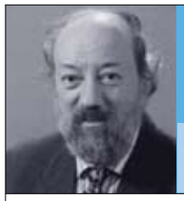


Bill Ziemba

The European, Icelandic, and US Investment Situations and Investment in Own-Company Stock

What all the squealing from the PIIGS sty means

The world financial situation, as I write this column in early March 2010, is focused on several regions. One of the main concerns is the PIIGS (Portugal, Italy, Ireland, Greece, and Spain).

Figure 1 shows the great comparative advantage of Germany over the PIIGS, and particularly Greece, which is in the news as being in the most current trouble. Rescue packages include extreme austerity, an approach that the Greek people likely will protest mightily. So, the problem with these countries, plus Iceland and others, will continue. It is a drag on the euro, which has been weakening. George Soros feels that the euro is in trouble. And so is the pound. Meanwhile, the US stock market has a good recovery to the 1,140 area, with the VIX falling under 18 as of the first week of March 2010. Unemployment and the lack of new jobs is still a problem, as Figure 2 reminds us.

Figure 1: Unit labor costs eurozone. Source: Gartman (2010).

PIIGS and the US recovery

The Iceland financial crisis continues

The mouse that roared the country of 316,000 people in a hikers' and spa paradise seems to owe about $5.3 billion (3.9 billion euro) to some 400,000 Dutch and British investors, for losses incurred by Icesave, the online branch of the Reykjavik bank, Landsbanki. There is blame on both sides. The investors were greedy for the higher-than-market rates offered in Iceland, which were encouraged by the Icelandic bank. Indeed, short-term interest rates reached 16 percent in 2007–2008. Landsbanki collapsed in October 2008. Of course, the depositors forgot that extra return usually has extra risk, so the default is understandable.

While the Icelandic people consider themselves "proud people who wish to shoulder their obligations ... the commitments must be fair, reasonable and normal," according to Johanna Sigurdottir, the Icelandic prime minister. The British and Dutch governments have bailed out their greedy investors through each country's deposit guarantees and now want their money back. An issue is to lower the 5.5 percent interest rate. A referendum to pay some €48,000 per Icelandic household (or over £10,000 per person) was soundly rejected by over 90 percent of the people who voted. Since the deal would require each Icelander to pay about $135 per month for eight years (about 25 percent of an average four-member family salary), it is clear that the burden is too high and had to be rejected.

Iceland is part of Europe but not in the EU, which it would like to join; it needs the approval of the Dutch, along with that of the other 26 member states. Since Iceland vows to pay up, the result here likely is a slightly lower settlement price. This is another example of the government bailing out Wall Street, except that the money will go to pay the losses, not line the pockets of the Landsbanki executives, as was done in the USA. Fortunately, up to 90 percent of the money owed is collateralized through assets salvaged from

Figure 2: New jobless claims with four-week moving average. Source: Gartman (2010).

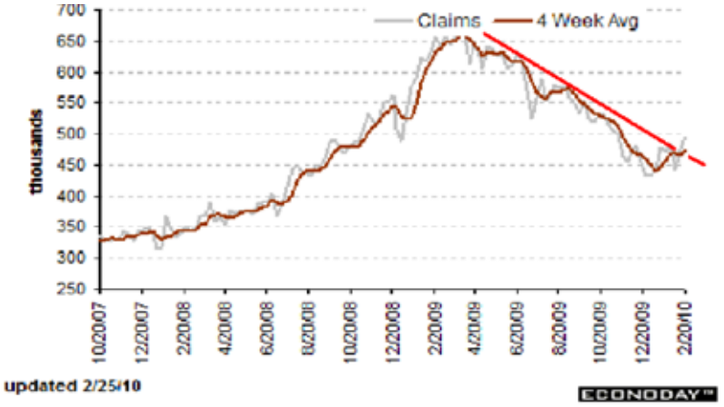


Table 1: Share of company own stock in 401(k) pension plans. Source: Updated from *The Economist*, December 15, 2001, p. 60

