WHAT AUSTRALIAN INVESTORS NEED TO KNOW *to diversify their portfolios*

VITALI ALEXEEV, Lecturer, School of Economics and Finance, University of Tasmania
FRANCIS TAPON, Professor, Department of Economics and Finance, University of Guelph, and Partner, Investment Portfolio Design Ltd (InPoDe), Guelph, Ontario, Canada

An ASIC survey in 2008 showed that Australian investors do not diversify their portfolios sufficiently, with the average investor holding only 2.19 securities. To study this issue, we simulate portfolios using daily observations for all traded and delisted equities in Australia between 1975 and 2011. We calculate two measures of risk, including heavy tailed distributions to account for extreme events. For each risk measure, we recommend the number of portfolio holdings that result in a 90 per cent reduction in diversifiable risk for an average and a more conservative investor. We find that, on average, 24 to 30 stocks are sufficient to attain a well-diversified portfolio.

In the past 20 years many Australians have become share owners via privatisation of government organisations such as Qantas, CBA and Telstra and the demutualisation of companies such as AMP. Many have received shares through an inheritance or gift, and the growth of self managed super funds has also increased the number of household equity investors. However, a number of surveys (e.g. ASIC 2008), show that Australian investors do not diversify their portfolios sufficiently.

According to a report by the Australian Securities and Investments Commission in 2008, most (78 per cent) of Australian investors had heard the term diversification. Nevertheless, around half of investors (49 per cent) held only one type of investment (shares only) with the average number of holdings of 2.19 securities. What is even more telling is that a third (33 per cent) of share owners acquired their shares passively (as part of a demutualisation or had received shares through an inheritance or gift), while almost two-thirds (63 per cent) of share owners acquired the shares actively. One conclusion is that Australian investors, on average, own poorly diversified portfolios and leave themselves exposed to excessive diversifiable risk.

In this paper, we study the issue of optimal portfolio diversification for Australian investors using data between 1975 and 2011. Investors are faced with a dilemma: how many stocks should be included in a portfolio to reduce diversifiable risk to an optimal level. To provide an answer to this question we calculate two measures of risk using daily data including one that reflects extreme events. Previous academic research (Solnik (1974), Bird and Tippett (1986), Statman (1987), and Brands and Gallagher (2005)) has analysed the optimal portfolio sizes for an average investor.

We build on our predecessors' contributions in three ways. First, we derive the average number of stocks required in a portfolio to reduce risk to a level where 90 per cent of the difference between the risk of an individual average stock and the risk of the market portfolio has been removed. For example, if the risk of an average stock is 40 per cent p.a. and the risk of the market portfolio is 20 per cent p.a., we find the number of stocks required such that the portfolio risk is 22 per cent. Second, we estimate upper confidence bands above the calculated average number of stocks, enabling us to show the (higher) number of stocks required to be 90 per cent confident that the risk target will not be exceeded. Third, we compare the year-by-year dynamic of required portfolio sizes.

Investors are often reminded that holding a number of uncorrelated securities in their portfolios is important for diversification. Of course, holding too many stocks is costly both in terms of transaction costs as well as the opportunity cost of monitoring a large diversified portfolio. Holding too few stocks exposes investors to unnecessary firm-specific risk. If it is possible to eliminate most diversifiable risk with a small portfolio, the need for the large portfolios held by equity funds is unjustified. Campbell et al. (2001), however, have shown that firm-specific risk in the US has grown over the past 30 years relative to the overall volatility of the stock market and that correlations between stocks have correspondingly decreased, reinforcing the advisability of larger portfolios. In contrast, when correlations between

stocks are very high, as during periods of market distress, selecting only a few stocks will align portfolio returns with those of the market, providing adequate diversification benefits under these conditions. We check whether these results also hold for Australia.

To trace the dynamics of diversification benefits over the past 37 years we simulate random portfolios based on actual daily Australian equity returns over the period 1975 to 2011. At the start of each year we construct equally weighted random portfolios of different sizes ranging from portfolios consisting of only one security to a broad market portfolio including all actively traded securities at the time. We do this 10,000 times for each year and calculate the resulting returns over the year, such that for each of these different-sized portfolios and each year we are able to calculate hypothetical standard deviation (*SD*) and expected shortfall (*ES*) measures for that year. We focus on *SD* as our benchmark to be able to compare our results to the previous literature. The *ES* provides a downside risk measure that captures the extreme tail in the historical return distribution. It is calculated as the expected return (loss) in the set of outcomes where the return was in the worst one per cent of outcomes, and denoted by $ES_{1\%}$.

