Portable Alphas from Pension Mispricing*

Francesco Franzoni
H.E.C. School of Management
José M. Marín
Universitat Pompeu Fabra and CREA

April 19, 2006

Abstract

We introduce a new dynamic trading strategy based on the systematic mispricing of U.S. companies sponsoring Defined Benefit pension plans. This portfolio produces an average return of 1.51% monthly between 1989 and 2004, with a Sharpe Ratio of 0.26. The returns of the strategy are not explained by those of primary assets. These returns are not related to those of benchmarks in the alternative investments industry either. Hence, we are in the presence of a "pure alpha" strategy that can be ported into a large variety of portfolios to significantly enhance their performance.

Journal of Economic Literature Classification Numbers: D8, G11, G12, G14
Keywords: Defined Benefit Plans, Portable Alpha, Enhanced Indexing, Pension Contributions, Pricing Anomaly.

Francesco Franzoni: Department of Finance, HEC School of Management, 1 rue de la Liberation, Jouy en Josas, 78351, France; *José M. Marín*: Department of Economics and Business, Universitat Pompeu Fabra (UPF), and CREA, c. R. Trias Fargas 25-27, Barcelona, 08005, Spain. F. Franzoni is also a member of GREGHEC, CNRS unit, FRE 2810. J. M. Marín acknowledges financial support from the Spanish Ministry of Science and Technology (BEC2002-00429 Grant) and from the BBVA Foundation.

In the last few years, the funding status of Defined Benefit (DB) pension plans in corporate America has attracted the attention of practitioners, politicians, and the media. The combination of a bear stock market and record low levels of interest rates during the first two years of the new millennium resulted in an unprecedented deterioration of the funding status of DB plans. This fact caused several research department in the securities industry to raise a red flag over the correct valuation of the sponsoring companies. Many firms faced pension liabilities, even pension shortfalls, that exceeded by far their market capitalization.[1] The intervention of the Pension Benefit Guarantee Corporation (PBGC) taking over the pension plans of US Airways and, more recently, United Airlines, has triggered the President's plan for pension reform, released on January 10th. The latest figures available still point to a large exposure of American companies to pension liabilities. For instance, pension plan assets for the companies reported in Compustat totalled about $1.75 trillion at the end of 2003. This figure is still short some $464 billion of the about $2.2 trillion represented by the total pension obligations.

In this article, we introduce a successful dynamic trading strategy based on the systematic mispricing of companies sponsoring DB plans. More specifically, the strategy draws on the pricing anomaly identified in Franzoni and Marin (2005) and it is not the result of data mining or manipulating tricks that enhance the performance of risk-reward measures.[2] These authors provide robust evidence of significant overpricing of companies that sponsor defined benefit (DB) pension plans running large pension shortfalls. They argue that it is hard to relate this mispricing to any of the known sources of economic risk. In the present article, we provide new insights on the economic principles behind the mispricing and capitalize on them to build our Pension

[1] The cases of AMR Corp and Delta Airlines Inc are just the tip of an iceberg that includes a large list of companies (for instance, see Zion and Carcache (2002)).

[2] For instance, the strategy does not rely on the the use of option like strategies to exhibit superior performance in "normal times" (say rolling over short positions on deep out of the money put options on some market index) or to "cut" the upper and lower tail of the distribution of the portfolio to increase the Sharpe Ratio (see, Goetzman et al. (2003)).

Plan Underfunding (PPU) trading strategy.

Figure 1 provides a first approximation to the outstanding performance of the strategy for the period from July 1989 to December 2004. The figure reports the cumulative monthly returns of a version of the strategy that is neutral to the three Fama and French (1993) factors. As we can appreciate, the strategy beats not only its natural benchmarks (LIBOR and bond returns) but also the S&P 500 and the HFR funds of hedge funds index. Furthermore, the strategy performs reasonably well during the turbulent market period of 2000-2002. Even more striking, it offers outstanding performance during the period 2002-2004, a dull time in the hedge fund industry. This graphic overview already suggests that we are in the presence of a true active constituent in many "portable alpha" strategies, a point that we formally explore below.

[Insert Figure 1 here]

In order to understand the economics behind the success of the strategy we first turn to a brief overview of the DB pension plan system.

1 DB Pension Plan Elements

In a DB pension plan, the sponsoring firm commits to provide retirement benefits to employees according to a formula that takes into account the employee's years of service and the present and future salaries. The sponsoring firm must make financial contributions over time according to legally specified formulas. These contributions are invested in assets at the sole discretion of the employer. Hence, at each point in time a company sponsoring a DB pension plan faces a financial *liability*, which is equal to the present value of the retirement benefits, and holds a portfolio of *assets* dedicated to the plan. When the market value of the pension assets is less than the value of the liability the pension plan is "underfunded"; otherwise the plan is "overfunded". By extension, we will refer to under- or overfunded firms. The funding status of each plan sponsored by an emplyer is reported annually in IRS Form 5500 and the aggregate funding status

of the sponsoring firms is reported annually in the footnotes of the company financial statements (SEC 10-K filing).