Company	Shares in own company as percent of 401(k) assets	Share price performance	
		2001, percent	2002, percent
Proctor & Gamble	94.7	–2.2	11.5
Pfizer	85.5	–12.3	–22.0
Coca Cola	81.5	–25.1	–5.5
General Electric	77.4	–23.3	–37.4
Enron	57.7	–99.1	–85.4
Texas Instruments	75.7	–34.5	–46.1
McDonald's	74.3	–22.1	–39.3
Ford	57.0	–28.9	–38.3
Qwest	53.0	–69.7	–64.6
AOL Time Warner	52.0	–8.1	–59.2

Landsbanki. But Britain and the Netherlands want Iceland to provide a sovereign guarantee to pay any shortfall. Meanwhile, the world's future banker, China, is interested in emerging sea routes through the Arctic to shorten trade routes, so this might help the Iceland economy (see Ward, 2010). But Russia is keen to keep Iceland out of the EU, as it regards Iceland as a fellow Arctic country.

The economic and political saga will continue. For more on Iceland as the crisis unfolded, see two chapters in Ziemba and Ziemba (2007). Ziemba and Ziemba looked into predicting this crash with the bond-stock model, and when the book went to press in late 2007, the model was close but quite in the danger zone, but it got there in 2008, well before the actual collapse. Before the financial crisis of fall 2008 hit Iceland, the stock market capitalization was about 120 percent of the country's GDP; now it is 20 percent.

Stock ownership decisions in defined-contribution pension plans[1]

It is surprising how much of the average DC company pension plan has been invested in own-company stock. In late 2001, Enron collapsed and their stock fell 99 percent, from $90 to under a dollar, and employees lost their jobs and also lost most of their pensions. There is considerable risk in having a pension fund largely in one asset, and the risk is even larger if that asset is also correlated with one's income. Enron employees lost over a billion dollars, some 60 percent of their 401(k) pension. This is a classic example of overbetting, lack of diversification, and being hit by a bad scenario.

Table 1 shows that, for many major companies, own-company stock has been a very high percent of 401(k) plans. The stock price moves in 2001 and 2002 show how big short-term losses can be.

Mitchell and Utkus (2002) observe that there are about five million 401(k) plan participants that hold 60 percent of their assets in company stock, but those that do generally have large amounts. In total, company stock is about 19 percent of assets. But for those who have any company stock, it is 29 percent. Employees have a lower percentage of stock, 22 percent, when they have free choice, versus 53 percent when the company decides.

Why do companies and employees invest so much of their own company stock in their pensions? Companies can either purchase shares in the open market, as some, like Microsoft, do, or they can issue shares just like options to key employees, slightly diluting their stock price, which is economical for the company. In the words of *The Economist* (December 15, 2001, p. 60):

> Employees who invest in their company's shares solve two problems, in theory. They resolve the issue of agency costs that arises between shareholders and the people hired to work on their behalf. And they reap the benefits of capital appreciation, a fundamental component of capitalism. The results can be spectacular; America is filled with tales of people who held jobs as cash-register clerks at Wal-Mart, or on the diaper-making line at Procter & Gamble, who survived on their wages but have made fortunes through steady accumulation of company stock in retirement plans.

There are many other spectacular positive examples such as Microsoft, Intel, and Nokia.

Employees can frequently purchase own-company shares at a discount to current market price or acquire the shares through options given for free. Also, there is the pressure of corporate culture. I saw that in Japan, while there in 1988–1989, where employees of the Yamaichi Research Institute were obliged by moral suasion and peer pressure to buy Yamaichi Security stock, which later went bankrupt in 1995. Enron has refocused this risk, which has been around for a long time.

Mitchell and Utkus (2002) remind us how volatility destroys wealth. They consider three workers who earn $50,000 per year and contribute 10 percent to a 401(k) fund, with contributions and inflation at 3 percent per year. The stock market index and company stock are assumed to return 10 percent per year, with annual standard deviations of 20 percent and 40 percent, respectively. After 30 years, the median employee who invested 100 percent in the market index had $830,000; with 50–50 splits, it was $615,000; and with 100

percent in company stock, it was $411,000. This is because of the geometric–arithmetic inequality caused by the volatility: gaining 50 percent and then losing 50 percent does not make one even; 100 becomes 75, with a rate of return of −13.4 percent. The greater the volatility, the lower the geometric mean, which determines long-run wealth gains, for a constant arithmetic mean.

What is the real risk of the own stock and job risk concentration? Douglass, Wu, and Ziemba (DWZ) (2004) have estimated this using mean-variance and stochastic programming assets-only models.