We measure diversifiable risk as the difference between the risk of an average security and market risk' this represents 100 per cent of diversifiable risk. As portfolios grow in size from one stock to *n* stocks, total risk is reduced but market risk remains. A 'well-diversified' portfolio is one where anywhere from 85 per cent to 95 per cent of diversifiable risk has been removed. In what follows, we use 90 per cent reduction in diversifiable risk as indicating a 'well-diversified portfolio'.

We find that well-diversified portfolios aimed at limiting extreme losses measured by $ES_{1\%}$ are, on average, smaller in size (18 stocks), compared to when *SD* is used as a risk measure (24 stocks). We hypothesise that this is the consequence of the increased correlations between securities and the market in the lower tail of the return distributions. However, to achieve a well-diversified portfolio with 90 per cent confidence of achieving the target risk reduction, we find no difference in portfolio sizes between the two risk measures (38 stocks). We conclude that the size of a well-diversified portfolio for Australian investors depends on the measure of risk used, the changing correlations between stock returns across time and market volatility.

Data and methodology

Daily total returns (inclusive of dividends) on common stocks listed on the Australian Securities Exchange (ASX) from 1975 to 2011 are obtained from Datastream. To avoid survivorship bias we acquire the data for both active and subsequently delisted securities. For each of these years, we consider only securities which have traded at least 75 per cent of the trading days in a particular year. This is done to avoid unreasonably low correlations of some thinly traded stocks with the rest of portfolio holdings.

We construct portfolios by randomly drawing stocks without replacement from all available stocks on the ASX each year. We use equal weights to construct portfolios. Given that our sample includes non-surviving stocks, a stock in the chosen portfolio that does not survive during the year is replaced for the remainder of the year with a new randomly selected stock not already in the portfolio — using the proceeds from selling delisted stocks at the price prevailing on the day prior to delisting. For each portfolio of size *n* we use 10,000 random draws. A unique equally weighted portfolio is constructed when all securities available in the market are included. We define it as the market portfolio.

We consider two risk measures. The first is standard deviation (*SD*), a well-accepted measurement of risk of a financial asset or portfolio. Another important risk measure is downside (or tail) risk. It accounts for deviations below a certain threshold, unlike *SD*, where positive and negative deviations from the expected level are penalised equally. One advantage of a downside risk measure is that it accounts, to some extent, for the asymmetries in returns during bull and bear markets. For this purpose, we use expected shortfall (*ES*) due to its well-behaved properties as opposed to the commonly used Value-at-Risk (*VaR*).

Results

Figure 1 displays the dynamic of diversifiable risk remaining for portfolios of various sizes between 1975 and 2011. Using *SD* as a measure of risk, a five-stock portfolio yields, on average, a 60 per cent to 70 per cent reduction in diversifiable risk and is thus not a well-diversified portfolio. On the other hand, a 40-stock portfolio exposes an investor to 2 per cent to 7 per cent of diversifiable risk. Looking at the year 1987 when a major crash occurred, an investor with a 10-stock portfolio was exposed to 18 per cent of diversifiable risk using *SD* as a risk measure, but the same 10-stock portfolio exposed this investor to 14 per cent of diversifiable risk using *ES*. Consequently, fewer stocks would be required for investors concerned with *ES* to achieve the same 18 per cent exposure to diversifiable risk.

In Figure 2 we trace the recommended portfolio sizes for the two risk measures to achieve a well-diversified portfolio on average (solid lines). The dotted lines show the recommended portfolio sizes for more conservative investors who require a higher level of assurance (that risk will not exceed the target level 90 per cent of the time instead of on average).

We conclude that in periods of anticipated high market volatility characterised by large correlations among stocks, conservative investors will need to add a relatively large number of securities to their portfolios compared to periods when markets are fairly stable and average correlations are low.