The funding status of DB plans affects corporate earnings and cashflows via mandatory contributions and amortization rules. For our purposes, and for the sake of brevity, it is enough to provide a broad description of how mandatory contributions affect cashflows.[3] Companies with overfunded pension plans are not required to make contributions. Companies running underfunded plans must contribute an amount equal to the larger of two components: the minimum funding contribution and the deficit reduction requirement. The first one is defined as the previous year 'normal cost' of the plan (i.e., the present value of pension benefits accrued during the period) plus the unfunded obligation amortized over a period of five to thirty years. The deficit reduction requirement imposes the full amortization of the underfunding during three to five years and sets the fraction that must be contributed during the first year according to the formula $min\{0.30, [0.30 - 0.25 * (funding\ status - 0.35)]\}$, where funding status is defined as plan liabilities over plan assets.[4] A firm running an underfunded plan can waive the contribution if the ratio of assets to liabilities in the plan is above 80% in the current year and was more than 90% for the past two years. As a consequence, a company running very large underfundings for a few years in a row cannot abstain from making the contributions.

We argue that this feature of the regulatory environment is at the basis of the success of our strategy. In particular, the regulatory environment generates the possibility of forecasting an important component of future cashflows using the company's funding history information. We exploit the role played by the mandatory deficit reduction contribution for companies that cannot avoid transfering money to the fund. This contribution can be as large as 30% of the shortfall for plans that did not experience shortfalls in the past, but can be even larger in the case of plans that have run

[3]We focus on the legal framework applicable during the period our study covers; in particular, on the rules set by the Pension Protection Act of 1987.

[4]The Retirement Protection Act of 1994 changed the deficit reduction rules in a way that the first year deficit-reduction is equal to $min\{0.30, [0.30 - 0.40 * (funding\ status - 0.60)]\}$.

underfundings for a few consecutive years.

2 A Theory of DB Companies Mispricing

Franzoni and Marin (2005) provide evidence of significant overpricing of companies experiencing large deficits in their DB pension plans and argue that the mispricing is not related to risk. In particular, the authors find alphas around -10.6% annually for the decile portfolio of most underfunded companies, in the context of the most widely accepted asset pricing models (i.e., controlling for the three Fama and French (1993) factors). In contrast, they find no evidence of mispricing in the case of overfunded companies. What are the economic principles behind this type of asymmetric mispricing? They propose a theory of the mispricing based on two basic assumptions: investors misperceptions and corporate management short-termism.

Since the mispricing is not related to risk, it must be the case that financial analysts, or investors in general, do miss some important information contained in the companies' funding status either because they do not pay enough attention to this type of information or because they are unable to correctly interpret it.[5] Hence, investors learn about this information when contributions hit the company's earnings and cashflows. Moreover, given the institutional framework described above, in the presence of corporate management short-termism[6], we should expect the managers of firms running pension deficits to delay as much as possible the recognition of the shortfall in cashflows and earnings. This can be done by contributing and amortizing the smallest allowable amount in the short term and hope for reversals in funding status in the long run. Hence, these companies will tend to be overpriced (as the current price does not adjust to the new liability the company faces). Later on, when the funding situation

[5]There is a generalized view that rules that regulate the incorporation of pension elements into income statements of the sponsoring firm and the mandatory contributions in case of shortfalls are too complex (for instance see, Zion and Carcache (2002)) and too vulnerable to management manipulation (Bergstresser et al. (2005)).

[6]For evidence on opportunistic behavior by managers of DB companies see, for instance, Bergstresser et al. (2005); for an analysis of management short-termism in general, see Stein (1989) .

does not improve and managers are compelled to reduce earnings and cashflows, investors are surprised and prices adjust downwards. On the other hand, we conjecture that companies running pension surpluses behave in the opposite way, using the overfundings to bust earnings and cashflows as soon as they arise. Because earnings and cashflows adjust immediately, we do not expect these companies to be mispriced.

3 PPU Strategies

In Franzoni and Marin (2005), the underpriced porfolio is obtained by selecting the most underfunded companies at each portfolio formation date. If the driving force of these results is the one we expose above, then we should be able to increase the size of the overpricing by identifying companies prone to experience the largest cashflow corrections in the period after portfolio formation. These firms are not necessarily the same as those facing the largest shortfalls. This is the basic philosophy behind our PPU strategy and what represents the departure from Franzoni and Marin (2005): select companies facing the largest expected cashflows corrections in the near term due to their funding history, rather than firms running large pension deficits in the most recent fiscal year.

Given the institutional setting described above, one simple way of achieving this goal is to select companies that have experienced large pension shortfalls for several consecutive years. For these companies, corporate managers can no longer delay the impact of mandatory contributions on cashflows. Accordingly, prices adjust within the year after portfolio formation. This simple forecasting rule is enough to form portfolios of underfunded companies that exhibit alphas of about -15.4% annually with respect to the Fama and French (1993) model. In other words, we are able to increase the mispricing reported in Franzoni and Marin (2005) by almost 50%.

We now turn to the description of the strategies in more detail and to the assessment of their performance.

3.1 First Building Block: The Overpriced Portfolio

As in Franzoni and Marin (2005) we define a firm's funding ratio for year t as:

$$FR_t = \frac{FVPA_t - PBO_t}{Mkt\ Cap_t},$$

where:

- *FVPA* represents the market value of the assets (stocks, bonds, and other investments) that are set aside and restricted (usually in a trust) to pay benefits when due.

- *PBO* represents the actuarial present value of vested and nonvested benefits earned by an employee for service rendered to date plus projected benefits attributable to salary increases.

- *Market Cap* is the company's market capitalization in December of the calendar year when the pension items are measured.

Thus, the variable FR_t measures the aggregate funding status of a company over all its pension plans relative to a measure of its size, that is, market capitalization. The pension data items can be obtained from Compustat.