DWZ consider the following situation: an investor chooses between the market index (S&P 500), a bond index (Lehman Brothers US aggregate), cash, and own-company stock. The parameter assumptions, estimated from 1985 to 2002 monthly data from Datastream, mirror long-run stock, bond, and cash returns from Dimson et al. (2009) and Siegel (2008). Yearly mean returns are 1.10, 1.05, 1.00, and 1.125 for these four assets, respectively. Standard deviations are 0.20, 0.04, 0.01, and 0.50 and the covariance matrix is:

$$\begin{bmatrix} 1.000 & 0.750 & 0.058 & 0.500 \\ 0.750 & 1.000 & 0.250 & 0.550 \\ 0.058 & 0.250 & 1.000 & 0.029 \\ 0.500 & 0.550 & 0.029 & 1.000 \end{bmatrix}$$

These assumptions have mean returns relative to cash, and higher expected returns, but with much higher volatility for own-company stock (two and a half times the S&P 500, which is typical for midcap equities). Figure 3 shows the results from the mean-variance model as a function of investor risk aversion with (3b) and without (3a) company stock and as a function of company stock mean return (3c). The shaded regions indicate portfolio weights (left-hand scale). The diamonds indicate the expected return of the optimal portfolios. When Arrow–Pratt absolute risk aversion is 8, there is a 60 percent stock, 40 percent bond mix.

Figure 3: Mean-variance model. The optimal portfolios as a function of risk aversion (a,b) and expected return on company stock (c). Shaded regions indicate portfolio weights (left-hand scale). The line represents the expected return on the optimal portfolio (right-hand scale). Diamonds indicate values of the independent variable for which calculations were made. Results for the three-asset case, with no own-company stock, are in (a). Results for the four-asset case are in (b) and (c). Source: Douglass, Wu, and Ziemba (2004)

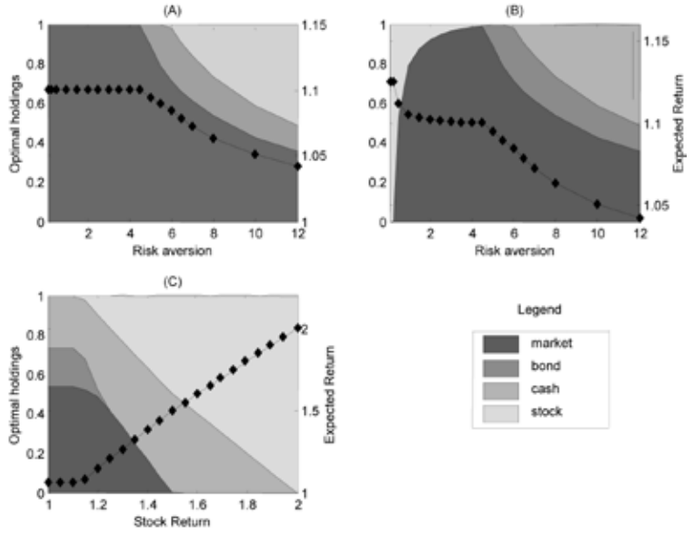
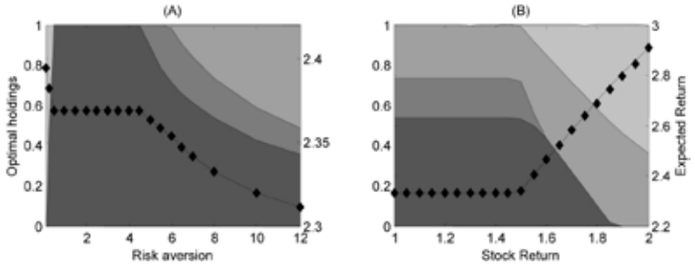


Figure 4: Results of the mean-variance model when human capital is modeled as an untradeable asset. Optimal portfolio properties are plotted as a function of risk aversion (a) and expected return on company stock (b). Shaded regions indicate portfolio weights (left-hand scale). The line represents the expected return on the optimal portfolio (right-hand scale). Diamonds indicate the values of the independent variable for which calculations were performed. Plots are interpolated between calculated points. Source: Douglass, Wu, and Ziemba (2004)