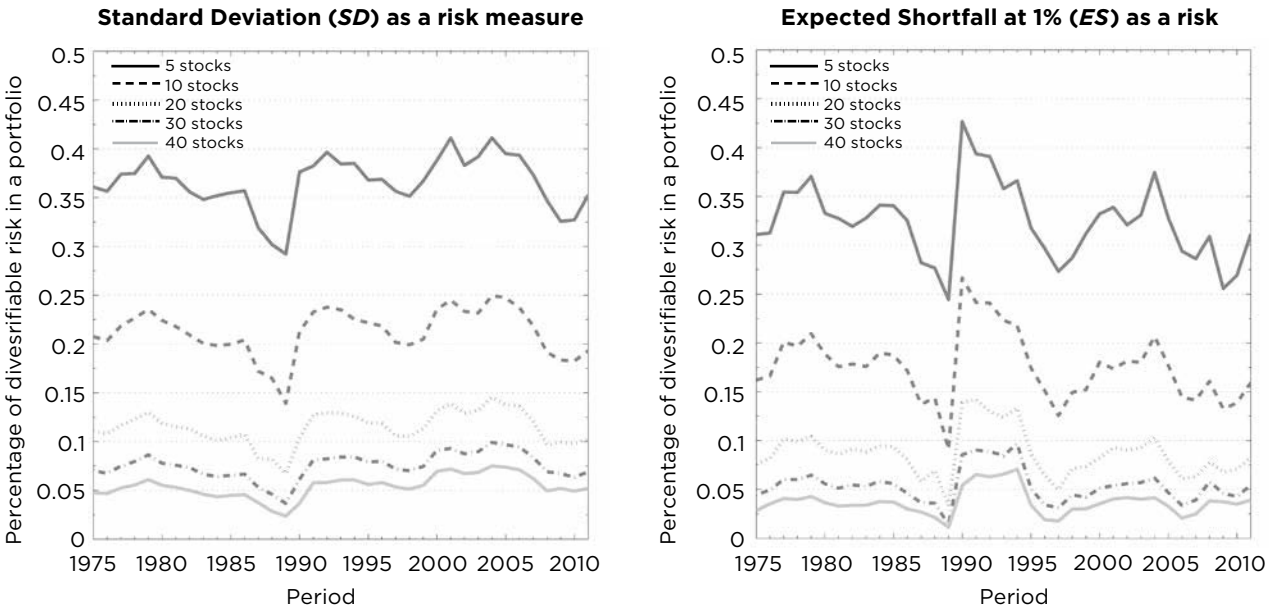
In Table 1 and Figure 2, we observe that between 2000 and 2006 the average investor needed to hold a higher number of stocks (*SD*: 27 to 30 stocks) compared to the periods 1987 to 1989 (*SD*: 14 to 18 stocks) and 2008 to 2010 (*SD*: 20 stocks). A similar trend is observed for more conservative investors. This is a consequence of higher average correlations among stocks in years 1987–89 (0.19) and 2008–10 (0.15) compared with years 2000–06 (0.05) in Figure 3.C.

The periods 1975–76 (oil crisis), 1987 (Black Monday), the bursting of the dot-com bubble following 2000, and the global financial crisis in 2008 were marked by a wide gap between average security *SD* and market *SD* (Figures 3.A and D). We note that correlations among stocks increase during market-wide crises (Figures 3.C and D) resulting in the lowest number of stocks required (Figure 3.D). Since we cannot predict crises ex ante, we propose a conservative approach by selecting a higher number of stocks from all past years (both crises and normal periods).

Average correlations among stocks in Australia have remained remarkably stable and low except in 1987, 1997–98 and rising post-2007, with the average correlation between 1975 and 2011 of 0.07 (Table 2 Panel B). As we mentioned previously, Campbell et al. (2001) find a different trend in average correlations for US equities. Average correlations among the US stocks prior to 1999 were declining, however, this trend reversed after 1999. We note that the higher the correlation among stocks, the lower the number of stocks needed for a well-diversified portfolio (Table 2 Panels A and B). When larger portfolios are needed (based on *SD*) we notice that the associated market volatility and correlations are lower than when required portfolios are smaller (Table 2 Panel C). For example, portfolios of fewer than 21 stocks are needed in periods with an average correlation of 0.34 and an increased market volatility of 16.7 per cent. In contrast, larger portfolios of 25 stocks or more are needed in periods with an average correlation of 0.21 and a market volatility of 8.1 per cent. Since during crises fewer stocks are needed to achieve most diversification benefits, optimistic investors not expecting a crisis in the forseable future, should form a portfolio with a larger number of stocks. Conservative investors, preparing for the worst can get most diversification benefits with fewer stocks. If these investors base the size of their portfolios on past recommendations during normal periods, they will find that their portfolios are overdiversified.