In July of year t, we construct a value weighted portfolio of underfunded companies with high expected cashflows corrections due to pension shortfalls. We choose July to make sure that all the necessary information for the construction is public. By that date, the accounting data, where the company funding status is reported, should be publicly available. This portfolio is composed of the companies in the bottom quintile of the distribution of FR_{t-1}, conditional on those companies that displayed a negative value of FR in years $t-1$, $t-2$, $t-3$ and $t-4$. Hence, the portfolio includes the most highly underfunded stocks in year $t-1$ among those that have run four consecutive years of underfunded pension plans. This feature is intended to capture those companies that cannot waive the contributions to the pension plans. Portfolios are reformed each year to obtain the time series of monthly returns of the strategy. The average number of

stocks in this portfolio for the period between July 1984 and December 2004 is about seventy-two.[7]

We provide evidence of the mispricing of this portfolio with respect to three different models: a one-factor model (CAPM), the Fama-French three-factor model, and a four-factor model composed of the Fama-French three factors plus a momentum factor.[8]

Table 1 reports the intercepts (alphas), factor loadings and R-squared from the time-series regression of portfolio excess returns (returns in excess of one-month T Bill rate) on three different set of factors between July 1984 and December 2004, according to the following regression:

$$R_{it} = \alpha_i + \beta_i factors_t + \varepsilon_{it}.$$

The factors are the excess return on the market value-weighted portfolio (Mkt-Rf), the return on a value factor (High-minus-Low Book-to-Market portfolio, HML), the return on a size factor (Small-minus-Big size portfolio, SMB), and the return on the momentum portfolio (return on past twelve months winners minus return on past twelve months losers, MOM).

In all cases reported in Table 1, the mispricing of our portfolio is more than 40% larger than the one identified in Franzoni and Marin (2005). For example, in the context of the three Fama-French factors, this portfolio produces a strikingly high alpha (in absolute terms) of 1.28% monthly (about 14.4% annually), compared to 0.89% monthly obtained in Franzoni and Marin (2005). Hence, the evidence presented in this table represents an extension of Franzoni and Marin's (2005) results concerning the mispricing of underfunded firms.

[Insert Table 1 here]

[7] More details on the constructions of the pension variables and the treatment of outliers are provided in Franzoni and Marin (2005).

[8] The factors data come from Prof. Ken French's website.

3.2 The PPU Strategy

The portfolio that we have just examined exhibits remarkable mispricing in the context of widely accepted asset pricing models but its returns are still sensitive to economic risks. In this section, we construct dynamic trading strategies based on this portfolio, in which those risks are hedged.

Since the strategy is based on equities, we first compute an equity-risk neutral version of the strategy. Following the standard procedure in the literature, we use the three Fama-French factors to summarize this risk. The resulting neutral strategy is the one we referred to at the beginning of this article and whose cumulative returns are reported in Figure 1.

In order to make the strategy neutral to the factors, we need to estimate the portfolio "betas" or factor loadings. To this purpose, using the returns on the porfolio examined in Table 1, we run time-series regression of portfolio excess return on the three factors over five years of monthly data. The sixty-month estimation window rolls forward by one month between July 1984 and December 2004. Then, each month between July 1989 and December 2004 we can construct a portfolio that is long in the three factors by an amount equal to the latest estimated betas and short in one unit of the portfolio considered in Table 1. The rest of the portfolio is invested in the risk free rate, that is, the one-month T bill rate. We label the resulting portfolio Pension Plan Underfunding (PPU) strategy. The returns on this strategy are neutral (on average) to equity risk, which is summarized by the three Fama-French risk factors.

Table 2 reports summary statistics on the monthly percent returns of this strategy, along with the returns of the S&P 500 and the HFR Funds of Funds Index. We choose these two benchmarks because the PPU strategy is equity based and, given its short position, it has the characteristics of a hedge fund. It is remarkable that not only does our strategy perform well in the bull market of the nineties, but also it earns positive returns in the bear market that followed. Furthermore, in the latest years, which have been notoriously disappointing for the hedge fund industry, the PPU strategy does not lose its vigor. For completeness, we have to say that the outstanding performance in

2001 is largely due to the extreme observation in September, when the strategy earned about 21.4%. It is possible that the crash that followed September 11 brought to a faster revelation of the mispricing of the firms sponsoring underfunded pension plans. Excluding September gives an average return in 2001 of 0.53% monthly, still higher than the two benchmarks, while the average return in the whole sample is largely unaffected, being 1.40%.

[Insert Table 2 here]

Table 2 also shows that the PPU strategy displays excess kurtosis. This kurtosis is, however, more than twice smaller than for the funds of funds index. Furthermore, the returns on the PPU strategy are positively skewed, unlike the returns on the S%P 500 and the hedge funds index. We postpone the normality tests to Section 4. For now, suffice it to say that those results legitimate us to proceed with mean-variance analysis.

Table 3 extends the comparison of the risk-return characteristics of the PPU strategy to other benchmark portfolios. In particular, we include the S&P 500 Index, the value factor (HML) and the size factor (SMB) to check that the strategy is neutral to U.S. equities; an index of global equities – the MSCI Global Equity Index (Gl. Eq.); two bond indices – the JP Morgan U.S. Bonds Index (U.S. B.) and the JP Morgan Global Bonds Index (Gl. B.); a hedge fund index – the HFR Funds of Funds Index; and a strategy that has received considerable attention in the last years, the momentum portfolio (MOM). All the series range from July 1989 to December 2004 (except for the HFR index that starts in January 1990). In terms of average returns, the strategy beats all the other portfolios, including the momentum strategy. The risk of the strategy is similar to the risk of the equity portfolios, hence, it is larger than the risk of the bonds and much larger than the risk of hedge funds. In terms of Sharpe Ratios, the strategy is only beaten by the index of funds of funds. This fact is expected, as in the index of hedge funds the idiosyncratic risks of many alpha strategies are diversified away, which results in a portfolio whose volatility must be smaller than that of individual alpha strategies. By construction, the strategy exhibits very low correlations with the S&P

and the value and size factors. This means the strategy can be ported into arbitrary equity benchmarks to create an equity based portable alpha strategy.