This optimal portfolio has no own-company stock holdings. Hence, without trading constraints, it is not optimal with a risk aversion of 8 to hold own-company stock. However, for investors with trading constraints, such as the inability to short sell, owning some company stock can be optimal. Company stock appears as an optimal portfolio choice if the investor's risk aversion is very low or their expected return for the stock is high. Notice, again, how important it is to get the mean right. At a risk aversion of 5, the short-selling constraint becomes binding and the optimal portfolio begins to shift to the riskier stock investment (Figure 3b). To obtain company stock holdings above 50 percent, as observed in Table 1, requires a risk aversion parameter below 0.5. Alternatively, a company stock holding of 50 percent is obtained if the employee is presumed to have an expected return for company stock of over 50 percent (Figure 3c). Own-company stock begins to enter when its mean return approaches 20 percent – that is, double the S&P 500. The expected return of own-company stock must be over 50 percent or five times the S&P 500 for the optimal allocation of own-company stock to reach 50 percent.

Our results demonstrate that the short-selling constraint is not sufficient to overcome the additional risk associated with owning company stock. High company stock weightings can only be explained by some combination of low risk aversion and/or high return expectations for company stock. These results hold with or without including extreme events. The inclusion of labor income risk in the models further reduces the optimal holding in company stock.

Figure 4 shows the results of the mean-variance model when human capital is modeled as an untradeable asset.

This analysis assumes that all employee wealth is contained in the company pension plan. This assumption is reasonable, considering that many North Americans save little beyond what enters their tax-sheltered accounts. However, Figure 3b shows the proportion of wealth that would have to be held outside the plan in order to support a 50 percent own-stock holding within the plan. An employee with a risk aversion of 8 who has 50 percent of their pension plan in their own company stock would have to have 50 percent of their retirement savings outside the company plan.

The difference between mean-variance and stochastic programming:

1. The mean-variance approach relies on distributional assumptions that must be relaxed to study the portfolio choice problem for pension plan investors.

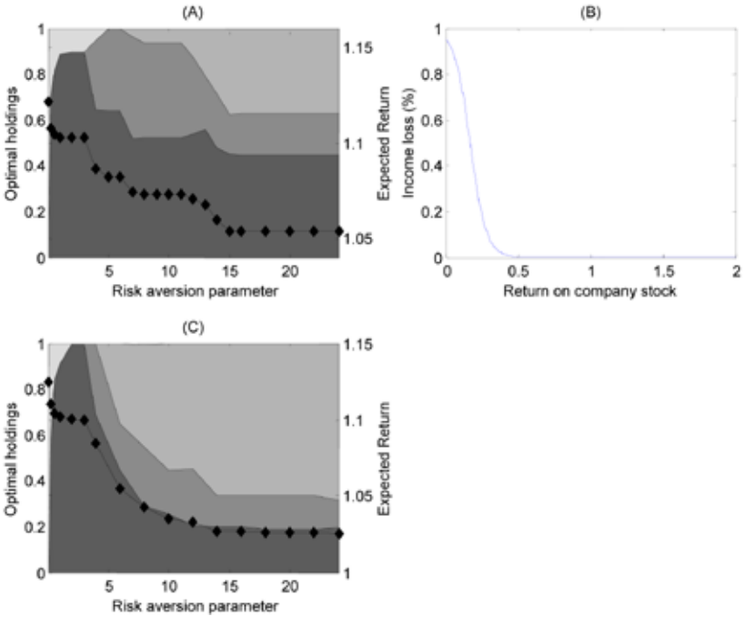
- The normal distribution does not fit stock returns well in the tails, particularly returns sampled at quarterly or greater frequency. This is especially true for individual stocks.
- The probability that an individual stock will experience an extreme negative event, such as bankruptcy, is greater than is predicted by a best-fitting normal distribution.
- Human capital can only be included in a mean-variance model as an asset that follows the same distributional assumptions as the financial assets.
- The mean-variance model assumes static holdings throughout the life of the portfolio. For pension plans that are held on the order of decades, such trading constraints are unrealistic.

2. An alternative that DWZ has developed is a discrete-time stochastic optimization model of the employee's investment problem, which is a static one-period version of the Geyer-Ziemba (2008) model.

