample period 1992–2012				**Panel B: Post-Choice, July 2005 to Dec 2012**			
(1)	(2) SFSS	(3) SFDS	(4) DFSS	(5) DFDS	(6) SFSS	(7) SFDS	(8) DFSS	(9) DFDS
Average correlation	0.9029	0.8439	0.8828	0.8234	0.9156	0.8640	0.8947	0.8435
Combinations where investing in one fund maximizes the Sharpe ratio (percentage)	3253 (68%)	7210 (70%)	26021 (66%)	56640 (67%)	2521 (67%)	5486 (73%)	21744 (65%)	48299 (69%)
Total number of combinations	4762	10252	39367	84920	3758	7517	33499	70139

Panel C. Full sample period, allowing short selling

	SFSS	SFDS	DFSS	DFDS
Average correlation	0.9029	0.8439	0.8828	0.8234
Combinations where investing in one fund maximizes the Sharpe ratio	79 (2%)	77 (1%)	518 (1%)	1058 (1%)
Total number of combinations	4762	10252	39367	84920