[Insert Table 3 here]

However, the strategy is positively correlated with bond returns and the momentum portfolio. Intuitively, a ceteris paribus decrease (increase) in interest rates generates a deterioration (improvement) in the pension status of a company, which in turn tends to increase (decrease) the return of our strategy, as well as the return of a portfolio of bonds. As for momentum, we notice that the PPU strategy is short in underfunded companies. Franzoni and Marin (2005) show that these companies experienced poor past operating performance and have earned negative returns in the recent past. Our strategy does well because these stocks display negative returns also in the period after portfolio formation. Hence, there is momentum in the PPU portfolio. Indeed, it is plausible that our sorting procedure, based on accounting data, partly overlaps with the sorting procedure in momentum strategies, which is entirely based on past returns.

The positive correlation with bonds and momentum questions the qualification of the PPU strategy as a "pure alpha" strategy, i.e. as an investment whose returns are not related to the performance of primary assets.[9]

To shed these concerns, we derive versions of our strategy that are immunized to these benchmarks and that preserve the outstanding performance of the original PPU strategy. In particular, we obtain the versions of the strategy that are neutral to bonds and momentum in addition to the three Fama-French factors. Relative to the original construction of the PPU strategy, we add an extra long position in the new assets (either the two bond indices or the momentum factor). The last two rows of Table 3 report the risk/return characteristics of these "super neutral" strategies (PPUb is bond neutral and PPUm is momentum neutral). Neutralizing the exposure to bonds reduces the monthly alpha by 17 basis points, from 1.51% to 1.34%. Neutralizing the momentum return is more costly, up to 32 monthly basis points. In both cases, the volatility of

[9]Strictly speaking the momentum strategy is not a primary asset. We include it here because the controversy on whether momentum is a proxy for some risk factor or an alpha is still open.

the strategy remains almost unchanged. The important fact, however, is that the two versions of the strategy beat many of the alternative asset classes included in Table 3 in terms of Sharpe Ratio. The evidence that we provide in the next section confirms that the actual correlation with bond returns or momentum is not high enough to denote the PPU strategy as a bond market style or a trend following style.

4 PPU as a "Portable Alpha" Strategy

The analysis conducted so far shows that the returns on the PPU strategy (either in its original version or in its "super-neutral" versions) are not strongly correlated with the returns of primary assets. This evidence, which is further explored in this section, suggests that the strategy is a pure alpha constituent in general portable alpha strategies.

First, we perform a style analysis using as benchmarks the asset classes that have been shown to capture most of the variation in mutual fund returns.[10] In particular, we follow Fung and Hsieh (1997) and choose eight indices: the MSCI U.S. Equity Index (US Eq); the MSCI non-U.S. Equity Index (Non-US Eq); the MSCI Emerging Markets Index (Em Mkt); the JP Morgan U.S. Bonds Index (US Bond); the JP Morgan non-U.S. Bonds Index (Non-US Bond); the one-month eurodollar deposit rate (1-Month ED); the gold price index (Gold); and the Federal Reserve's Trade Weighted Dollar Index (US Dollar).

Table 4 reports the results from the regression of the PPU strategy (in the version which is immunized to the three Fama-French factors) on the eight benchmarks. We consider three samples. The longer sample coincides with the period of availability of the PPU returns. The two sub-periods have been chosen as in Fung and Hsieh (2004) to isolate two potential structural breaks in the market: the collapse of LTCM in September 1998 and the end of the Internet bubble in March 2001. In all samples, the explanatory power of the factors is very low, the adjusted R^2 never exceeding 6%.

[10] First introduced in Sharpe (1992) for the study of mutual funds performance, style analysis was later on extended in Fung and Hsieh (1997) to the case of hedge funds performance.

Also, none of the proposed benchmarks is statistically significant at conventional levels (the t-statistics are given in parentheses). The factor with the highest explanatory power is the U.S. Bonds Index, confirming the correlation of the PPU strategy with bond returns. Finally, in two regressions out of three, there is an economically and statistically significant intercept, testifying that the returns on the PPU strategy are largely unexplained by the conventional benchmarks.[11]

[Insert Table 4 here]

The eight factors used above work well for mutual funds, because the location choice, i.e. the choice of the asset class, is more relevant than the dynamic aspect of the trading strategy (see Fung and Hsieh (1997)). However, the PPU trading strategy is inherently dynamic and it involves short positions. These characteristics make it close to a hedge fund strategy. It is commonly believed that a style analysis of the type proposed by Sharpe (1992) is not suitable to describe the performance of actively managed portfolios such as hedge funds (see, for example, Brown and Goetzmann (1997) and Fung and Hsieh (1997)).