- The employee's concave utility is the expected discounted value of terminal wealth minus a shortfall penalty.
- Concavity of the utility function is obtained with piecewise linear convex shortfall penalties.
- The problem is equivalent to a large linear program for computational purposes.
- To obtain results comparable to the mean-variance model, the penalty function is constructed to approximate a quadratic in the shortfall.
- The expected penalty is approximately half the variance when the expected return on the optimal portfolio equals the wealth target.
- A judicious choice of target wealth minimizes the difference between the two solutions.

The stochastic programming model is similar to a static one-period version of Geyer and Ziemba (2008). The decision variables are the purchases and sales of each of the assets in each scenario. The investor chooses an asset allocation at time 0, and receives investment proceeds at time 1, which is a risk measure. The static stochastic programming problem is

Figure 5: Solution of the employee's problem formulated as stochastic program. Figure (a) correponds to the base case discussed in the text. Portfolio properties obtained when human capital returns are modeled as a logit function of wealth are plotted in (c). The logit function used in the model is plotted in (b). In (a) and (c), portfolio weights (shaded regions/right-hand scale) and expected return on the optimal portfolio (line/right-hand scale) are plotted as a function of the risk aversion parameter, λ. The plots are interpolated between values indicated by diamonds. In (b), the probability of job retention is plotted *versus* company stock return. Source: Douglass, Wu, and Ziemba (2004)



$$\max\ E\left[\sum_{i=1}^{N} W_{i1} - \lambda c(M)\right],$$

where W_{it} is wealth in asset i at time t. λ is a coefficient of risk aversion, and $c(M)$ is a convex function (risk measure) of the wealth shortfall, at time 1. At time zero, the investor faces N balance constraints and a budget constraint

$$\begin{aligned} W_{i0} - P_{i0} + S_{i0} &= E_i, \qquad i = 1, \cdots, N, \\ \sum_{i=1}^{N} [P_{i0}(1+t) - S_{i0}(1-t)] &= 0. \end{aligned}$$

The *Ei* are endowments of each asset. P_i and S_i are purchases and sales, respectively, of asset *i*, and *t* represents transaction costs. The time 1 constraints are

$$\begin{aligned} W_{i1} &= W_{i0}R_i, \qquad i = 1, \cdots, N, \\ \sum_{i=1}^{N} W_{i1} + M &\geq \bar{W}_t, \end{aligned}$$

where $\bar{W}_t$ are the thresholds for determining wealth shortfalls, and the R_i are the realized returns.

Approximation of return distributions is a significant challenge in stochastic programming. The solution of this problem requires a means of approximating the expectations that appear in the objective function. The usual method is to perform a discrete approximation to the integral, by replacing a continuous multivariate distribution with a discrete distribution. For multiperiod problems, the discrete distribution takes the form of a scenario tree (see Douglas, Wu, and Ziemba (2004) for the solution method used with pseudo-random sequences).

Figure 5 shows the results of the stochastic programming model. Here, the employee's íncome is a function of the own-company stock price.

Portfolio decisions for the base scenario are plotted in Figure 5a. The overall pattern of the solution is similar to that obtained by mean variance. Since mean variance penalizes excess returns as well as losses, mean-variance solutions for risk aversion equal to R_A will correspond to mean-shortfall solutions with penalty parameter, $\lambda = 2R_A$. In both cases, company stock disappears from the portfolio completely for risk aversions above 5.