In Table 2 Panel D we show the spread between the number of stocks required in a well-diversified portfolio for conservative investors (using *SD*) and for the average investor (defined as Δn)[5]. Large spreads ($\Delta n > 19$ are associated with increased market volatility (16.9 per cent) and increased correlations (0.33). Spreads of fewer than 11 stocks

FIGURE 1: Diversifiable risk remaining for portfolios of various sizes. The panels below show the dynamic of diversifiable risk remaining for portfolios of various sizes.



($\Delta n < 11$) are associated with market volatility of 7.5 per cent and an average correlation of 0.21. We conclude that in periods of anticipated high market volatility characterised by large correlations among stocks, conservative investors will need to add a relatively large number of securities to their portfolios compared to periods when markets are fairly stable and average correlations are low.

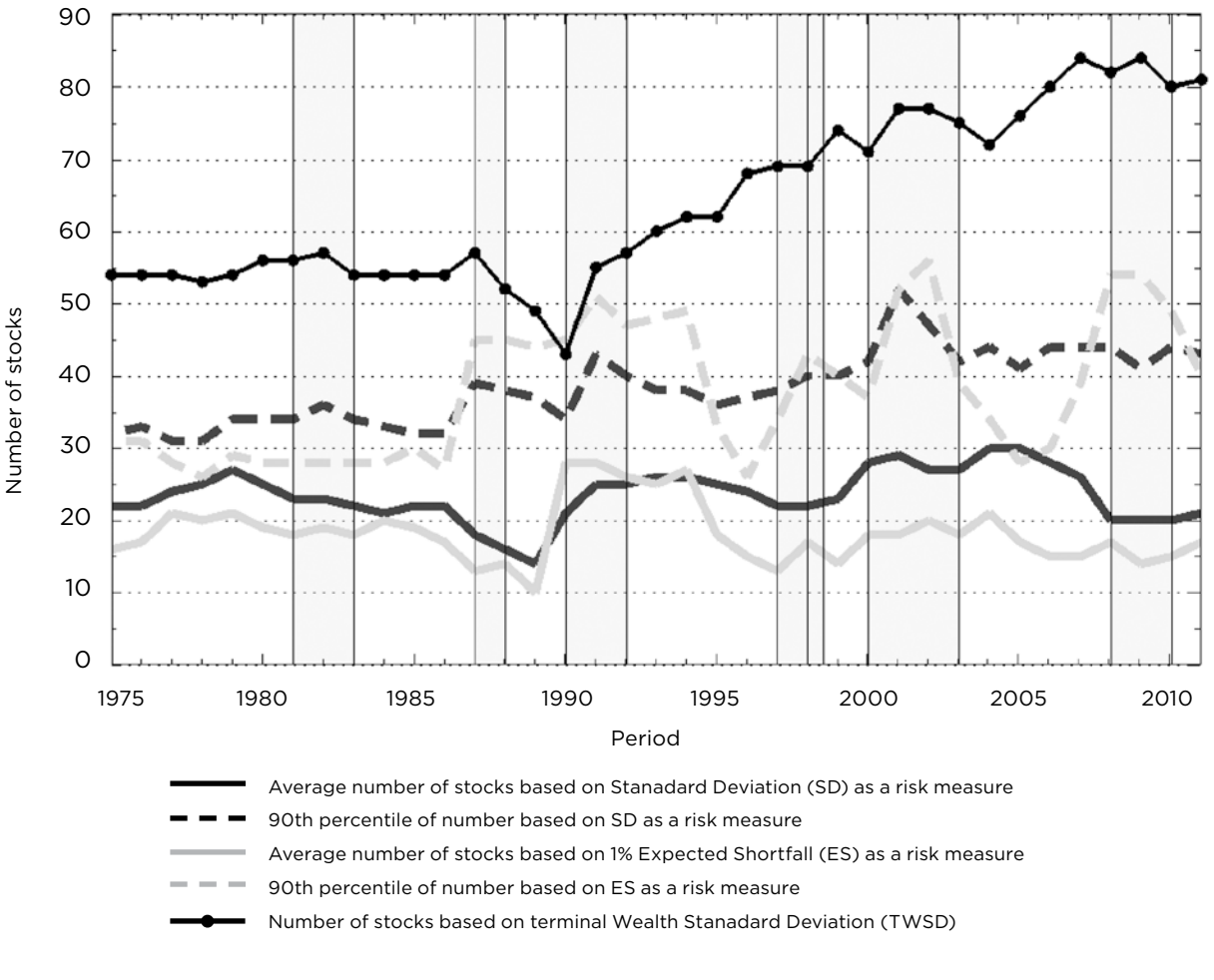
Conclusion

The period 1975 to 2011 witnessed some significant events in Australian financial market history. We show that portfolio size required for adequate diversification is determined by the particular risk measure used and by market conditions influencing correlations among stocks.

On average, to remove 90 per cent of idiosyncratic risk, portfolios of around 24 stocks are needed. In the case of market crashes, we note increased market risk coupled with greatly increased average correlations among securities and with the market portfolio. During market crashes, the number of stocks required for an average investor to attain a well-diversified portfolio decreases (18 to 22 stocks when risk is measured by *SD* and 