For this reason, we replicate the style analysis using a set of alternative benchmarks that have been found to capture the dynamic connotation of hedge fund strategies. These factors are the seven Asset Based Styles (ABS) identified by Fung and Hsieh (2004). There are two equity-oriented benchmarks: the S&P 500 index (S&P500) and a portfolio that captures the size risk, that is, the Wilshire 17500 index minus the Wilshire 750 index (SC-LC). Two factors describe the bond market: the month end-to-month end change in the Federal Reserve's ten-year constant maturity yield (10Y); and the month end-to-month end change in the difference between Moody's Baa yield and the Federal Reserve's ten-year constant maturity yield (Cred Spr). Finally, there are three factors that capture the returns of trend following managers: a portfolio

[11] The cause of the insignificant intercept in the later sub-period is the fact that the currency factor had a large negative realization, due to the U.S. Dollar depreciation. However, the lack of statistical significance of both the loading on the currency factor and the intercept cannot lead us to conclude that returns on the PPU strategy are explained by this factor.

of lookback straddles on bond futures (Bd Opt); a portfolio of lookback straddles on currency futures (FX Opt); and a portfolio of lookback straddles on commodity futures (Com Opt).

The results from the style analysis with these alternative benchmarks are reported in Table 5. In terms of explanatory power the ABS do not perform better than the standard benchmarks. Again, the R^2 is never higher than 6%. The only factor that has some statistical significance according to the t-statistics reported in parentheses is the size spread (SC-LC), but only in the overall sample. Further, the lack of significance of the bond market factors and of the trend following styles address the concern raised by the correlation of PPU returns with bond and momentum returns. Our trading strategy does not overlap with bond market or trend following styles. Finally, the large and significant intercepts confirm that the set of alternative benchmarks does not capture the performance of the PPU strategy.

[Insert Table 5 here]

Overall, the evidence in Tables 4 and 5 suggests that the PPU strategy, which is hedged against the risks in the three Fama-French factors, does not load on any source of risk among the ones that describe the performance of mutual and hedge funds. This finding contributes to characterize PPU returns as a portable alpha for standard and alternative investments.

Style analysis rules out linear dependence on the returns of benchmark portfolios. As a robustness check, we would like to make sure that the PPU strategy does not display a non-linear relationship with these factors, which is an important requirement for portability. To this purpose, we use the method developed in Fung and Hsieh (2005). The monthly returns on the eight standard benchmarks and the seven ABS factors are individually sorted from worst to best into quintiles. The average return for each quintile of the indices and the average of the corresponding months for the PPU returns are graphed in the same plot. Figure 2 contains the eight plots for the standard benchmarks and Figure 5 the corresponding plots for the seven alternative

factors. With a few exceptions, the prevalent pattern is a flat relationship between PPU returns and the benchmarks, which suggests a lack of non-linear dependence. The exceptions concern the bond market factors in the two sets of benchmarks. There is some positive (negative) correlation between bond returns (yields) and PPU returns. This finding was first revealed in Section 3. There, we show that a version of the PPU strategy that is neutral to bond risk factors still displays outstanding performance (see Table 3).

[Insert Figures 2 and 3 here]

Finally, to justify the mean-variance analysis of Section 3, we need to assess the normality of PPU returns. Indeed, based on statistical tests on the skewness and the kurtosis reported in Table 2, normality is rejected. However, excess kurtosis could be due to time-varying volatility. In such as a case, returns could still be normal and mean variance analysis would be justified. Hence, as in Fung and Hsieh (2005), we fit an AR(1) model to PPU returns and a GARCH(1,1) model to the conditional volatility. Then, we consider the distribution of the standardized residuals (that is, the residuals divided by the conditional volatility).[12] At first, it seems that normality is still rejected for the standardized residuals. However, a closer look allows us to identify September 2001 as the outlier, which is causing the excess kurtosis. As said above, in this anomalous month, PPU returns were extremely high (21.4%). Once we discard this admittedly unusual month, the excess kurtosis of the standardized residuals is 0.06, the skewness is 0.08, and normality is not rejected. We are then legitimated to evaluate the PPU strategy in terms of its mean-variance performance.

5 Concluding Remarks

In this article, we formally establish that the pension related mispricing identified in Franzoni and Marin (2005) can be magnified by at least 50% to achieve an annual alpha of about -15.4%. Moreover, we construct a hedged trading strategy that can be used in

[12] To save space, we do not report the estimated coefficients, but they are available upon request.

combination with a wide range of benchmarks to create portable alphas. In particular, our results can be employed to enhance indexing in equity and bond portfolios.

The combination of the actual institutional settings of Defined Benefit pension plans and corporate management short-termism drive the outstanding performance of the strategy. Because we do not expect major changes in these two elements during the next few years, we believe that the strategy, or some refined version of it, will continue performing well in the near future.

References

Bergstresser, D., Desai, M., and Rauh, J. (2005). Earnings manipulation, pension assumptions and managerial investment decisions. *The Journal of Finance*, forthcoming.

Brown, S. J. and Goetzmann, W. N. (1997). Mutual fund styles. *Journal of Financial Economics*, 43:373–399.

Fama, E. F. and French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33:3–56.

Franzoni, F. and Marin, J. (2005). Pension plan funding and stock market efficiency. *The Journal of Finance*, forthcoming.

Fung, W. and Hsieh, D. A. (1997). Empirical characteristics of dynamic trading strategies: The case of hedge funds. *Review of Financial Studies*, 10:275–302.

Fung, W. and Hsieh, D. A. (2004). Hedge fund benchmarks: A risk based approach. *Financial Analyst Journal*, 60:65–80.

Fung, W. and Hsieh, D. A. (2005). Extracting portable alphas from equity long-short hedge funds. *Journal of Investment Management*, forthcoming.

Goetzman, W., Ingersoll, J., Spiegel, M., and Welch, I. (2003). Sharpening sharpe ratios. Working Paper 02-08, Yale ICF.

Sharpe, W. (1992). Asset allocation: Management style and perfromance measurement. *Journal of Portfolio Management*, 18:7–19.