Discussion of the results

- Various risk factors that dictate against the holding of company stock have led most previous studies to presume that employee investment decisions are the result of behavior that is inconsistent with rational portfolio choice.
- Employers, as plan fiduciaries, may be in a position to influence employee decisions and steer them towards company stock (Mitchell and Utkus, 2002).
- Employees may interpret the channeling of employer contributions into company stock as an endorsement of that investment (Mitchell and Utkus, 2002).
- Alternatively, employees may choose company stock simply because it is a listed investment option. Benartzi and Thaler (2001) found that many DC plan investors follow some version of the 1/n strategy – that is, they divide their contributions evenly across plan offerings.
- In addition, employees may be myopic when evaluating the risk of company stock. John Hancock (2001), in a survey of DC plan participants during a period of stock market growth, reported that DC plan participants rated company stock as less risky than an equity mutual fund.
- Other factors, such as loyalty and peer pressure considerations, may also influence employee investment decisions.
- Trading constraints have also been discussed as explanations for high company stock holdings.
- Many companies that match contributions to pension plans deposit company stock.
- Often, an employee is restricted from trading this stock.
- However, our interest is in exploring potential explanations for extremely high company stock weights.
- In most cases, any minimum holding constraint for company stock is not binding. Employees hold more company stock than they have to (Mitchell and Utkus, 2002).
- The results reinforce the conclusion that large holdings of company stock in pension accounts cannot be explained by traditional models of rational portfolio choice.
- Hence, explanation of the exceptionally high observed holdings continues to rely on behavioral factors.
- The problem with behavioral explanations of company stock holdings is that they presuppose some ignorance on the part of the employee or an ability of the employer to dupe the employee.
- However, large holding in company stock is a phenomenon that has persisted for decades.
- Employees appear to have been making the same errors in their portfolio choices for a long time.
- One would expect the irrationality of employee choices to lessen over time as employees learn from previous actions and consequences.
- This leads us to suspect that there are other factors that need to be included in rational choice models to explain company stock holdings.

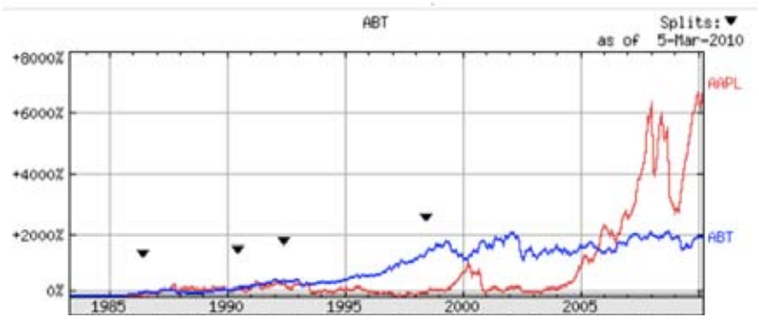
Grace Groner's legacy: A good long-term buy and hold own-company stock story

There are many examples of people who bought stock cheap, held it for a long time, and reaped huge returns in the end, with the equity version of compound interest being a major factor. Claude Shannon, the great information theorist who influenced Kelly of the Kelly criterion and worked with Ed Thorp, made 28 percent over a long period by largely investing in a few big winners.

Grace Groner was orphaned at age 12. She graduated from Lake Forest College in Illinois in 1931, having been sponsored by George Abbott, a friend of Groner's parents who raised Grace and her twin sister Gladys. She worked as a secretary at Abbott Labs for 43 years. In 1935, she bought three shares in this company for $60 each. She lived a frugal life. She had lived in an apartment until a friend willed her a tiny house in a part of town once reserved for servants on Chicago's North Shore. She did not own a car, and walked to where she wanted to go. She traveled widely in her retirement and donated $180,000 to a scholarship program at Lake Forest (see Keilman (2010)).

As the stock gave dividends, she reinvested in more stock, and there were many stock splits (see Figure 6 for these since 1985). When she died at the age of 100 in January 2010, the stock was worth $7 million, for a geometric rate of return of 15.13 percent over the 75 years that she held the stock. The taxes she paid on the capital gains are unknown. Abbott stock made its big gains

Figure 6: Abbott share value compared with Apple, 1985–2010. Source: Yahoo Finance



well before 2000 and has been flat since then. Had she switched out of Abbott (ABT) into Apple (AAPL) around 2005, she would have had a full Kelly-type wild ride and gotten a Buffett-style high final wealth, as shown in Figure 6. This compares favorably with the best mutual funds over the past 45 years. Fidelity Magellan has returned 16.3 percent and the Templeton growth fund 13.4 percent, according to Morningstar, versus 9.3 percent for the S&P 500. Meanwhile, Warren Buffett running Berkshire Hathaway made 22 percent since 1965, based on market price, and 20.3 percent, based on book value, Buffett's preferred way to measure growth (see Mamudi (2010)). Siegel (2008) showed that Philip Morris returned about 15 percent over a similar but slightly shorter long period, outdistancing essentially all other stocks.

Grace Groner donated this money to the college to be used by students for internships and to study abroad. Her house is now used by students.

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FOOTNOTE

1. Parts of this are adapted from Bertocchi et al. (2010).