13 to 17 stocks when risk is measured by $ES_{1\%}$). Increased correlations among stocks coupled with increased market volatility and lower levels of idiosyncratic risk during market crashes make portfolio diversification easier to achieve with a small number of stocks. In the case of industry specific meltdowns, the market experiences high volatility. The average correlation among securities and with the market portfolio, however, is among the lowest and thus, more stocks are needed to get the desired level of diversification.

One interpretation of our findings is that the recommended number of stocks in a buy-and-hold portfolio to attain most diversification benefits, should not be based on results in periods when markets are in distress. Rather, Australian long-term investors should instead conservatively rely on historical results obtained during normal financial market periods opting for larger portfolios.

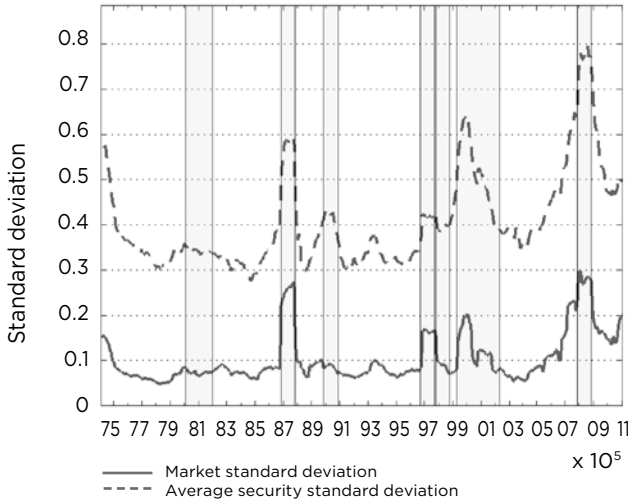
FIGURE 2: Recommended portfolio size to achieve a well-diversified portfolio. The solid dark line represents the number of stocks recommended for an average investor to achieve 90% reduction in diversifiable risk when *SD* is used as a risk measure. For conservative investors portfolio size is depicted by the dashed dark line. Similarly, light solid and dashed lines depict recommendations for investors concerned with $ES_{1\%}$ as the risk measure. Shaded regions represent periods of crises and correspond to events of the 1973 oil crisis (1973–74), the 1979 oil crisis (1979–82), Black Monday (1987), the collapse of Long Term Capital Management (LTCM) in 1998, the dot-com bubble (2000–02) and the global financial crisis (2008).