Stein, J. (1989). Efficient capital markets, inefficient firms: A model of myopic corporate behaviour. *Quarterly Journal of Economics*, 104:773–787.

Zion, D. and Carcache, B. (2002). The magic of pension accounting. Research report, Credit Suisse First Boston.

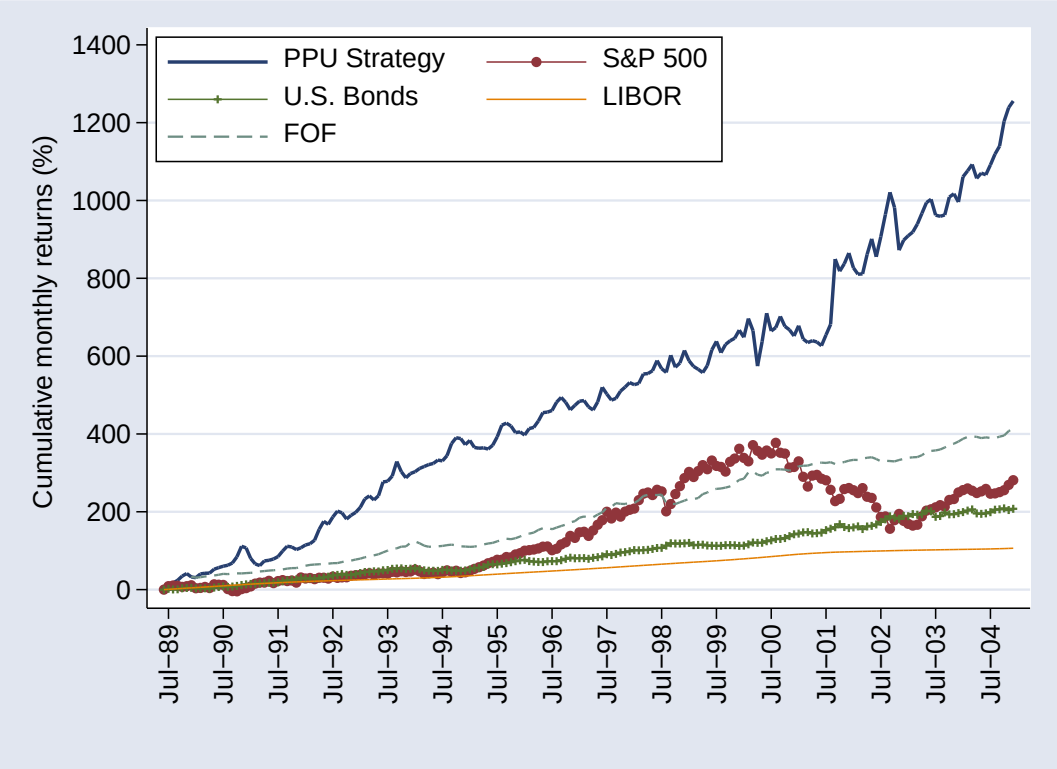

Figure 1: Cumulative returns

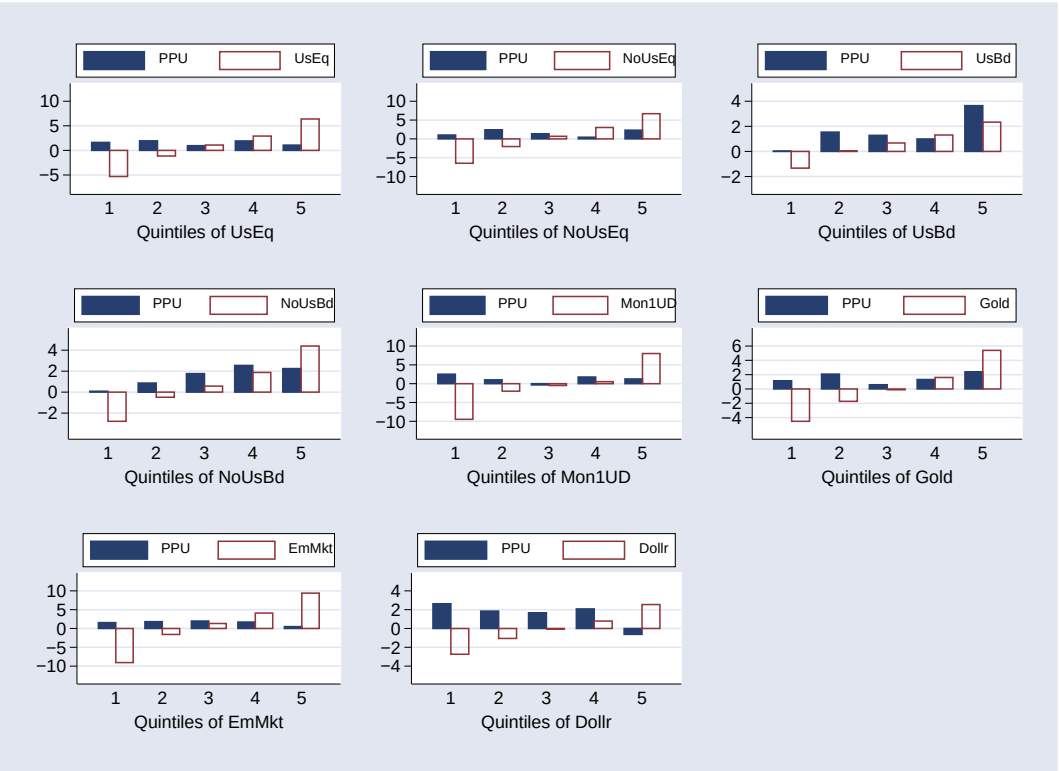

Figure 2: PPU by Quintiles of Standard Benchmarks

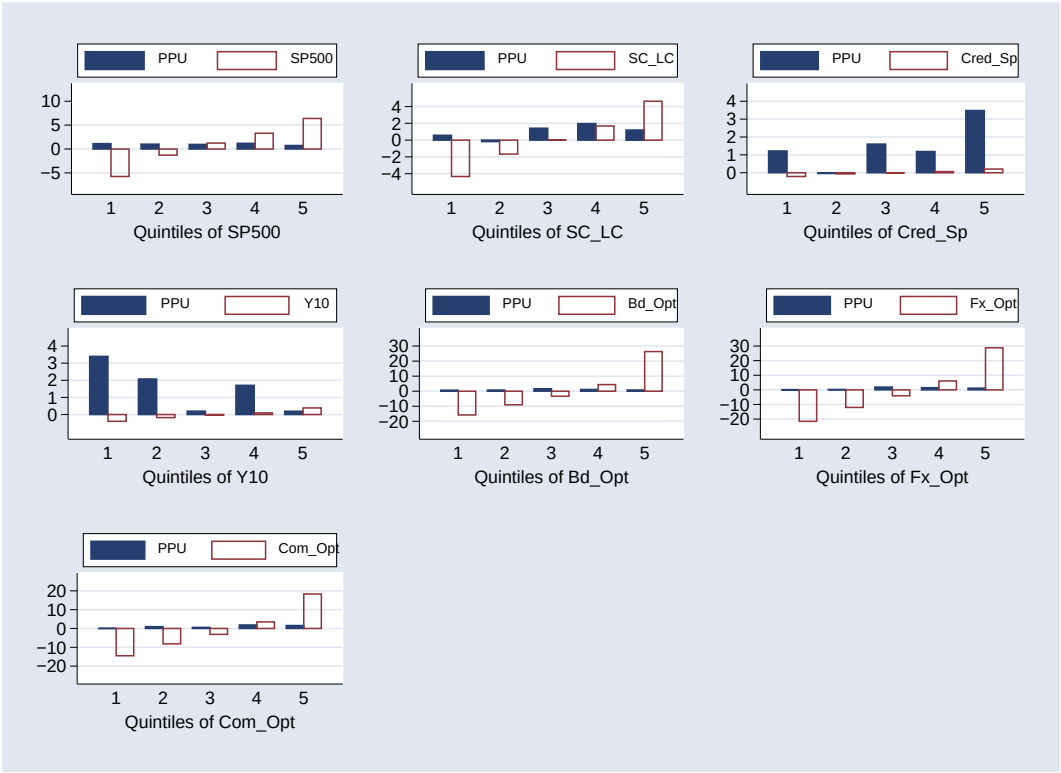

Figure 3: PPU by Quintiles of Alternative Benchmarks

Table 1: Alphas. The table reports alphas, factor loadings, and R^2 for the portfolio based on pension plan underfunding. The portfolio is formed in July of year t by value weighting the returns of companies that are in the first quintiles of the distribution of FR in year $t-1$, among the firms for which FR was negative in the years $t-1$, $t-2$, $t-3$, and $t-4$. The one-factor model includes the excess return on the market value-weighted portfolio from CRSP. The three-factor model includes Fama and French's (1993) three factors (the Market, HML, and SMB). The four-factor model includes Fama and French's (1993) three factors plus the momentum factor from Prof. Ken French's website. T-statistics are reported in parentheses.

	Alpha	Mkt-Rf	HML	SMB	MOM	R^2
1 Factor	-0.69	1.16				0.48
	(-1.99)	(15.29)				
3 Factors	-1.28	1.48	1.00	0.38		0.61
	(-4.12)	(19.10)	(8.64)	(4.02)		
4 Factors	-1.07	1.44	0.97	0.41	-0.20	0.62
	(-3.43)	(18.71)	(8.49)	(4.32)	(-3.11)	

Table 2: Annual Performance and Summary Statistics. The table reports average monthly returns for each year of data availability for the PPU strategy, S&P 500, and HFR Funds of Funds Index. The average, standard deviation, skeweness, and excess kurtosis are also reported for the whole sample. The sample ranges from July 1989 to December 2004, except for the HFR index, which starts in January 1990.

Year	PPU	S&P500	FoF
1989	4.99	1.84	NA
1990	3.90	-0.44	0.61
1991	0.19	2.06	0.90
1992	3.18	0.39	0.94
1993	2.56	0.58	1.83
1994	1.46	-0.09	-0.37
1995	0.60	2.49	0.97
1996	1.09	1.59	1.30
1997	0.85	2.37	1.34
1998	1.08	2.18	0.16
1999	0.63	1.56	1.27
2000	0.03	-0.78	0.61
2001	2.28	-1.01	0.42
2002	0.41	-2.03	0.09
2003	0.80	2.02	0.82
2004	1.81	0.74	0.58
Average	1.51	0.81	0.76
Std Dev	4.44	4.20	1.23
Skewness	0.41	-0.44	-0.92
Exc. Kurt.	2.68	0.62	6.30

Table 3: Performance Comparison. The table reports means, standard deviations (St. Dev.), Sharpe Ratios (S.R.) and correlations for the monthly percentage returns on the Pension Plan Underfunding (PPU) strategy and other portfolios. The other portfolios are: the S&P 500 Index, the Fama and French (1993) SMB and HML factors, the MSCI Global Equity Index, the JP Morgan U.S. Bonds Index, the JP Morgan Global Bonds Index, the HFR Fund of Funds Composite Index, and the momentum factor (MOM) from Prof. Ken French's website. We also include two super-neutral versions of the PPU strategy: the first one (PPUb) is neutral to the three Fama and French factors plus the two bond factors; the second one (PPUm) is neutral to the three Fama and French factors plus the momentum factor (MOM). The sample period is July 1989 to December 2004, except for the HFR index which is only available from January 1990.