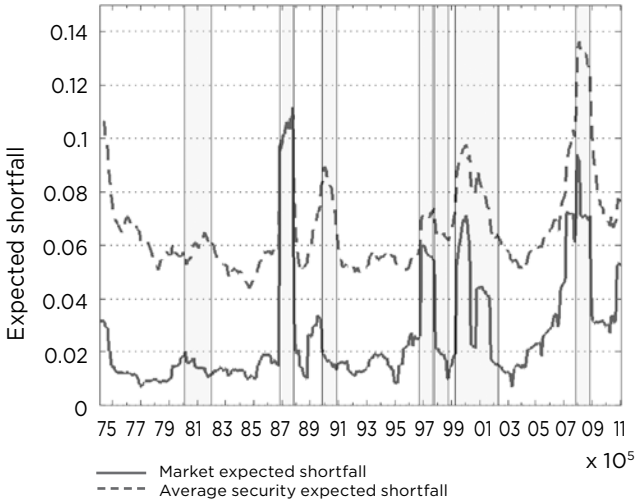
We recommend, for an average investor, concerned with *SD* or (*ES*) as a measure of risk to hold 24 to 30 (15 to 21) stocks. These size recommendations are among the largest portfolio sizes over the period of our study, providing investors with a more conservative diversification strategy over longer investment horizons. We realise that these recommendations greatly exceed the average actual share holdings of ordinary Australians (two to three stocks). However, holding as few as five securities in a portfolio over 1997 to 2011 would have exposed investors to a considerable amount of diversifiable risk. This problem could be partly alleviated by holding market-wide ETFs which are becoming more popular with Australian investors. ■

FIGURE 3: Australian equity market statistics. In Panel A the solid line shows the annualised standard deviation of daily market returns based on the past 12 months' returns. The dashed line represents the average security standard deviation. Similarly, statistics in Panel B are based on $ES_{1\%}$. Panel C shows the average security correlation with the market portfolio (solid line) and the average correlation among securities (dashed line). Shaded regions are defined in Figure 1. Panel D compares the average idiosyncratic risk with the average correlation among stocks. We also include the rescaled recommended portfolio size, *N*/100, for an average investor concerned with *SD* as a measure of risk.

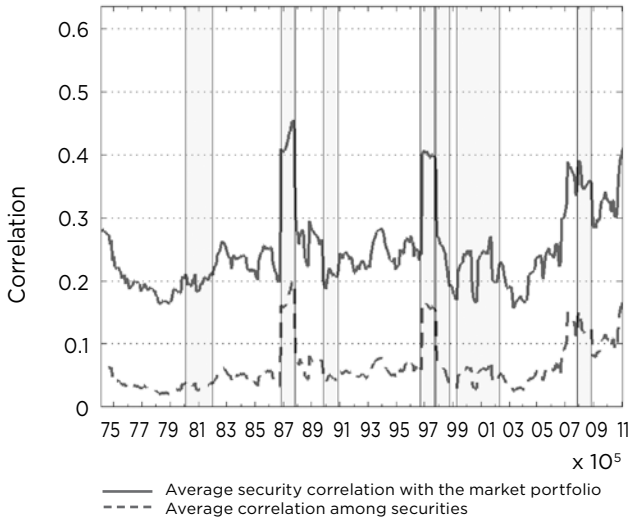
(A) Australia: Annualised standard deviations (*SD*) for the market portfolio and average security



(B) Australia: 1% expected shortfall (*ES*) for the market portfolio and average security



(C) Australia: Average correlation among securities and with the market portfolio



(D) Factors affecting sizes of well-diversified portfolios

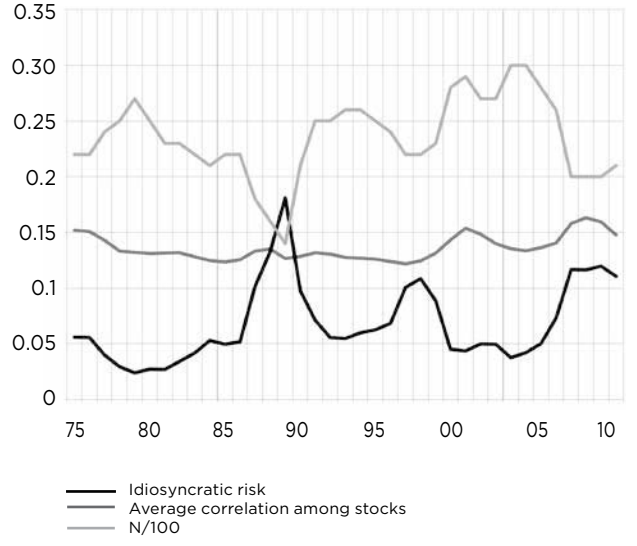


TABLE 1: Recommended portfolio size to attain a well diversified portfolio on average (and 90% of the time)