				Correlations								
	Mean	St. Dev.	S. R.	PPU	S&P500	HML	SMB	Gl. Eq.	U.S. B.	Gl. B.	FoF	MOM
PPU	1.51	4.44	0.26	1.00								
S&P500	0.81	4.20	0.11	-0.02	1.00							
HML	0.33	3.51	0.09	-0.12	-0.43	1.00						
SMB	0.14	3.78	0.04	0.06	0.00	-0.44	1.00					
Gl. Eq.	0.56	4.29	0.05	0.01	0.82	-0.42	0.13	1.00				
U.S. B.	0.61	1.33	0.20	0.21	0.02	0.11	-0.18	-0.01	1.00			
Gl. B.	0.68	1.83	0.18	0.23	0.07	0.02	-0.13	0.22	0.65	1.00		
FoF	0.76	1.23	0.34	0.11	0.52	-0.30	0.40	0.53	0.09	-0.01	1.00	
MOM	0.95	4.93	0.19	0.28	-0.23	-0.06	0.11	-0.14	0.23	0.14	0.12	1.00
PPUb	1.34	4.47	0.22	0.97	-0.02	-0.14	0.03	-0.02	0.06	0.05	0.08	0.26
PPUm	1.19	4.44	0.19	0.97	0.02	-0.13	0.04	0.03	0.17	0.20	0.07	0.08

Table 4: Style Analysis: Standard Benchmarks. The table reports estimates of the intercept and slopes from the regression of the returns on the PPU strategy on eight benchmarks. The adjusted R^2 is also reported. The regression is performed on different samples, which are provided in the table. The eight factors are: the return on the MSCI U.S. Equity Index (US Eq); the return on the MSCI non-U.S. Equity Index (Non-US Eq); the return on the MSCI Emerging Markets Index (Em Mkt); the return on the JP Morgan U.S. Bonds Index (US Bond); the return on the JP Morgan non-U.S. Bonds Index (Non-US Bond); the return on the one-month eurodollar deposits (1-Month ED); the return computed from a gold price index (Gold); the return on the Federal Reserve's Trade Weighted Dollar Index (US Dollar). T-statistics are given in parentheses.

	Dep. Var.: PPU		
	Jul 89 - Dec 04	Jul 89 - Sep 98	Apr 02 - Dec 04
Intercept	1.23	1.72	0.45
	(3.19)	(3.11)	(0.62)
US Eq	0.04	0.08	0.25
	(0.39)	(0.52)	(0.68)
Non-US Eq	-0.06	-0.01	-0.46
	(-0.51)	(-0.11)	(-1.08)
Em Mkt	-0.03	-0.02	-0.04
	(-0.45)	(-0.21)	(-0.21)
US Bond	0.60	0.74	0.27
	(1.90)	(1.48)	(0.52)
Non-US Bond	-0.21	-0.52	-0.13
	(-0.56)	(-1.09)	(-0.15)
1-Month ED	-0.02	0.04	-0.08
	(-0.33)	(0.54)	(-0.93)
Gold	0.07	-0.04	0.22
	(0.74)	(-0.32)	(1.10)
US Dollar	-0.64	-1.07	-1.03
	(-1.38)	(-1.79)	(-0.89)
R^2	0.04	0.01	0.06

Table 5: Style Analysis: Alternative Benchmarks. The table reports estimates of the intercept and slopes from the regression of the returns on the PPU strategy on the Fung and Hsieh (2001) factors. The adjusted R^2 is also reported. The regression is performed on different samples, which are provided in the table. The seven factors are: the return on the S&P500 index (S&P); the return on the Wilshire 17500 index minus the return on the Wilshire 750 index (SC-LC); the month end-to-month end change in the Federal Reserve's ten-year constant maturity yield (10Y); the month end-to-month end change in the difference between Moody's Baa yield and the Federal Reserve's ten-year constant maturity yield (Cred Spr); the return on a portfolio of lookback straddles on bond futures (Bd Opt); the return on a portfolio of lookback straddles on currency futures (FX Opt); the return on a portfolio of lookback straddles on commodity futures (Com Opt). T-statistics are given in parentheses.

	Dep. Var.: PPU		
	Jan 94 - Dec 04	Jan 94 - Sep 98	Apr 02 - Dec 04
Intercept	1.02	1.07	1.35
	(3.04)	(2.74)	(2.00)
S&P500	0.00	0.13	0.09
	(-0.02)	(1.24)	(0.52)
SC-LC	0.23	0.24	-0.13
	(2.23)	(1.62)	(-0.55)
10Y	0.44	4.10	-3.10
	(0.27)	(1.90)	(-1.04)
Cred Spr	5.92	6.70	4.69
	(1.86)	(1.28)	(0.81)
Bd Opt	-0.01	-0.01	0.02
	(-0.37)	(-0.38)	(0.46)
FX Opt	0.00	0.01	-0.01
	(-0.05)	(0.75)	(-0.15)
Com Opt	0.04	0.00	0.09
	(1.27)	(0.08)	(1.48)
R^2	0.03	0.06	0.03