Year	*SD*	*ES*	Year	*SD*	*ES*
1975	22 (32)	16 (31)	1994	26 (38)	27 (49)
1976	22 (33)	17 (31)	1995	25 (36)	18 (33)
1977	24 (31)	21 (28)	1996	24 (37)	15 (26)
1978	25 (31)	20 (26)	1997	22 (38)	13 (34)
1979	27 (34)	21 (29)	1998	22 (40)	17 (43)
1980	25 (34)	19 (28)	1999	23 (40)	14 (40)
1981	23 (34)	18 (28)	2000	28 (42)	18 (37)
1982	23 (36)	19 (28)	2001	29 (52)	18 (52)
1983	22 (34)	18 (28)	2002	27 (47)	20 (56)
1984	21 (33)	20 (28)	2003	27 (42)	18 (39)
1985	22 (32)	19 (30)	2004	30 (44)	21 (34)
1986	22 (32)	17 (27)	2005	30 (41)	17 (28)
1987	18 (39)	13 (45)	2006	28 (44)	15 (30)
1988	16 (38)	14 (45)	2007	26 (44)	15 (39)
1989	14 (37)	10 (44)	2008	20 (44)	17 (54)
1990	21 (34)	28 (45)	2009	20 (41)	14 (54)
1991	25 (43)	28 (51)	2010	20 (44)	15 (49)
1992	25 (40)	26 (47)	2011	21 (43)	17 (40)
1993	26 (38)	25 (48)	Average	24 (38)	18 (38)

TABLE 2: Portfolio size results. Panel A provides the number of stocks required for a well-diversified portfolio for an average and a conservative investor. Panel B details average correlations among individual stocks ($\bar{\rho}_{ij}$), average correlations of stocks with the market ($\bar{\rho}_{im}$), average security SD ($\bar{\sigma}_i$) and market volatility (σ_m). Panel C relates recommended number of stocks with market characteristics. We identify years with the largest and lowest recommended portfolio sizes (top and bottom 3rd of the sample) and estimate $\bar{\rho}_{im}$ and σ_m for these years only. Panel D is constructed similarly to Panel C but relies on the difference between the number of stocks required to assure conservative investors of the desired level of diversification 90% of the time and the portfolio sizes of average investors. This is the difference between the dashed and solid lines in Figure 2.

Panel A: Number of stocks in a well-diversified portfolio, 1975–2011		
	on average	90% of the time
Based on SD	24	38
Based on $ES_{1\%}$	18	38

Panel B: Stock market statistics	
$\bar{\rho}_{ij}$	0.07
$\bar{\rho}_{im}$	0.26
$\bar{\sigma}_i$	39.9%
σ_m	10.4%

Panel C: Small vs Large portfolios and associated market characteristics		
Recommended *n* based on SD	Small (n < 21)	Large (n > 25)
$\bar{\rho}_{im}$	0.34	0.21
$\bar{\sigma}_m$	16.7%	8.1%

Panel D: Difference (Δn) b/w average and 90th percentile recommended number of holdings		
Recommended based on *SD*	Small (Δn < 11)	Large (Δn > 19)
Δn based on *SD*	0.21	0.33
$\bar{\rho}_{im}$	7.5%	16.9%
σ_m	7.5%	16.9%

Notes

1. Hereafter, referred to as portfolio size.
2. Our aim is not to exceed a target risk level 90 per cent of the time rather than achieving a set risk target. Randomly constructed portfolios with lowest estimated risk levels are beneficial to investors. Thus, we consider only the 90th percentile of risk measures of 10,000 randomly constructed portfolios for any given fixed number of stocks, *n*. This is in contrast with an average of risk measures of the same 10,000 random constructed portfolios for an average investor.
3. In Alexeev and Tapon (2012), four additional developed equity markets are discussed at length.
4. The number of actively traded stocks on the ASX has steadily increased from 1975 (145 stocks) to 2011 (1,562 stocks).
5. Refer to the difference between the dashed and solid lines in Figure 2.

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